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A Study on the Determinants of Artificial Intelligence Industry: Evidence from United Kingdom's Macroeconomics

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Abstract

Recently, the rapid development of artificial intelligence industry has resulted in a great change in our modern society. Due to this background, this paper takes the United Kingdom as an example to explore the determinants of artificial intelligence industry in terms of United Kingdom's macroeconomics. The quarterly time series from the first quarter of 2010 to the fourth quarter of 2017 will be employed to conduct an empirical analysis under the vector error correction model. In this paper, the real GDP, the employment figure, the real income, the foreign direct investment, the government budget and the inflation will be regarded as independent variables. The input of artificial intelligence industry will be regarded as a dependent variable. These macroeconomic variables will be applied to perform an empirical analysis so as to explore how the macroeconomic variables affect the artificial intelligence industry. The findings show that the real GDP, the real income, the foreign direct investment and the government budget are the driving determinants to promote the development of artificial intelligence industry. Conversely, the employment figure and the inflation is the obstructive determinants to hamper the development of artificial intelligence industry.

Keywords: Artificial Intelligence Industry, Determinants, United Kingdom's Macroeconomics.

1. Introduction

In May 2017, AlphaGo who is developed and designed by Google artificial intelligence company defeats Chinese professional Go player Jie Ke who takes the first place in Go field for a long time in the world. This "man-machine war" triggers the heated discussions on the development of artificial intelligence in the theoretical circle. In recent years, countries around the world have begun to pay attention to the field of artificial intelligence and they do their most to size the opportunity to take over the artificial intelligence market by issuing relevant strategic plans. Currently, there are only few researches on the decision factors of development of artificial intelligence industry in the academic circle. However, the vast majority of academic researches mainly focus on the application of artificial intelligence in various fields. For example, Kunda (2018) investigates whether, and how, an artificial intelligence system can be said to use visual, imagery-based representations in a way that is analogous to the use of visual mental imagery by people. Holmes, Sacchi Bellazzi and Peek (2017) analyze the contribution of artificial intelligence to the bio-medicine and health. To distinguish this paper from other works, this paper takes the United Kingdom as an example to explore the determinants of artificial intelligence industry in terms of United Kingdom's macroeconomics. Due to that the macroeconomics is a broad concept, we only focus on the impact of United Kingdom's real GDP, employment figure, real income, foreign direct investment, government budget and inflation on artificial intelligence industry.

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In order to make the operation mechanism between between artificial intelligence industry and GDP, employment figure, real income, foreign direct investment, government budget, Inflation more clearly. A menu of econometric approaches such as the Johensan cointegration test and the vector error correction model will be employed to exploit how the United Kingdom's macroeconomic variables (real GDP, employment figure, real income, foreign direct investment, government budget and inflation) impact the artificial intelligence industry. These econometric approaches will be used to conduct an empirical analysis. The findings of this paper indicate that there is a long-run relationship between artificial intelligence industry and GDP, employment figure, real income, foreign direct investment, government budget, Inflation. More concretely, the real GDP, the real income, the foreign direct investment and the government budget have a positive effect on artificial intelligence industry; Oppositely, the employment figure and the inflation have a negative effect on artificial intelligence industry. Meanwhile, the results of vector error correction estimation show that when the long-run equilibrium breaks due to the short-run shock, the short-run fluctuation will return to the long-run equilibrium by 0.267% in the opposite direction.

Via the statistical analysis, this paper can provide some empirical evidence for United Kingdom's government to take some corresponding measures to promote the development of artificial intelligence industry. To this end, the whole of this paper will be constructed as following indicated. The first part presents the introduction, which demonstrates the background, the objective, the econometric approach, the structure of this paper. The second part provides the literature review, which shows the summary of previous achievements and the innovation of this paper. The third part tenders the theoretical framework, which offers the basis for this paper. The fourth part regulates the empirical analysis, which provides the findings of this paper in statistics. The fifth part states the conclusion, which is a summary of the whole paper.

