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# The Impact of Economic Policy Uncertainty on Industrial Output: The Regulatory Role of Technological Progress

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**Abstract:** Since the 2008 financial crisis, EPU has become an important issue for the stable and healthy development of the economy and society. The existing research has not analyzed the nonlinear impact of economic policy uncertainty (EPU) on output at the industrial level, and it has also ignored the regulatory role of technological progress in the impact of EPU on economic growth. Based on panel data of China's industry from 2005 to 2017, this paper makes an empirical analysis on the nonlinear impact of EPU on industry output. The results show that: (1) Different from the existing research, this paper finds that EPU has a significant inverted "U"-type nonlinear effect on industrial output, and when the EPU index is close to 221, this is best for output growth. This paper firstly finds that technological progress has a positive regulatory effect in the impact of EPU on industrial output. Technological progress can promote industrial output when EPU is low, and it can reduce the adverse impact of economic policy fluctuations when the EPU index is high. (2) The regulatory effect of technological progress only exists in the industries dominated by state-owned enterprises, and the impact of EPU on the output of non-state-owned enterprises' leading industries is greater than that of state-owned enterprises. (3) The impact of EPU on the output of cyclical industries shows a significant inverted "U" shape, but there is no regulatory effect of technological progress. Its impact on the output of noncyclical industries is not significant, but it will work together with technological progress. (4) The influence of EPU on the output of the tertiary industry is characterized by an inverted "U" shape, in which technological progress can play a positive regulatory role. However, its impact on the output of primary and secondary industries is not significant.

**Keywords:** economic policy uncertainty; technological progress; industry output; regulatory effect



**Citation:** Zhu, S.; Yu, G. The Impact of Economic Policy Uncertainty on Industrial Output: The Regulatory Role of Technological Progress. *Sustainability* **2022**, *14*, 10428. https://doi.org/10.3390/su141610428

Academic Editor: Marc A. Rosen

Received: 12 July 2022
Accepted: 17 August 2022
Published: 22 August 2022



## 1. Introduction

Economic policy uncertainty (EPU) refers to the uncertainty that the economic subject cannot accurately predict whether, when, and how the government will change the current economic policy [1]. The international environment affected by COVID-19 has become more complex, severe, and uncertain. EPU has turned into an important factor that is affecting the economic development of various countries. Promoting technological progress is the driving force for maintaining output growth, which is conducive to the optimization and upgrading of the economic structure and high-quality economic development. The technological progress of the industry undoubtedly promotes the overall technological progress. For a long time, how to improve industrial technological progress has been an important issue in the field of output growth. China's economy has entered a new stage of development. Improving technological progress has become the key to promoting high-quality economic development. The report of the 19th National Congress of the Communist Party of China also puts forward the urgent requirement to improve the total factor productivity.

The Chinese government dominates the allocation of important resources, especially when the economic environment deteriorates, and the government's decisions have played a very important role in the economic operation. In order to maintain the development of different industries, various administrative departments have also formulated many industrial policies. Once the policy changes, different industries will size up the situation and dynamically adjust their production and business activities, which will affect the output of the industry. When facing the impact of common macroeconomic policies, different types of industries may also have different performances due to industry differences. Although there are relatively abundant studies on how EPU will affect the macroeconomy, there are few and scattered studies that refer to the impact of EPU on output from the perspective of industry. In particular, the existing studies do not consider the regulatory role of technological progress in the impact of EPU on industry output. Therefore, this paper attempts to conduct in-depth research to make up the gap in the existing research in this area.

The rest of the article is structured as follows. Section 2 reviews the existing literature and mainly includes the summary of the measurement of EPU and the macroeconomic impact of EPU, as well as the theoretical analysis of the impact of EPU on industrial output, and the regulatory effect of technological progress. Section 3 presents the determination of the research methods and variable description, which involves the measurement of technological progress and the setting of the nonlinear regulatory-effect model. Section 4 presents the empirical analysis of the whole sample. This paper first analyzes the impact of EPU on industry output, and then analyzes the regulatory effect of technological progress. Section 5 makes a detailed analysis of the research theme from three levels. Section 6 presents the summary and research prospects.

## 2. Literature Review

The research on EPU mainly focuses on the measurement of EPU and its macroeconomic-effect analysis. With the deepening of research, some scholars began to pay attention to the impact of EPU on technological progress.

In the measurement of EPU, early studies often divided uncertainty into economic uncertainty and policy uncertainty. Economic uncertainty is mainly measured from the macro- and microlevels. The measurement of the economic-uncertainty indicators at the macrolevel generally adopts the market volatility index (VIX), vector autoregressive model (VAR), and GARCH model to capture the fluctuations in the macroeconomic variables, such as the GDP, investment, and exchange rate [2,3], as well as the fluctuations in stocks and other asset return indexes [4,5]. Some scholars also use political election or term change [6], changes in the political landscape [7], and differences in professionals' predictions of the future economy [8] as proxy variables for economic uncertainty. Economic uncertainty at the microlevel is generally measured by the differences in cross-sectional data or time-series data. For instance, some scholars use statistical methods to calculate the variance in or standard deviation of stock prices, fluctuations in business performances, etc. [9]. The research on policy uncertainty is relatively specific. Scholars from different fields have discussed the impact of uncertainty at different levels. Barradale [10] analyzed the impact of changes in public policies on renewable energy. Creal and Wu [11] used the VAR model to describe the uncertainty of monetary policy when analyzing the relationship between monetary policy uncertainty and economic fluctuations. Li and Mao [12] used the tariff-rate difference to measure the uncertainty of the tariff policy when studying the impact of tariff uncertainty on wages and employment. Caldara et al. [13] used the data of newspaper coverage, first discovery calls, and tariff rates to construct the uncertainty of trade policy by using the comprehensive index method. The measurement of EPU is mainly measured by constructing a composite index through text analysis [14,15]. The study believes that EPU is more hidden than policy uncertainty and is an important driving force for economic recession [16].

The macroeconomic effect of EPU is mainly reflected in the troika of economic growth. First, EPU can influence domestic and foreign investment. EPU will restrain investment through real options [16], corporate financing constraints [17], and financial frictions [18], and will also bring uncertainty to cross-border investment (FDI and OFDI) [19]. Second, EPU can affect consumption. Some studies believe that EPU has a negative impact on consumption [20]. Some studies also show that the impact of EPU on consumption is short-term [21], and there are differences between urban and rural areas [22]. Third, EPU has an impact on imports and exports. The overall research revealed that EPU will have an adverse impact on exports [23], but some studies believe that the sources of EPU that produce this impact should be specifically distinguished [24].

In terms of the impact of EPU on technological progress, on the one hand, EPU will have an impact on research-and-development (R&D) investment and innovation, which drive technological progress. When the external environment changes dynamically, enterprises lack complete information about customer needs [25]. EPU can urge enterprises to seek the "self-development" effect [26] and the competitive-strategy-tool effect of corporate social responsibility [27] to promote innovation by increasing R&D investment. It will also force enterprises to use redundant resources for innovation [28]. At the same time, it will also stimulate the diffusion of knowledge, improve the utilization of human capital, and then strengthen the innovation efficiency of enterprises [29]. At the same time, EPU will have incentive effect and selection effect on enterprise innovation, and then affect the R&D investment and the number of patent applications of listed companies [30]. However, some studies also believe that EPU will increase the waiting-option value of enterprises' R&D and innovation activities, urge enterprises to postpone innovation [31], and increase the financing costs of enterprises and inhibit innovation investment [32]. On the other hand, EPU will have an indirect impact on technological progress through two-way FDI and service trade [33]. In addition, EPU will affect the resource-allocation efficiency of enterprises. Uncertainty will increase the financing-environment differences of enterprises, cause the inefficient investment of enterprises, reduce the overall resource-allocation efficiency, and then hinder the improvement in technological progress [34]. However, EPU may also strengthen market competition and promote the improvement in the enterprise production efficiency [35].