2. Research Methodology

The artificial intelligence industry has resulted in a great impact on modern society. A great deal of experts and scholars regards the artificial intelligence as an important industrial revolution such as the first industrial revolution and the second industrial revolution. Therefore, they have begun to analyse the determinants that affect the intelligence industry from various perspectives. Their research achievements will be shown below.

Gao (2000) conducts a research on the characteristics of Java language and the action of influence and promotion of it for artificial intelligence technology. Via his analysis, his result shows that characteristics of Java language can facilitate the development of artificial intelligence technology. Yang (2005) discuses the thinking method of artificial intelligence development from philosophical angle and believes that the development of thinking research will affect the research and development of artificial intelligence. Great importance should be attached to both the research of thinking science and especially, the research of its leading subject of 21th century-pan system thinking.

Artificial intelligence is developing at an unexpected speed and affecting all fields of society. Xu (2017) analyzes the impact of artificial intelligence on manufacturing through the perspective of career education. His findings show that the artificial intelligence plays a positive role in career education. Simultaneously, His findings also indicate that the rapid development also can promote the development of artificial intelligence. Rynjolfsson and Syverson (2017) find that the use of artificial intelligence technology can greatly increase the productivity. Of course, via the empirical analysis, they also find that if the productivity is put forward to a higher level, more input should be added to the artificial intelligence. Lei (2017) tries to study the impact of artificial intelligence on accounting industry. He finds that even the artificial intelligence has a positive effect on accounting industry. Meanwhile, the accounting industry is also a driving factor that impact the artificial intelligence.

The development of artificial intelligence is regarded as an important and new industrial revolution. The application of artificial intelligence technology has begun to change all aspects of economic and social life. All countries attach great importance to the development of artificial intelligence and have adopted a wide range of supportive policies. The application of artificial intelligence technology has promoted the improvement of public service, the upgrading of traditional industries and the development of independent artificial intelligence industry. Yang (2018) studies the artificial intelligence in terms of tax policy and tax theory. He finds that the support of tax policy on the development of artificial intelligence is comprehensive. The tax policy should be chosen according to the actual situation so as to avoid undermining the decisive role of the market in the allocation of resources. The development of artificial intelligence may gradually require the restructuring of the tax system, and even new requirements for the financing of public services, which in turn will require the innovation of tax theories. Zhang, Shi, and Liu (2018) attempt to explore how to understand the impact of artificial intelligence on media industry from

technical logic. They finds that the impact of artificial intelligence on media industry is not very significant. However, the media industry has a positive effect on artificial intelligence.

As a new technological revolution, artificial intelligence is bound to bring huge social and economic utility. Under this background, Zhu and Li (2018) perform an empirical study on artificial intelligence, technological progress and the optimization countermeasures of labor structure. They use the vector error correction model to exploit the relationship among them. Their results show that the development of artificial intelligence and the improvement of technological level will increase the relative supply of skilled and unskilled labor, which will help to improve the overall quality of labor force and to optimize the labor force structure. At the same time, the technological progress and labor force structure optimization also promote the development of artificial intelligence. Xue (2018) finds that the impact of artificial intelligence on college students' employment is unconfirmed. But he finds that the college students' employment is a positive effect on the development of artificial intelligence. Cao and Zhou (2018) focus on the impact of artificial intelligence on economy in terms of productivity, economic growth, employment and inequality. Their results show that the artificial intelligence has a positive effect on productivity and economic growth. And the artificial intelligence has a negative effect on employment and inequality. Conversely, these variables also affect the development of artificial intelligence.

In summary, the previous researches try to explore the determinants of artificial intelligence industry from a certain angle such as the characteristics of Java language, the tax policy and tax theory, the media industry and so on. To distinguish this paper from these research achievements mentioned above, namely, this paper sets the United Kingdom as an example to exploit the determinants of artificial intelligence industry in terms of United Kingdom's macroeconomics. Certainly, this is also the biggest innovation of this paper.