According to the existing studies, it can be simply inferred that EPU may have an impact on output through technological progress. Economic theories, such as neoclassical growth theory and endogenous growth theory, point out that technological progress is the power source of economic growth. Technological progress reflects the comprehensive strength of a country's economy, and it presents the internal stability and sustainability of economic development. In a broad sense, technological progress includes technological innovation, management innovation, and better resource-allocation methods brought about by the development of science and technology. The rise of technological progress can improve the overall economic anti-risk ability and hedge the adverse impact of EPU on output growth to a certain extent.

Technological progress can create new products, improve the working efficiency of machinery and equipment, directly reduce the input of various factors required for unit product production, and promote the improvement in the industrial production efficiency. The upgrading of network-information technology and transportation-logistics technology can shorten the transaction process and reduce the cost of each link, although the external impact brought about by EPU will increase the external financing constraints of enterprises [34], interfere with the decision-making behavior of enterprises, and then affect the output of the industry. However, industries with high levels of technological progress mean that relevant enterprises can still maintain a high profit margin under the EPU environment, making them subject to less liquidity constraints. In uncertain environments, innovation is conducive to enterprises relying on their own technology to lead the market order, thereby reducing the impact of uncertainty [36]. Technological progress can enable enterprises in various industries to more actively adapt to changes in the external environment and avoid risks. The realization of economic restructuring, transformation, and upgrading is an inherent requirement for comprehensively enhancing the ability of the economy to resist risks. In this process, technological innovation is the main driving force [37]. In addition, by improving the development speed of domestic technological progress in the long term, China can better eliminate the technical constraints and technical blockades of other countries in the face of external EPU shocks, and especially when it is subject to technical sanctions from other countries. Therefore, this paper argues that technological progress can weaken the negative impact of EPU on industry output.

Different industries have heterogeneity in technological progress, and they will have different performances when facing the impact of EPU. For instance, Su et al. [38] found that cyclical enterprises have a higher cash-adjustment speed than noncyclical enterprises when facing the impact of economic policy uncertainty. The research of Liu et al. [39] shows that EPU significantly inhibits the investment of traditional energy enterprises but has no significant impact on renewable-energy enterprises. Zhang et al. [40] found that non-state-owned enterprises have a stronger motivation and ability to cope with policy fluctuations through service transformation than state-owned enterprises. Therefore, this paper analyzes the regulatory role of technological progress in the impact of EPU on industry output from the overall level of the industry, and it also makes a heterogeneity analysis. Based on the above analysis, this paper establishes the following analysis framework (see Figure 1).

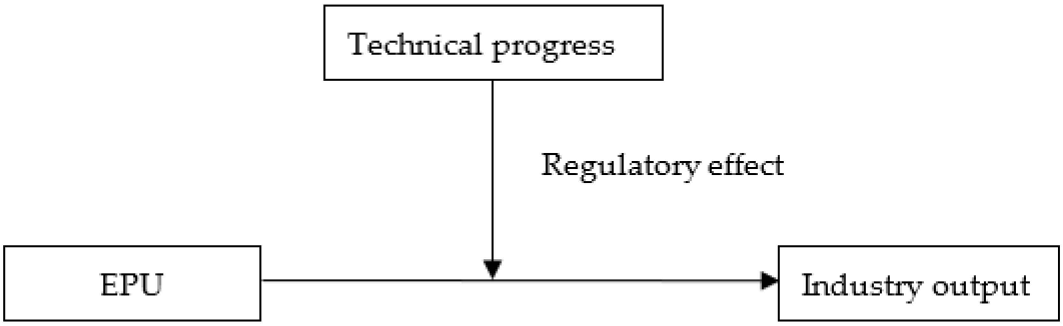


**Figure 1.** Action mechanism of EPU on industrial output.

## 3. Empirical Design

### *3.1. Calculation of Industrial Technological Progress*

At present, there are three kinds of methods used to measure technological progress. The first is OP [41], LP [42], and the "Solow residual" method. The second is to find the relevant alternative indicators as the proxy variables of technological progress. For instance, Hao and Li [43] studied technological progress and human-capital accumulation from the perspective of international division of labor and technology diffusion, and they used the proportion of high-tech exports in manufactured-goods exports to express the level of technological progress. Cloodt et al. [44] used the amount of patent authorization to represent the technological progress of the region when studying issues related to manufacturing upgrading. In a broad sense, technological progress is represented by scientific and technological progress, and it also includes management innovation, institutional innovation, and other aspects [45]. Relevant proxy indicators are only the influencing factors or materialized performance of technological progress, and they cannot fully reflect the overall picture and internal characteristics of technological progress. Therefore, proxy indicators of technological progress have certain limitations in their general applicability. Third, the Malmquist index, proposed by Fare et al. [46], is used to describe technological progress. This method does not need to set the specific form of the production function, thus avoiding the measurement deviation caused by the wrong model setting. Therefore, this method is widely used in the existing research.

The Malmquist index was first proposed by Malmquist [47] to discuss the movement of consumption bundles on different indifference curves. Caves et al. [48] then extended this method to the analysis of productivity, and they named the measured productivity index the Malmquist index. Fare et al. [46] further expanded the Malmquist index based on the above idea of constructing a productivity index, and they used it to measure the change in the total factor productivity. A large number of subsequent studies also used the Malmquist index to refer to technological progress. In this paper, the Malmquist index, based on DEA, is used to calculate the technical-progress index. According to the research method of Fare et al. [46], the technical-progress index, from $t$ to $t+1$ is defined as:

$$M\left(x^{t+1}, y^{t+1}, x^{t}, y^{t}\right) = \left[\frac{d^{t}\left(x^{t+1}, y^{t+1}\right)}{d^{t}\left(x^{t}, y^{t}\right)} \times \frac{d^{t+1}\left(x^{t+1}, y^{t+1}\right)}{d^{t+1}\left(x^{t}, y^{t}\right)}\right]^{\frac{1}{2}} \quad (1)$$

In the above formula, $x^t$ and $y^t$ are the input and output variables in a period ($t$), respectively; $d^t\left(x^t, y^t\right)$ represents the distance function, and other variables are similar; $M > 1$ shows that the current technological progress of the decision-making unit has increased compared with the previous period; $M < 1$ means that the technological progress of the decision-making unit has degraded compared with the previous period.

### *3.2. Empirical Model Setting*

In order to investigate the relationship between EPU, technological progress, and industrial output, this paper adopts the setting of the regulatory-effect model in Wen and Ye [49], and it constructs the corresponding econometric model according to the study of Zhu and Ye [50].

Test the direct impact of EPU on industrial output. The opportunity expectation theory believes that uncertainty is the source of enterprise profits. If future changes can be predicted, then the profits will disappear. For China, which is in the ranks of developing countries, when EPU is low, the opportunity expectation motivation of various industries is strong, and EPU has a positive effect on output because, when the fiscal policy and monetary policy are within the original framework and the uncertainty is small, the motivation to seek opportunities can easily become the consensus expectation among stakeholders in various industries. The optimism of the market also affects all industries. The motivation to seize future growth opportunities and gain market first-mover advantages encourages entrepreneurs to take risks. In addition, when the EPU is low, part of the production of EPU comes from the government in order to correct improper market behavior, improve the economic system, and standardize the market order. Such behavior can make up for market deficiencies and correct market failures, which has a positive role in promoting industry output. When the EPU is high, due to the imperfect market system and the lack of an internal stability mechanism, all industries lack the ability to identify the frequent "policy tests" formulated by the government, which will inevitably increase the motivation for risk avoidance in all industries, and high EPU will hinder output. According to real option theory and financing premium theory, high EPU will also hinder the investments of enterprises, increase the financing constraints of enterprises, and then inhibit the growth of output. We found, in the study of Zhu and Ye [50], that the partial derivative of the output to EPU decreases with the increase in the EPU index, and finally shows an increasing inhibitory effect. In this paper, the squared EPU is added to the model, which can reflect the nonlinear characteristics of EPU on the industry output to a certain extent. Although the panel-data model can overcome the endogenous problem caused by missing variables, the two-way causal relationship between technological progress and output may also cause the endogenous problem. In addition, the impact of some variables on output, such as investment and human-capital investment, may not be reflected in the current period, and it takes a longer period to bring about the output effect. To avoid endogenous problems and better portray the relationship between variables, this paper treats all time-related explanatory variables and control variables with a lag period, and it constructs the following panel-data model:

$$\ln \mathrm{y}_{it} = \alpha_1 + \beta_{10} TFP_{it-1} + \beta_{11}\mathrm{epu}_{t-1} + \beta_{12}\mathrm{epu}^2_{t-1} + \lambda_{1i}\sum_{i=1}^{n} Controls_{it-1} + \varepsilon_{it} \quad (2)$$

In Formula (2), $i$ represents the industry; $t$ represents the year; y stands for the industry output; epu and epu$^2$, respectively, represent the primary term and square term of the EPU, which are used to test whether the EPU has a nonlinear impact on industry output and reflects the parameterized nonlinear characteristics. Specifically, if the square regression coefficient of EPU ($\beta_{12}$) is negative, then this indicates that the EPU has a nonlinear inhibitory effect on the industry output, which increases with the EPU index. *Controls* represents a series of other explanatory variables or control variables that affect the industrial output, including industrial investment (inv), foreign direct investment (fdi), the number of foreign-direct-investment projects (fdixm), the human cost (hum), and the ownership composition type (ownership). $\alpha_1$ is a constant term, and $\varepsilon_{it}$ is a random-interference term.

To test the regulatory effect of technological progress, the interaction term with EPU is put into the model to replace technological progress, and the regulatory-effect model of technological progress is established as follows:

$$\ln \mathrm{y}_{it} = \alpha_2 + \beta_{20}\mathrm{epu}_{t-1} \times TFP_{it-1} + \beta_{21}\mathrm{epu}_{t-1} + \beta_{22}\mathrm{epu}^2_{t-1} + \lambda_{2i}\sum_{i=1}^{n} Controls_{it-1} + \zeta_{it} \quad (3)$$

### 3.3. Variable Description and Data Source

According to the change characteristics of the statistical caliber and the availability of the data, this paper takes the statistical data of 19 subindustries in China from 2005 to 2017 (national economic industry classification and code: gb/t4754-02) as the initial sample to study the nonlinear impact of EPU on industrial output and the regulatory role of technological progress. The specific variable sources and processing are as follows:

(1) Explained variable: industry output.

The output of subdivided industries is measured by the output added value of each industry. The value calculated at current prices is converted into the actual added value at constant prices, based on 2004, by using the deflator of the three major industries. These data come from the China Statistical Yearbook and WIND database.

(2) Moderating variable: technical-progress index (TFP).

The Malmquist index, based on DEA, is used to measure technological progress. The input is labor and capital stock, and the output is industry added value. It should be noted that this paper uses the method of Tian [51] to calculate the capital stock of subdivided industries from 2004 to 2017. The specific sources and treatment are as follows. Labor input: Theoretically, this should include the quantity, time, and quality of the labor input. However, in practical research, the formation of variables often depends on the availability of indicators. As the data on the labor time and quality of China's industries have not been counted or published, this paper, as does most studies, uses the number of the labor force as the proxy variable of labor input, and uses the estimation method of Yao et al. [52] to calculate the number of the labor force in the three industries. That is, except for the primary industry, the number of the labor force in the service industry by industry is equal to the total employment of the whole society in the service industry, multiplied (the number of urban unit employment in the service industry/the total number of urban unit employment in the service industry). The calculation method of the number of the labor force in the manufacturing industry is similar to that in the service industry. The data on the total social employment in the three industries, the employment in urban units by industries, and the total employment in urban units are from the China Statistical Yearbook and WIND database. In terms of capital stock, the capital stock is represented by the material capital stock of the national economy by industry. Due to the lack of official data on capital stock, we directly use the industry-specific capital-stock data from 2004 to 2014 estimated by Tian [51], convert the base period to 2004, according to the investment price index of the whole society's fixed assets, and use the estimation method in this paper to calculate the capital-stock data to 2016. The capital-stock formula, calculated by using the perpetual-inventory method, is: $k_{it} = (1 - \delta_i) \times k_{it-1} + (1 - \tau) \times i_{it}$ where $k_{it}$ is the industry's capital stock in the period $(t)$;$\delta_i$ is the industry's capital depreciation rate; $i_{it}$ is the industry's investment; $\tau$ is the "overestimated" part of the investment; $1-\tau$ is the investment conversion rate (that is, the proportion of investment converted into capital). In order to simplify the calculation, this paper assumes that the conversion rate of investment is 100%, and it uses the average depreciation rate of each industry from 2004 to 2013 as the depreciation rate of each industry from 2015 to 2016. These data come from the China Statistical Yearbook.

(3) Other explanatory or control variables.

Domestic investment (inv): This is expressed by the investment in fixed assets of subindustries and is converted into the actual value based on 2004, with the unit of CNY trillion.

The amount of foreign direct investment (fdi) and the number of foreign-direct-investment projects (fdixm): Existing studies indicate that FDI can promote the growth of the host-country output and bring about the technology spillover effect, which is the main way for developing countries to obtain foreign technological progress. According to the fixed-asset investment index, the amount of foreign direct investment is converted into the actual value based on 2004, with units of USD 100 million and 10,000, respectively. Both types of data are derived from the China Statistical Yearbook.

Labor costs of subdivided industries (hum): The labor cost is the cost for enterprises, but it is the income for workers. Liu et al. [53] conducted an empirical study on the impact of labor wages on economic growth in China, and they found that China is in the stage of wage-driven growth. Although the rise in wages may have a restraining effect on exports and investment, the promotion effect on the growth of consumer demand is enough to offset this adverse effect. In fact, the average remuneration of the labor force also reflects the human-capital or knowledge level of the labor force, and the industry average remuneration of the labor force, to a certain extent, reflects the industry average human-capital or knowledge level. Therefore, this paper takes the average wage of urban employees in different industries as the proxy variable of the human cost, and it converts it into the actual value with the CPI index. The unit is CNY 10,000. These data come from the China Statistical Yearbook.