3. Theoretical Framework

3.1. Modeling

The artificial intelligence industry belongs to emerging industry, also, called sunrise industry. Recently, the explosive development of artificial intelligence industry has attracted a mass of experts and scholars' interests to explore its law of development. In this paper, we will excavate the factors that affect the development of artificial intelligence industry from a entirely new angle. That is, this paper will attempt to unearth the determinants of artificial intelligence industry from United Kingdom's macroeconomics. Due to that there are a great deal of indexes to measure the development of macroeconomics, this paper will select some variables that can stand for the United Kingdom's macroeconomics. Generally speaking, there are the real GDP, the employment figure, the real income, the foreign direct investment, the government budget and the inflation. These macroeconomic variables will be used to form a model to exploit how these United Kingdom's macroeconomic variables affect the artificial intelligence industry. Because of that there are only few empirical references about this proposition, this paper will employ the linear econometric approach to study the determinants of artificial intelligence industry from the United Kingdom's macroeconomics for the sake of accuracy. In order to reduce heteroscedasticity and remove special points, all United Kingdom's macroeconomic variables will be taken the logarithm.

The general linear model gives:

$$\log AI_t = C + \alpha \log GDP + \beta \log EMP_t + \gamma \log INC_t + \delta \log FDI_t + \rho \log GB_t + \sigma \log INF_t + \varepsilon_t \quad (1)$$

Where C represents the constant; GDP represents the economic growth; EMP represents the employment figure; INC represents the real income; FDI represents the foreign direct investment; GB represents the government budget; INF represents the inflation; ε represents the error term; $\alpha, \beta, \gamma, \delta, \sigma, \rho$ are the coefficients.

According to the value of $\alpha, \beta, \gamma, \delta, \sigma, \rho$, it can be known how these variables (real GDP, employment figure, real income, foreign direct investment, government budget and inflation), namely, United Kingdom's macroeconomic variables affect artificial intelligence industry. Specifically speaking, if $\alpha, \beta, \gamma, \delta, \sigma, \rho > 0$, the United Kingdom's macroeconomic variables have a positive effect on artificial intelligence industry; if $\alpha, \beta, \gamma, \delta, \sigma, \rho < 0$, the United Kingdom's macroeconomic variables have a negative effect on artificial intelligence industry; if $\alpha, \beta, \gamma, \delta, \sigma, \rho = 0$, the United Kingdom's macroeconomic variables have no effect on artificial intelligence industry.

3.2. Variable Description

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In order to make a good foundation for empirical analysis, it is quite necessary to perform a good description of the macroeconomic variables used in this paper. We mainly focus on the definitions, the sources and something else. The United Kingdom's macroeconomic variables will be characterized as following depicted.

(1) GDP: It is a macroeconomic indicator that measures the economic development of a country. In this paper, it will be used to weigh the economic growth of United Kingdom.

(2) Employment figure: It is a kind of macroeconomic indicator that presents the employment status of a country. In this paper, it will be used to measure the actual number of employment figure of United Kingdom.

(3) Real income: It is a kind of macroeconomic indicator that refers to the income of an individual or group after taking into consideration the effects of inflation on purchasing power. In this paper, it will be used to measure the overall living standard of United Kingdom.

(4) Foreign direct investment: It is a kind of macroeconomic indicator that is an investment in the form of a controlling ownership in a business in one country by an entity based in another country. In this paper, it will be used to measure the actual use of foreign direct investment in United Kingdom.

(5) Government budget: It is a kind of macroeconomic indicator that is an annual financial statement presenting the government's proposed revenues and spending for a financial year that is often passed by the legislature, approved by the chief executive or president and presented by the Finance Minister to the nation. In this paper, it will be used to measure the scope, direction and policy of activities in United Kingdom.

(6) Inflation: It is a kind of macroeconomic indicator that is the rate at which the general level of prices for goods and services is rising and, consequently, the purchasing power of currency is falling. In this paper, it will be used to measure the currencies' appreciation and depreciation in United Kingdom.

(7) Artificial intelligence: It is an area of computer science that emphasizes the creation of intelligent machines that work and react like humans. Its input is also a kind of macroeconomic indicator. In this paper, its input will be used to measure its development.

In summary, all these quarterly data sets are sourced from Pitchbook Data, Statistics-GOV.UK and Organisation for Economic Co-operation and Development (OECD).