Types of industry ownership structures (ownership): Differences in industry ownership structures may also affect the industry's technological progress and output. In this paper, the 19 industries are divided into state-owned leading and non-state-owned leading industries, according to the number of industry employees. Specifically, if the number of employees of state-owned enterprises in an industry is greater than the sum of urban collectives and other units, then the ownership type of the industry is assigned as 1; otherwise, it is assigned as 0. Because there are no official statistics that contain the number of employees of state-owned and non-state-owned enterprises in various industries from 2004 to 2005, this paper uses the assignment of 2006 to fill it in. These data come from the WIND database.

EPU index: To measure China's economic policy uncertainty, Baker et al. [14] construct a scaled frequency count of articles about policy-related economic uncertainty in the South China Morning Post (SCMP), Hong Kong's leading English-language newspaper. This method follows the news-based economic-policy-uncertainty index for the United States and other countries. In order to obtain China's annual EPU index, this paper uses the weighted-average method to convert the monthly data into annual data. For the convenience of analysis, this paper divides the EPU index by 100. The descriptive statistical results of each variable are shown in Table 1.

**Table 1.** Descriptive statistics of variables.

| Variable | Symbol | Mean Value | | Standard Deviation | Minimum Value | Maximum |
|---|---|---|---|---|---|---|
| Industry added value | $\mathrm{lny}_{it}$ | overall | 9.22068 | 1.02961 | 6.71228 | 12.09287 |
| | | between | | 0.99669 | 7.27428 | 11.58820 |
| | | within | | 0.33934 | 8.24417 | 9.84862 |
| Technical progress | $TFP_{it}$ | overall | 1.04255 | 0.08053 | 0.75300 | 1.38400 |
| | | between | | 0.02735 | 0.98500 | 1.08869 |
| | | within | | 0.07599 | 0.73624 | 1.39294 |
| Investment | $\mathrm{inv}_{it}$ | overall | 1.38759 | 2.62162 | 0.01040 | 15.00601 |
| | | between | | 2.25243 | 0.05798 | 8.44306 |
| | | within | | 1.43071 | −5.04648 | 7.95053 |
| Foreign direct investment | $\mathrm{fdi}_{it}$ | overall | 54.02680 | 106.40500 | 0 | 521.01000 |
| | | between | | 104.30210 | 0.04000 | 434.34920 |
| | | within | | 31.20542 | −99.52089 | 220.16370 |
| Number of foreign-direct-investment projects | $\mathrm{fdixm}_{it}$ | overall | 0.15831 | 0.34344 | 0 | 2.89280 |
| | | between | | 0.29513 | 0.00015 | 1.15819 |
| | | within | | 0.18734 | −0.59859 | 1.89291 |
| Labor cost | $\mathrm{hum}_{it}$ | overall | 3.67699 | 1.67663 | 0.80620 | 9.51996 |
| | | between | | 1.21939 | 1.64338 | 6.27115 |
| | | within | | 1.18182 | 0.27708 | 6.95810 |
| Ownership composition type | $\mathrm{ownership}_{it}$ | overall | 0.44534 | 0.49801 | 0 | 1 |
| | | between | | 0.46479 | 0 | 1 |
| | | within | | 0.20622 | −0.47773 | 1.29150 |
| EPU | $\mathrm{epu}_{t}$ | overall | 1.68353 | 0.96870 | 0.64962 | 3.64833 |
| | | between | | 0 | 1.68353 | 1.68353 |
| | | within | | 0.96870 | 0.64962 | 3.64833 |

## 4. Analysis of Empirical Results

### *4.1. Statistical Test*

Table 2 shows the correlation-coefficient test. The results indicate that the industrial output has a significant positive correlation with investment, foreign direct investment, the number of foreign-direct-investment projects, labor costs, and EPU, and a significant negative correlation with the composition of the industrial ownership type. In order to test whether there is multicollinearity among the explanatory variables, this paper uses the variance expansion factor to test the collinearity among the variables. The results show that all the variables can satisfy the general rule of thumb, and there is no serious collinearity problem between the variables ($\max\{VIF_1, VIF_2, \cdots, VIF_k\} = 6.74 < 10$). Although correlation analysis can explain the quantitative relationship between variables, more rigorous quantitative analysis still needs to be characterized by econometric models.

**Table 2.** Correlation analysis of variables.

| | $\mathrm{lny}_{it}$ | $TFP_{it}$ | $\mathrm{inv}_{it}$ | $\mathrm{fdi}_{it}$ | $\mathrm{fdixm}_{it}$ | $\mathrm{hum}_{it}$ | $\mathrm{ownership}_{it}$ | $\mathrm{epu}_{t}$ |
|---|---|---|---|---|---|---|---|---|
| $\mathrm{lny}_{it}$ | 1 | | | | | | | |
| $TFP_{it}$ | 0.0122 | 1 | | | | | | |
| $\mathrm{inv}_{it}$ | 0.4749 *** | 0.0254 | 1 | | | | | |
| $\mathrm{fdi}_{it}$ | 0.6036 *** | −0.0053 | 0.7417 *** | 1 | | | | |
| $\mathrm{fdixm}_{it}$ | 0.4558 *** | 0.0025 | 0.2369 *** | 0.6931 *** | 1 | | | |
| $\mathrm{hum}_{it}$ | 0.1525 ** | −0.1621 ** | 0.0451 | 0.0438 | −0.0683 | 1 | | |
| $\mathrm{ownership}_{it}$ | −0.424 *** | 0.1499 ** | −0.2097 *** | −0.3734 *** | −0.302 *** | −0.1695 *** | 1 | |
| $\mathrm{epu}_{t}$ | 0.228 *** | −0.084 | 0.2134 *** | 0.0802 | −0.0228 | 0.5125 *** | −0.0836 | 1 |

Note: "***", "**", and "*" indicate significance levels of 0.01, 0.05, and 0.1, respectively.

### *4.2. Analysis of Whole-Sample Results*

Before the regression analysis of the whole sample, an appropriate model should be selected according to the data test. For Equations (2) and (3), the fixed-effects (FE) model, random-effects (RE) model, and pooled ordinary least squares (POLS) are used for the parameter estimation. The regression results are shown in Tables 3 and 4. It can be seen from the table that the fixed-effects F test of Formulas (2) and (3) strongly rejects all the original assumptions ($u_i$ = 0), indicating that the fixed-effects model is better than the mixed-effects model. According to the Hausman test, the *p* values corresponding to the statistics are all at the significance level of 10%, rejecting the original assumption that the random-disturbance term is not related to the explanatory variable, which indicates that the fixed-effects model is better than the random-effects model. It can also be seen from the regression table that the regression results of the fixed-effects model and the random-effects model are relatively close. Therefore, the fixed-effects model is selected for the result analysis later.

**Table 3.** The baseline regression results.

| **Variable** | **Model (2)** | | | | | |
|---|---|---|---|---|---|---|
| | **Fe** | **Re** | **POLS** | **Fe** | **Re** | **POLS** |
| L.TFP | 0.26432 **<br>(0.10346) | 0.27196 **<br>(0.10519) | 0.8054<br>(0.63286) | 0.27371 ***<br>(0.10088) | 0.28113 ***<br>(0.10251) | 0.86868<br>(0.63312) |
| L.inv | 0.02029 **<br>(0.00871) | 0.02286 ***<br>(0.00881) | 0.04749<br>(0.04205) | 0.02427 ***<br>(0.00857) | 0.02674 ***<br>(0.00867) | 0.05262<br>(0.04212) |
| L.hum | 0.24981 ***<br>(0.01092) | 0.24599 ***<br>(0.01105) | 0.03767<br>(0.03738) | 0.24141 ***<br>(0.01093) | 0.23771 ***<br>(0.01105) | 0.03143<br>(0.03756) |
| L.fdi | 0.00061 *<br>(0.00031) | 0.00073 **<br>(0.00031) | 0.003 **<br>(0.00131) | 0.00047<br>(0.00031) | 0.00058 *<br>(0.00031) | 0.00274 *<br>(0.0013) |
| L.fdixm | −0.02<br>(0.05806) | −0.00348<br>(0.05877) | 0.46252 *<br>(0.26594) | 0.01649<br>(0.05760) | 0.03258<br>(0.05827) | 0.51799 **<br>(0.26832) |
| L.ownership | 0.08851 **<br>(0.04122) | 0.07931 *<br>(0.04175) | −0.48477 ***<br>(0.11288) | 0.07836 *<br>(0.04029) | 0.06955 *<br>(0.04079) | −0.49323 ***<br>(0.11279) |
| L.epu | 0.00321<br>(0.01247) | 0.00391<br>(0.01268) | 0.1402 *<br>(0.07146) | 0.14846 ***<br>(0.04436) | 0.15137 ***<br>(0.04508) | 0.52231 *<br>(0.28251) |
| L.epu2 | | | | −0.03355 ***<br>(0.00985) | −0.03408 ***<br>(0.01002) | −0.09103<br>(0.06512) |
| _cons | 8.01136 ***<br>(0.12081) | 8.00759 ***<br>(0.23344) | 8.00975 ***<br>(0.68294) | 7.91126 ***<br>(0.12138) | 7.90603 ***<br>(0.23359) | 7.65828 ***<br>(0.72637) |
| R2 | 0.8727 | 0.8726 | 0.4527 | 0.8798 | 0.8795 | 0.4576) |
| F statistic | 198.06 *** | | 26 *** | 183.84 *** | | 23.09 *** |
| Fixed-effects F test | 530.97 *** | | | 554.41 *** | | |
| Wald test | | 1338.57 *** | | | 1422.34 *** | |
| Hausman test | 13.25 * | | | 12.93 * | | |
| Sample size | 228 | 228 | 228 | 228 | 228 | 228 |

Note: "***", "**", and "*" are significant at the levels of 0.01, 0.05, and 0.1, respectively. The values in brackets are the standard errors corresponding to the statistics. L. represents the lag period, and _cons is a constant term.

**Table 4.** Regression results of the regulatory effect of technological progress.

| **Variable** | **Model (3)** | | | | | |
|---|---|---|---|---|---|---|
| | **Fe (01)** | **Re** | **POLS** | **Fe (02)** | **Fe (03)** | **Fe (04)** |
| L.TFP × epu | 0.20841 ***<br>(0.07089) | 0.21382 ***<br>(0.07173) | 0.34888<br>(0.45283) | 0.20386 ***<br>(0.07182) | | 0.14366 *<br>(0.07624) |
| L.TFP × epu2 | | | | 0.00003<br>(0.0025) | | −0.00246<br>(0.00268) |
| L.inv | 0.02369 ***<br>(0.00847) | 0.02595 ***<br>(0.00854) | 0.05161<br>(0.04257) | 0.02388 ***<br>(0.00872) | 0.02427 ***<br>(0.00871) | 0.01892 *<br>(0.01021) |

**Table 4.** *Cont.*

| Variable | Model (3) | | | | | |
|---|---|---|---|---|---|---|
| | **Fe (01)** | **Re** | **POLS** | **Fe (02)** | **Fe (03)** | **Fe (04)** |
| L.hum | 0.24123 ***<br>(0.01063) | 0.23801 ***<br>(0.01072) | 0.03197<br>(0.03801) | 0.24066 ***<br>(0.01185) | 0.23643 ***<br>(0.01094) | 0.22273 ***<br>(0.01255) |
| L.fdi | 0.0005<br>(0.00031) | 0.0006 **<br>(0.00031) | 0.00285 **<br>(0.00133) | 0.00052 *<br>(0.00031) | 0.00036<br>(0.00031) | 0.00038<br>(0.00035) |
| L.fdixm | 0.02165<br>(0.05702) | 0.03631<br>(0.05748) | 0.51141 *<br>(0.2704) | 0.01895<br>(0.05816) | 0.007<br>(0.05839) | −0.00218<br>(0.06166) |
| L.ownership | 0.10699 ***<br>(0.03857) | 0.09941 **<br>(0.03891) | −0.45984 ***<br>(0.11441) | 0.07906 *<br>(0.04031) | 0.08352 *<br>(0.04088) | 0.04849<br>(0.04276) |
| L.epu | −0.06300<br>(0.08753) | −0.06709<br>(0.08858) | 0.09235<br>(0.54722) | −0.06811<br>(0.08875) | 0.14952 ***<br>(0.04505) | 0.1558<br>(0.1281) |
| L.epu2 | −0.03407 ***<br>(0.00972) | −0.03438 ***<br>(0.00984) | −0.0794<br>(0.06541) | −0.03272 ***<br>(0.01003) | −0.03282 ***<br>(0.01) | −0.08501 ***<br>(0.03129) |
| _cons | 8.1779 ***<br>(0.04661) | 8.18035 ***<br>(0.21125) | 8.60292<br>(0.26319) | 8.20067 ***<br>(0.04716) | 8.21593 ***<br>(0.0468) | 8.27347 ***<br>(0.06812) |
| R2 | 0.8824 | 0.8822 | 0.4495 | 0.8827 | 0.8554 | 0.8523 |
| F statistic | 188.51 *** | | 22.35 *** | 163.27 *** | 202.67 *** | 116.01 *** |
| Fixed-effects F test | 575.62 *** | | | 553.64 *** | 541.80 *** | 500.27 *** |
| Wald test | | 1470.04 *** | | | | |
| Hausman test | 12.27 * | | | | | |
| Sample size | 228 | 228 | 228 | 228 | 228 | 209 |

Note: In Fe (04) regression, the explanatory variables were treated with two lag periods. "***", "**", and "*" are significant at the levels of 0.01, 0.05, and 0.1, respectively.