4. Empirical Analysis

4.1. Unit Root Test

In virtue of that a great deal of economic variables themselves are not stationary, if these economic variables are directly used to perform an empirical analysis, it will be very easy to generate the spurious regression. Namely, the results of empirical estimation are biased and inconsistent. Therefore, for fear of the spurious regression, it is extremely necessary to examine the stability of these economic variables before conducting an empirical analysis. At present, a menu of approaches can be used to inspect the stationarity of general variables such as the Levin-Lin-Chu test, the Agumented Dicky-Fuller test, the Philips-Perron Test and so on. In this paper, in order to ensure correctness of the testing results, two kinds of approaches will be employed to perform the empirical analysis. That is, there are the Agumented Dicky-Fuller test, the Philips-Perron Test. <Table 1> show the results of unit root test.

Table 1: Unit Root Test

	Augmented Dicky-Fuller Test			***Philips-Perron Test***		
Variable	***T-Statistic***	***5% test critical value***	***Prob.****	***Adj.t-Stat***	***5% test critical value***	***Prob.****
$\log AI$	-1.434	-2.964	0.553	-0.612	-2.960	0.854
$\log EMP$	0.496	-2.960	0.984	0.338	-2.960	0.977
$\log FDI$	-2.389	-2.964	0.153	-1.893	-2.960	0.331
$\log GDP$	-2.575	-2.960	0.109	-2.850	-2.960	0.063
$\log GB$	-1.473	-2.981	0.531	0.755	-1.952	0.872
$\log INF$	-2.440	-2.960	0.140	-2.660	-2.960	0.092
$\log INC$	-1.911	-2.964	0.323	-1.358	-2.960	0.590
$\Delta \log AI$	-2.979	-2.964	0.048	-2.984	-2.964	0.048
$\Delta \log EMP$	-3.017	-2.964	0.045	-3.475	-2.964	0.015

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$\Delta \log FDI$	-3.654	-2.998	0.013	-3.299	-2.964	0.024
$\Delta \log GDP$	-6.390	-2.964	0.000	-6.384	-2.964	0.000
$\Delta \log GB$	-3.270	-2.998	0.029	-7.354	-1.952	0.000
$\Delta \log INF$	-6.163	-2.964	0.000	-6.126	-2.964	0.000
$\Delta \log INC$	-5.450	-2.964	0.000	-7.086	-2.964	0.000

Δ indicates the first difference.

<Table 1> indicates that the all null hypothesis (having a unit root) are not rejected at their own levels. It means that all these variables are not stationary at their own levels. However, all null hypothesis are rejected after conducting the first difference under 5% significant level. In other words, all these variables are stationary after conducting the first difference under 5% significant level. It can be summarized that these variables are the process of $I(1)$.

4.2. Long-run Effect

Any change in explanatory variables will lead to two kinds of reactions to the explanatory variables. Namely, they are the long-run effect and the short-run effect. In this sector, the long-run effect will be analyzed. In econometrics, there are a lot of methods that can be used to verify the long-run effect. The most used are the Johansen cointegration test and the Engle-Granger cointegration test. In this paper, the Johansen cointegration test will be used to inspect the long-run relationship between artificial intelligence industry and GDP, employment figure, real income, foreign direct investment, government budget, inflation. The testing results show in <Table 2> and <Table 3>.

Table 2: Unrestricted Cointegration Rank Test (Trace)

Hypothesized No. Of CE(s)	***Eigenvalue***	***Trace Statistic***	***0.05 Critical Value***	***Prob.*****
$r = 0^*$	0.843	214.273	125.615	0.000
$r \le 1^*$	0.829	158.734	95.754	0.000
$r \le 2^*$	0.682	105.667	69.819	0.000
$r \le 3^*$	0.641	71.292	47.856	0.000
$r \le 4^*$	0.543	40.542	29.797	0.002
$r \le 5^*$	0.412	17.042	15.495	0.029
$r \le 6$	0.036	1.091	3.841	0.296

1) Trace test indicates 6 cointegrating eqn(s) at the 0.05 level; 2) * denotes rejection of the hypothesis at the 0.05 level.