#### 4.2.1. Impact of EPU on Industrial Output

The regression results of Formula (2) in Table 3 report the impact of EPU on the industrial output. In the regression that does not include the squared EPU, we can see the coefficient of the EPU in the fixed-effects model, and the random-effects model is not significant (even if the coefficient is significant at the 10% level in the POLS model, the test finds that the model is not reliable as the fixed-effects model), which is likely because the impact of the EPU on the output is not a simple linear relationship. This view can be verified in the model containing the squared EPU. In the fixed-effects model with the EPU square term, the coefficient of the EPU is significantly positive (0.148), and the coefficient of the squared EPU is significantly negative (−0.034). It can be judged that the EPU has an inverted "U"-shaped nonlinear impact on the industrial output. This result verifies the previous theoretical analysis. When the EPU is low, the generation of EPU is more likely to come from the slight effective intervention made by the government to correct improper market behavior, improve the economic system, and regulate the market order. Such behavior can effectively make up for the market shortage and correct the market failure, thereby having a positive role in promoting the industry output. With the increase in EPU, the impact of EPU on the industrial output gradually turns from promotion to inhibition. The high EPU caused by excessive government intervention or frequent policy changes will hinder the industrial output. However, in recent years, China's EPU index fluctuated at a high level, and the EPU had a significant negative impact on China's economic growth. On the one hand, EPU can have a negative impact on industrial output by affecting import and export trade, investment, consumption, and employment; on the other hand, in the incomplete information market, the frequent changes of policies will lead to market economy participants being unable to make the best decisions by using the policy information reasonably and effectively, which may lead to low market efficiency, or even market chaos, and will then reduce the industry output. It is not difficult to calculate the partial derivative of the EPU in Equation (2). When the EPU index is close to 221, the partial-derivative value is 0. The results obtained in this paper are consistent with the research results of Zhu and Ye [50] (they concluded that the critical value of the impact of EPU on output is between 200 and 300).

In terms of other explanatory variables, the coefficient of technological progress is significantly positive (0.274), indicating that technological progress can drive the growth of industrial output. When the overall level of technological progress is low, comprehensively improving technological progress is the key to maintaining sustained output growth. Technological progress can be promoted mainly by improving the allocation efficiency of resources and the level of science and technology. The implementation of an innovation-driven strategy will be conducive to the continuous improvement in technological progress. In addition, the industry investment, labor costs, and industry ownership type all have a significant positive impact on the industry output. However, the effect of industrial investment on industrial output growth is relatively small (0.024). China has entered the digestion period of early stimulus policies, and the pulling effect of investment on output growth is significantly weaker than in the past.

#### 4.2.2. The Regulative Role of Technological Progress in the Influence of EPU on Industrial Output

From the fixed-effects regression results of Equation (3) in Table 4, it can be seen that the EPU has a nonlinear impact on the industrial output. After adding the interactive term of technological progress, the coefficient of the squared EPU is still significant (−0.034), and the sign has not changed, which shows that the impact of the EPU on the industry output is nonlinear. We also found that the coefficient of the EPU is reversed (but not significantly), while the coefficient of the interactive term of technological progress is significantly positive, indicating that some part of the impact of the EPU on the industrial output is through technological progress (after all, the coefficient of the EPU square term is significantly negative). Combined with the actual situation, the average value of technological progress calculated during the sample period in this paper is 1.04. If it is substituted into the regression model, then we find that the regulatory-effect model is basically consistent with the baseline regression model in Table 3.

From the regression results of Equation (3) in Table 4, it can be found that the interaction term of technological progress is significantly positive (0.208), indicating that technological progress can adjust the adverse impact of EPU on the industrial output. Technological progress can improve the anti-risk ability of the economy and society, and thus help to resolve the adverse impact of EPU on the industrial output. First, the improvement in technological progress can bring higher industry benefits. In an uncertain environment, industries with higher technological progress will face less financing constraints. Similarly, in industries with low technological progress, EPU is an external random impact faced by enterprises, which will cause enterprises to face greater financing constraints. In order to prevent the risks brought on by EPU, these enterprises will have to increase their cash holdings, which will lead to reductions in their current investments [54]. This process will affect the production and operation activities of enterprises, which is not conducive to the growth of industrial output. Second, industries with higher levels of technological progress tend to have higher resource-allocation efficiency. Facing the impact of EPU, higher resource-allocation efficiency is conducive to maintaining industry output. Finally, the higher the level of technological progress, to some extent, the stronger the self-learning ability of enterprises. Moyen and Platikanov [55] found that the improvement in enterprises' own learning abilities helps to weaken the impact of EPU on enterprises' business decisions. The new knowledge and information acquired by enterprises through learning also help to reduce or eliminate the uncertainty caused by changes in economic policies. The above factors enable the improvement in technological progress to reduce the adverse impact of EPU.

In order to test the robustness of the results, we added the interaction term of the TFP and squared EPU to the regression. However, from Fe(02) in Model (3), it can be seen that this coefficient is not significant, and the coefficients of other variables have not changed significantly. Therefore, we further believe that the nonlinear effect of EPU on output can be explained by the squared EPU and the interaction term of the EPU and TFP. We also reported the baseline regression results without the TFP in Table 4. We found that the sample is in line with the theoretical expectation. In addition, investment and human-capital investment may not bring about the output effect in the short term. In this paper, the explanatory variables are treated with two lag periods. From the regression results of Fe (04), it can be seen that the conclusion is still robust.

The regression results of Equation (3) also show that the coefficient values and significance levels of other explanatory variables are not different from those of Equation (2). From the regression model, it can be preliminarily concluded that the leading industries of state-owned enterprises are generally conducive to promoting industrial output.

## 5. Empirical Analysis of Subdivided Samples

### *5.1. Comparative Analysis of Industries Dominated by State-Owned Enterprises and Non-State-Owned Enterprises*

The state-owned economy is an important pillar of China's economy. When the macroeconomic environment is poor, state-owned enterprises play an important role in solving local employment, increasing fiscal revenue, and stimulating economic growth, in many fields. Compared with private enterprises, state-owned enterprises have stronger institutional and political connections, and so they may have stronger anti-risk abilities. Therefore, facing EPU, industries dominated by state-owned enterprises and non-state-owned enterprises will have different performances in output growth. In this paper, the 19 industries are divided into industries dominated by state-owned enterprises and industries dominated by non-state-owned enterprises (in the sample period, if there are more times of Type 1 ownership composition, then they are classified as industries dominated by state-owned enterprises; otherwise, they are classified as industries dominated by non-state-owned enterprises). The fixed-effects model is used to analyze the regulatory effect of technological progress. The results are shown in Table 5.

**Table 5.** Regression results of industries dominated by state-owned enterprises and non-state-owned enterprises.

| Variable | Industries Dominated by State-Owned Enterprises | | Industries Dominated by Non-State-Owned Enterprises | |
|---|---|---|---|---|
| L.TFP | 0.5135 ***<br>(0.14538) | | 0.12052<br>(0.13965) | |
| L.TFP × epu | | 0.35339 ***<br>(0.10879) | | 0.1257<br>(0.09718) |
| L.inv | 0.04274 **<br>(0.01969) | 0.04925 **<br>(0.01975) | 0.02241 **<br>(0.01013) | 0.02201 **<br>(0.01007) |
| L.hum | 0.27181 ***<br>(0.01576) | 0.26703 ***<br>(0.01581) | 0.21539 ***<br>(0.01517) | 0.2162 ***<br>(0.015) |
| L.fdi | −0.00437 **<br>(0.0019) | −0.00403 **<br>(0.00194) | 0.00061 *<br>(0.00035) | 0.00065 *<br>(0.00035) |
| L.fdixm | 1.98975 ***<br>(0.72056) | 2.16000 ***<br>(0.73233) | −0.00574<br>(0.0659) | −0.00278<br>(0.06555) |
| L.epu | 0.1302 **<br>(0.05603) | −0.24535 *<br>(0.13336) | 0.18501 ***<br>(0.06709) | 0.05421<br>(0.11873) |
| L.epu2 | −0.03581 ***<br>(0.01251) | −0.0349 ***<br>(0.01266) | −0.03726 **<br>(0.01501) | −0.03747 **<br>(0.0149) |
| _cons | 7.23147 ***<br>(0.16689) | 7.77505 ***<br>(0.05821) | 8.46927 ***<br>(0.17537) | 8.59006 ***<br>(0.06219) |
| R2 | 0.9029 | 0.9047 | 0.8724 | 0.8736 |
| F statistic | 122.19 *** | 124.73 *** | 100.64 *** | 101.67 *** |
| Sample size | 108 | 108 | 120 | 120 |

Note: "***", "**", and "*" are significant at the levels of 0.01, 0.05, and 0.1, respectively.

As can be seen from Table 5, with the continuous rise in the EPU index, the impact of EPU on the industry output, whether it is the industries dominated by state-owned enterprises or the industries dominated by non-state-owned enterprises, shows the characteristics of first promotion, and then inhibition; that is, it shows the characteristics of an inverted "U". The regulatory effect of technological progress on the impact of EPU on the industry output is only significant in the industries dominated by state-owned enterprises, but not in the industries dominated by non-state-owned enterprises, which indicates that the state-owned enterprises can more effectively resist the risks brought on by EPU by improving the level of technological progress.

The output coefficients of the EPU and squared EPU in industries dominated by state-owned enterprises are (0.130) and (−0.036), respectively, and for industries dominated by non-state-owned enterprises, they are (0.185) and (−0.037), respectively. The absolute value of the former coefficient is less than that of the latter coefficient, indicating that the impact of EPU on the output of the leading industries of state-owned enterprises is less than that of non-state-owned enterprises; that is, the impact of EPU on the output of the leading industries of state-owned enterprises is limited. Due to the support of national strategies or policies, state-owned enterprises have huge resource advantages and institutional linkage advantages. On the one hand, these advantages mean that state-owned enterprises have more unobstructed policy information channels. They can timely and accurately understand the policy guidance, and gradually transmit the information to the whole industry. The impact of policy fluctuations on the leading industries of state-owned enterprises is relatively weak. On the other hand, having a large number of unregulated or weakly regulated resources means that state-owned enterprises have a stronger ability to cope with policy fluctuations. Therefore, the leading industries of state-owned enterprises are less vulnerable to the impact of EPU, which is consistent with the conclusion of Zhang et al. [40].

### *5.2. Comparative Analysis of Samples of Cyclical and Noncyclical Industries*

Cyclical industries refer to industries that are greatly affected by the economic cycle. Existing studies have found that the impact of EPU on China's macroeconomy is related to the economic cycle. When economic policies change greatly, cyclical industries have a faster cash-adjustment speed than noncyclical industries [56]. This indicates that cyclical and noncyclical industries may have different performances in the face of EPU. Therefore, this paper divides the samples into cyclical industries and noncyclical industries, and it discusses the impact of EPU on the output of these two categories of industries. At present, there is no consensus on the division of cyclical and noncyclical industries. According to the industry-division idea of Boudoukh et al. [57], this paper analyzes the correlation between the growth rate of the added value of the subdivided industries and the growth rate of the economic aggregate. Those with a coefficient higher than 0.5 are classified as cyclical industries, and others are classified as noncyclical industries. Cyclical industries include mining, manufacturing, construction, information transmission, computer services and software, wholesale and retail, finance, scientific research, technical services, and geological exploration. The rest are noncyclical industries. The fixed-effects regression results are shown in Table 6.

As can be seen from Table 6, the impact of EPU on the output of cyclical and noncyclical industries is quite different. The impact of EPU on cyclical industries still shows a significant nonlinear inverted "U" shape, and the absolute values of the coefficients of the EPU and squared term are greater than the absolute values of the regression coefficients of the total samples, indicating that the impact of EPU on cyclical industries is quite obvious. The regulatory effect of technological progress on the impact of EPU on the output of cyclical industries is no longer significant, indicating that, in cyclical industries, EPU directly affects the output of industries mainly through investment, trade, and consumption. The impact of EPU on noncyclical industries is not significant, and it is significantly positive for the interaction items (EPU and technological progress), indicating that the impact of

EPU on the output of noncyclical industries is weak, but it can still act on the output of industries together with technological progress. The results of this paper are different from those of Su et al. [38]. The possible reason is that EPU has the characteristics of a counter economic cycle. Although the enlargement of EPU may have a certain negative impact on the output of noncyclical industries, when the economic cycle goes down, noncyclical industries can maintain a certain output level due to their own characteristics, and they are more vulnerable to investors' attention. Market behavior will reduce or offset the adverse impact of EPU on noncyclical industries. On the contrary, for cyclical industries, moderate fluctuations in economic policies are conducive to industrial output, but frequent changes in economic policies are more likely to have a greater impact on output.

**Table 6.** Regression results of cyclical and noncyclical industry samples.

| Variable | Cyclical Industry | | Noncyclical Industry | |
|---|---|---|---|---|
| L.TFP | 0.09444<br>(0.28005) | | 0.51036 **<br>(0.21440) | |
| L.TFP × epu | | 0.11597<br>(0.19421) | | 0.34321 **<br>(0.15792) |
| L.inv | −0.01748<br>(0.02723) | −0.01728<br>(0.02719) | −0.00246<br>(0.02157) | −0.00141<br>(0.02163) |
| L.hum | 0.24916 ***<br>(0.03013) | 0.25032 ***<br>(0.02987) | 0.25756 ***<br>(0.02413) | 0.25393 ***<br>(0.02405) |
| L.fdi | −0.00161 *<br>(0.00096) | −0.00156<br>(0.00096) | 0.00114<br>(0.00075) | 0.00116<br>(0.00076) |
| L.fdixm | −0.20201<br>(0.14223) | −0.1967<br>(0.14220) | −0.17219<br>(0.63520) | −0.06916<br>(0.63595) |
| L.epu | 0.32159 **<br>(0.1456) | 0.19362<br>(0.25869) | 0.05107<br>(0.08600) | −0.30043<br>(0.18649) |
| L.epu2 | −0.08498 **<br>(0.03213) | −0.08338 **<br>(0.03214) | −0.0009<br>(0.01915) | −0.00258<br>(0.01924) |
| _cons | 8.70525 ***<br>(0.35934) | 8.79937 ***<br>(0.14288) | 7.4904 ***<br>(0.24565) | 8.02062 ***<br>(0.08833) |
| R2 | 0.6994 | 0.7005 | 0.7604 | 0.7587 |
| F statistic | 23.27 *** | 23.39 *** | 56.67 *** | 56.14 *** |
| Sample size | 84 | 84 | 144 | 144 |

Note: "***", "**", and "*" are significant at the levels of 0.01, 0.05, and 0.1, respectively.

In the regression of noncyclical and cyclical samples, the impact of investment on industry output is negative and not significant, and the increase in the human cost still plays a significant role in promoting industry output.

### *5.3. Comparative Analysis of Regression Results of Three Industries*

In order to distinguish the differences between the three industries in the impact of EPU on output, and whether technological progress can play a regulatory role, this section selects the corresponding subsamples for regression analysis. The primary industry only includes agriculture, forestry, and animal husbandry and fishery, and so the fixed-effects panel-data regression cannot be carried out. This paper makes a combined analysis with the secondary industry. The regression results of the primary, secondary, and tertiary industries are shown in Table 7.