<Table 2> shows the results of trace test. Via comparing with the trace statistic value and the 0.05 critical value, it can be summarized that there are at most five cointegration relationships among them under 5% significant level.

Table 3: Unrestricted Cointegration Rank Test (Maximum Eigenvalue)

Hypothesized No. Of CE(s)	***Eigenvalue***	***Max-Eigen Statistic***	***0.05 Critical Value***	***Prob.*****
$r = 0^*$	0.843	55.539	46.231	0.004
$r = 1^*$	0.829	53.066	40.078	0.001
$r = 2^*$	0.682	34.375	33.877	0.044
$r = 3^*$	0.641	30.751	27.584	0.019
$r = 4^*$	0.543	23.500	21.132	0.023
$r = 5^*$	0.412	15.950	14.265	0.027
$r = 6$	0.036	1.091	3.841	0.296

1) Max-eigenvalue test indicates 6 cointegrating eqn(s) at the 0.05 level; 2) * denotes rejection of the hypothesis at the 0.05 level.

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<Table 3> shows the results of Max-eigenvalue test. It can be found that there are six groups that the Max-Eigen statistic value is greater than 0.05 critical value. In other words, there are at most five cointegration relationships among them under 5% significant level.

In summary, combined the results of <Table 2> and <Table 3>, we can conclude that there are at most five cointegration relationships between artificial intelligence industry and GDP, employment figure, real income, foreign direct investment, government budget, inflation under 5% significant level. In this paper, we only select one cointegration relationship with a explained variable, namely, the artificial intelligence industry.

<Table 4> shows the normalized cointegrating coefficients

Table 4: Normalized Cointegrating Coefficients

Variable	$\log AI$	$\log EMP$	$\log FDI$	$\log GDP$	$\log GB$	$\log INF$	$\log INC$
Coefficient	1.000	-0.671 (0.033)	0.471 (0.015)	0.575 (0.036)	1.676 (0.385)	-1.240 (0.098)	0.058 (0.012)

1) ( ) indicates the standard error.

The normalized cointegrating equation gives:

$$\log AI_t = -0.671\log EMP_t + 0.471\log FDI_t + 0.575\log GDP_t + 1.676\log GB_t - 1.240\log INF_t + 0.058\log INC_t \quad (2)$$

Equation (2) indicates the long-run relationship between artificial intelligence industry and GDP, employment figure, real income, foreign direct investment, government budget, inflation under 5% significant level. It can be found that the foreign direct investment, the real GDP, the government budget and the real income have a positive effect on artificial intelligence industry. Conversely, the employment and the inflation have a negative effect on artificial intelligence industry. More concretely, 1% increase in the employment figure will lead to 0.671% decrease in the artificial intelligence industry; 1% increase in the foreign direct investment will generate 0.471% increase in the artificial intelligence industry;1% increase in the economic growth will result in 0.575% increase in the artificial intelligence industry;1% increase in the government budget will give a rise to 1.676% increase in the artificial intelligence industry;1% increase in the inflation will lead to 01.240% decrease in the artificial intelligence industry;1% increase in the real income will lead to 0.058% increase in the artificial intelligence industry. These results are also consistent with economic theories.

4.3. Short-run Effect

The short-run effect indicates that the explained variable will perform a quick response when it is suffering from an impulse of explanatory variable. In this paper, the vector error correction model will be used to manifest the short-run relationship between artificial intelligence industry and GDP, employment figure, real income, foreign direct investment, government budget, inflation. Via the lag length test, it can be found that the lag two is optimal. <Table 5> the results of vector error correction estimation with two lags.

Table 5: Vector Error Correction estimation

Model	***Model (1)***	***Model (2)***	***Model (3)***	***Model (4)***	***Model (5)***	***Model (6)***	***Model (7)***
Variable	$\Delta\log AI_t$	$\Delta\log EMP_t$	$\Delta\log FDI_t$	$\Delta\log GB_t$	$\Delta\log GDP_t$	$\Delta\log INC_t$	$\Delta\log INF_t$
ECM_{t-1}	-0.267 (0.083) [-3.217]	-0.343 (0.053) [-6.472]	0.199 (0.026) [7.654]	-0.049 (0.012) [-1.885]	0.114 (0.065) [1.754]	0.091 (0.026) [3.500]	0.486 (0.056) [8.679]
$\Delta\log AI_{t-1}$	0.196	-0.738	0.321	-0.154	-1.950	-0.432	-0.153

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	(0.025)	(0.156)	(0.079)	(0.035)	(0.079)	(0.085)	(0.065)
	[7.656]	[-4.731]	[4.063]	[-4.400]	[-2.468]	[-5.082]	[-2.354]
	0.664	-0.414	0.367	-0.183	-0.551	-0.116	-0.781
$\Delta \log AI_{t-2}$	(0.270)	(0.072)	(0.086)	(0.088)	(0.184)	(0.058)	(0.081)
	[2.459]	[-5.751]	[4.267]	[-2.080]	[-2.995]	[-2.001]	[-9.642]
	-1.169	0.665	-0.970	0.288	0.636	0.550	-0.766
$\Delta \log EMP_{t-1}$	(0.125)	(0.175)	(0.614)	(0.061)	(0.093)	(3.577)	(0.157)
	[-9.352]	[3.801]	[-1.580]	[4.721]	[6.625]	[0.433]	[-4.879]
	-0.526	1.523	-1.331	0.193	0.841	0.774	-0.352
$\Delta \log EMP_{t-2}$	(0.096)	(0.989)	(0.520)	(0.057)	(0.807)	(0.484)	(0.037)
	[-5.479]	[1.540]	[-2.560]	[3.386]	[1.042]	[1.599]	[-9.514]
	0.364	1.186	0.031	0.240	-0.132	-0.294	-0.265
$\Delta \log FDI_{t-1}$	(0.069)	(0.417)	(0.025)	(0.099)	(0.038)	(0.202)	(0.066)
	[5.275]	[2.844]	[1.240]	[2.424]	[-3.475]	[-1.455]	[-4.015]
	-0.892	1.409	-0.911	0.226	0.909	0.507	0.601
$\Delta \log FDI_{t-2}$	(0.078)	(0.969)	(0.503)	(0.121)	(0.418)	(0.078)	(0.243)
	[-11.436]	[1.454]	[-1.811]	[1.868]	[2.175]	[6.501]	[2.473]
	0.565	-3.100	1.734	-0.333	0.659	0.222	-0.956
$\Delta \log GB_{t-1}$	(0.082)	(0.929)	(0.512)	(0.091)	(0.089)	(0.045)	(0.640)
	[6.890]	[-3.337]	[3.887]	[-3.659]	[7.404]	[4.933]	[-1.494]
	1.115	0.690	0.166	0.032	-0.921	-0.266	0.342
$\Delta \log GB_{t-2}$	(0.095)	(0.153)	(0.114)	(0.029)	(0.098)	(0.061)	(0.071)
	[11.737]	[4.510]	[1.456]	[1.103]	[-9.398]	[-4.361]	[4.817]
	0.207	-0.956	0.651	-0.164	-0.648	-0.224	0.795
$\Delta \log GDP_{t-1}$	(0.058)	(0.381)	(0.071)	(0.065)	(0.077)	(0.067)	(0.078)
	[3.569]	[-2.509]	[9.169]	[-2.523]	[-8.416]	[-3.343]	[10.192]
	0.517	-1.881	0.823	-0.162	-0.920	-0.477	0.199
$\Delta \log GDP_{t-2}$	(0.121)	(0.512)	(0.718)	(0.069)	(0.479)	(0.246)	(0.087)
	[4.273]	[-3.674]	[1.146]	[-2.349]	[-1.921]	[-1.939]	[2.287]
	0.727	2.716	-1.767	0.135	0.222	0.423	-0.114
$\Delta \log INC_{t-1}$	(0.175)	(0.240)	(0.195)	(0.056)	(0.092)	(0.090)	(0.053)
	[4.154]	[11.317]	[-9.062]	[2.389]	[2.337]	[4.701]	[-2.151]
	0.435	2.380	-0.253	0.152	0.266	0.115	-0.656
$\Delta \log INC_{t-2}$	(0.081)	(0.886)	(0.119)	(0.034)	(0.033)	(0.091)	(0.087)
	[5.397]	[2.686]	[-2.109]	[4.471]	[8.061]	[1.264]	[-7.540]
	-0.830	0.042	-0.010	-0.118	-0.185	-0.063	0.424
$\Delta \log INF_{t-1}$	(0.060)	(0.008)	(0.009)	(0.086)	(0.026)	(0.019)	(0.401)
	[-13.833]	[5.251]	[-1.111]	[-1.372]	[-7.115]	[-3.316]	[1.058]
	-0.229	0.069	-0.198	0.112	-0.377	-0.156	-0.505
$\Delta \log INF_{t-2}$	(0.061)	(0.038)	(0.194)	(0.087)	(0.265)	(0.019)	(0.407)
	[-3.754]	[1.816]	[-1.206]	[1.287]	[-1.419]	[-8.211]	[-1.239]
	-0.111	0.131	-0.078	0.034	0.151	0.114	0.149
C	(0.021)	(0.013)	(0.067)	(0.030)	(0.091)	(0.066)	(0.139)
	[-5.286]	[10.077]	[-1.166]	[1.140]	[1.660]	[1.727]	[1.071]