**Table 7.** Sample regression results of primary, secondary, and tertiary industries.

| Variable | Primary and Secondary Industries | | Tertiary Industry | |
|---|---|---|---|---|
| L.TFP | 0.23368<br>(0.21842) | | 0.34808 ***<br>(0.11636) | |
| L.TFP × epu | | 0.16988<br>(0.14495) | | 0.25943 ***<br>(0.0863) |
| L.inv | 0.00559<br>(0.02692) | 0.00496<br>(0.02687) | 0.03982 ***<br>(0.01058) | 0.03894 ***<br>(0.0106) |
| L.hum | 0.21689 ***<br>(0.03483) | 0.2179 ***<br>(0.03467) | 0.24422 ***<br>(0.01073) | 0.2419 ***<br>(0.01053) |
| L.fdi | 0.00032<br>(0.00118) | 0.00032<br>(0.00118) | −0.00003<br>(0.00037) | 0.00003<br>(0.00038) |
| L.fdixm | −0.10501<br>(0.13587) | −0.10611<br>(0.13556) | 0.16818<br>(0.14972) | 0.20534<br>(0.15027) |
| L.epu | 0.11149<br>(0.12423) | −0.06836<br>(0.19207) | 0.1744 ***<br>(0.04434) | −0.0998<br>(0.10225) |
| L.epu2 | −0.02154<br>(0.02745) | −0.0216<br>(0.02738) | −0.0413 ***<br>(0.00989) | −0.04019 ***<br>(0.00988) |
| _cons | 9.14527 ***<br>(0.28577) | 9.39149 ***<br>(0.17938) | 7.48126 ***<br>(0.13722) | 7.8505 ***<br>(0.04101) |
| R2 | 0.7577 | 0.7588 | 0.9155 | 0.9155 |
| F statistic | 21.44 *** | 21.57 *** | 227.50 *** | 227.64 *** |
| Sample size | 60 | 60 | 168 | 168 |

Note: "***", "**", and "*" are significant at the levels of 0.01, 0.05, and 0.1, respectively.

Similar to the results of cyclical and noncyclical industries, the impact of EPU on the primary and secondary industries and the tertiary industry are also quite different. In the regression results of the samples of the primary and secondary industries, except that the impact of the human cost on the industrial output is significantly positive, the other variable coefficients are not significant, illustrating that the primary and secondary industries are not affected by the impact of EPU, foreign direct investment, or technological progress. However, the tertiary industry will still be affected by EPU, showing a nonlinear inverted "U" shape.

From the perspective of regression value, this nonlinear characteristic is close to the regression results of industry samples dominated by state-owned enterprises and non-state-owned enterprises. In the impact of EPU on the tertiary industry, technological progress can also play a significant positive regulatory role. With the improvement in technological progress, technological progress can promote industrial output when the EPU is low, and it can reduce the adverse impact of EPU on industrial output when the EPU level is high.

## 6. Conclusions and Research Prospects

This paper analyzes the nonlinear impact of EPU on industry output and the regulatory role of technological progress by using the panel data of China's industry segments from 2005 to 2017. The results show that EPU has a significant inverse "U"-shaped nonlinear impact on industry output, and technological progress has a positive regulatory effect on the impact of EPU on industry output. Technological progress can promote industrial output when the EPU is low, and it an reduce the adverse impact of economic policy fluctuations when the EPU index is high. The regression results show that the regulatory effect of technological progress only exists in the industries dominated by state-owned enterprises. The influence of EPU on the output of cyclical industries shows a significant inverted "U" shape, but there is no regulatory effect of technological progress. EPU has no significant impact on the output of noncyclical industries, but it will work together with technological progress on the output of industries. The impact of EPU on the output of primary and secondary industries is not significant, and technological progress has no regulatory effect.

According to the research results of 19 industries in China, the following policy suggestions can be given. (1) Low EPU is conducive to promoting industrial output, while high EPU hinders industrial output. All industries should improve the effectiveness and sustainability of economic policies and reduce the adverse effects of changes in economic policies from the industry source. When formulating various industry policies, the effective needs of enterprises should be conveyed to the government through industry associations. (2) Technological progress can promote industrial output and adjust the impact of EPU on industrial output. Each industry shall: fully consider the sustainability of the innovation strategy under the impact of the external environment; formulate phased innovation implementation plans; reduce the impact of changes in the internal business environment or external political environment of the industry; encourage microenterprises to innovate; give play to the leading role of leading enterprises in technological innovation management innovation, and business-activity innovation; comprehensively and steadily improve the level of the total factor productivity; promote technological progress.

In addition, the impact of EPU on different types of industries is quite different. First of all, the leading industries of state-owned enterprises have strong anti-risk abilities due to institutional linkages and the mastery of important resources, but they also have formed low efficiency in the long-term production process. When implementing the market-oriented reform of the "separation of government and enterprise" in state-owned enterprises, we should also pay attention to the improvement in technological progress. The leading industries of non-state-owned enterprises are vulnerable to the impact of EPU, and so we need to focus on improving the abilities of independent innovation and enhancing anti-risk immunity. Secondly, the impact of EPU on cyclical industries and the tertiary industry is particularly obvious. In addition to improving its own anti-risk ability, the government should provide policy help or financial support to enterprises in cyclical industries when EPU fluctuates greatly. For example, in the environment of larger EPU, targeted tax and fee-reduction policies were implemented to reduce the threshold of bank loans to enterprises and ease the external financing constraints.

Although this paper describes the nonlinear impact of EPU on industry output with a fixed-effects model at the industry level, and analyzes the regulatory role of technological progress, some important variables at the industry level, such as openness and import and export trade data, cannot be obtained, which is not conducive to the further extension of the research. Therefore, future research can consider more from the microenterprise level to expand its research. In recent years, the outbreak of COVID-19 has had a great impact on the economies of all countries in the world. Changes in epidemic prevention and control policies in various countries have also further exacerbated EPU, which must be taken into account when discussing the impact of economic policy uncertainty. Affected by the impact of COVID-19, whether the impact of EPU on the macroeconomy will change in the future is also worth further analysis.

**Author Contributions:** Conceptualization, S.Z.; methodology, S.Z.; software, S.Z.; validation, S.Z. and G.Y.; formal analysis, S.Z.; investigation, G.Y.; resources, G.Y.; data curation, S.Z.; writing—original draft preparation, S.Z.; writing—review and editing, S.Z.; visualization, S.Z.; supervision, S.Z.; project administration, S.Z.; funding acquisition, S.Z. All authors have read and agreed to the published version of the manuscript.

**Funding:** This research was funded by [research on the impact of the integration of manufacturing and producer services on high-quality economic development] grant number [2022j05100] And The APC was funded by [Science and Technology Department of Fujian Province].

**Institutional Review Board Statement:** Not applicable.

**Informed Consent Statement:** Not applicable.

**Data Availability Statement:** The data is available on http://www.stats.gov.cn/ (accessed on 5 May 2022) and https://www.wind.com.cn/ (accessed on 5 May 2022).

**Conflicts of Interest:** The authors declare no conflict of interest.

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