1) ( ) indicates the standard error. 2) [ ] indicates the statistic value.

<Table 5> the results of vector error correction estimation with two lags. The model one shows the short-run relationship between artificial intelligence industry and GDP, employment figure, real income, foreign direct investment, government budget, inflation.

Their equation gives:

$$\begin{aligned}\Delta \log AI_t &= -0.267 ECM_{t-1} + 0.196\Delta \log AI_{t-1} + 0.664\Delta \log AI_{t-2} - 1.169\Delta \log EMP_{t-1} \\ &- 0.526\Delta \log EMP_{t-2} + 0.364\Delta \log FDI_{t-1} - 0.892\Delta \log FDI_{t-2} + 0.565\Delta \log GB_{t-1} \\ &+ 1.115\Delta \log GB_{t-2} + 0.207\Delta \log GDP_{t-1} + 0.517\Delta \log GDP_{t-2} + 0.727\Delta \log INC_{t-1} \\ &+ 0.435\Delta \log INC_{t-2} - 0.830\Delta \log INF_{t-1} - 0.229\Delta \log INF_{t-2} - 0.111\end{aligned} \tag{3}$$

Equation (3) shows the short-run relationship between artificial intelligence industry and GDP, employment figure, real income, foreign direct investment, government budget, inflation. It can be concluded that the artificial intelligence industry has a positive effect on itself whenever in the t-1 period and t-2 period; the employment figure has a negative effect on artificial intelligence industry whenever in

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the t-1 period and t-2 period; the foreign direct investment has a positive effect on artificial intelligence industry at period t-1 and has a negative effect on artificial intelligence industry at period t-2. the government budget has a positive effect on artificial intelligence industry whenever in the t-1 period and t-2 period; the GDP has a positive effect on artificial intelligence industry whenever in the t-1 period and t-2 period; the real income has a positive effect on artificial intelligence industry whenever in the t-1 period and t-2 period; the inflation has a negative effect on artificial intelligence industry whenever in the t-1 period and t-2 period. To be specific, 1% increase the artificial intelligence industry at the t-1 period will lead to 0.196% increase the artificial intelligence industry at the t period; 1% increase the artificial intelligence industry at the t-2 period will lead to 0.664% increase the artificial intelligence industry at the t period; 1% increase the employment figure at the t-1 period will lead to 1.169% decrease the artificial intelligence industry at the t period; 1% increase the employment figure at the t-2 period will lead to 0.526% decrease the artificial intelligence industry at the t period; 1% increase the foreign direct investment at the t-1 period will lead to 0.364% increase the artificial intelligence industry at the t period; 1% increase the foreign direct investment at the t-2 period will lead to 0.892% decrease the artificial intelligence industry at the t period;1% increase the government budget at the t-1 period will lead to 0.565% increase the artificial intelligence industry at the t period; 1% increase the government budget at the t-2 period will lead to 1.115% increase the artificial intelligence industry at the t period; 1% increase the GDP at the t-1 period will lead to 0.207% increase the artificial intelligence industry at the t period; 1% increase the GDP at the t-2 period will lead to 0.517% increase the artificial intelligence industry at the t period; 1% increase the real income at the t-1 period will lead to 0.727% increase the artificial intelligence industry at the t period; 1% increase the real income at the t-2 period will lead to 0.435% increase the artificial intelligence industry at the t period; 1% increase the inflation at the t-1 period will lead to 0.830% decrease the artificial intelligence industry at the t period; 1% increase the inflation at the t-2 period will lead to 0.229% decrease the artificial intelligence industry at the t period. The coefficient of ECM is -0.267. It means that when the long-run equilibrium breaks due to the short-run shock, the short-run fluctuation will return to the long-run equilibrium by 0.267% in the opposite direction.

5. Conclusion

The artificial intelligence industry belongs to emerging industry, also, called sunrise industry. Its rapid development has changed our traditional lifestyle and brought a lot of convenience to our everyday life. Due to this background, this paper sets United Kingdom as an example to analyze the determinants of artificial intelligence industry in terms of United Kingdom's macroeconomics. The quarterly time series from the first quarter of 2010 to the fourth quarter of 2017 will be used and a menu of econometric approaches such cointegration test and the vector error correction model will be employed to testify the operation mechanism of each determinant in macroeconomics so as to the artificial intelligence industry. The overall result of this paper indicates that there is a long-run relationship between artificial intelligence industry and GDP, employment figure, real income, foreign direct investment, government budget, inflation.

To be specific, the result of cointegration test shows that the cointegration relationship between artificial intelligence industry and real GDP, employment figure, real income, foreign direct investment, government budget, inflation. There into, the real GDP, the real income, the foreign direct investment and the government budget have a positive effect on artificial intelligence industry. Conversely, the employment figure and the inflation have a negative effect on artificial intelligence industry. The result of the vector error correction model shows the short-run relationship artificial intelligence industry and real GDP, employment figure, real income, foreign direct investment, government budget, inflation. It can be concluded that the artificial intelligence industry has a positive effect on itself; the employment figure has a negative effect on artificial intelligence industry; the foreign direct investment has a positive effect on artificial intelligence industry at period t-1 and has a negative effect on artificial intelligence industry at period t-2. the government budget has a positive effect on artificial intelligence industry; the real GDP has

a positive effect on artificial intelligence industry; the real income has a positive effect on artificial intelligence industry; the inflation has a negative effect on artificial intelligence industry.

The empirical evidence in this paper also provides some suggestions to United Kingdom's government. In macroeconomics, the United Kingdom's government should take macroeconomic regulation and control to promote the artificial intelligence industry. For instance, even though the United Kingdom's government's artificial intelligence industry experiences a high speed development, the United Kingdom's government should spare no effort to offer some room such as the developing circumstance and capital input for the development of artificial intelligence industry. Then, with the economic globalization, the United Kingdom's government's government should open its artificial intelligence market so as to promote the exchange of artificial intelligence. Meanwhile, the United Kingdom's government can use the tax means to adjust the real income. A good tax means can make the national capital distributed best. Finally, the United Kingdom's government still needs monetary policy to balance the inflation. The smaller inflation can lead to more input of artificial intelligence industry.

All in all, the purpose of this paper is to exploit the determinants of artificial intelligence industry in terms of United Kingdom's macroeconomics. Therefore, via the evidence in this paper, the United Kingdom's government can take proper measures to promote the development of the artificial intelligence industry so as to bring more benefits to United Kingdom. Specifically speaking, there are two approaches to promote the development of the artificial intelligence industry. One is that United Kingdom's government can increase the real GDP, the real income, the foreign direct investment and the government budget so as to promote the artificial intelligence industry. Another is that United Kingdom's government can aggrandize the development of artificial intelligence industry via lowering the inflation.

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