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ARTICLE

Sustainability of Public Debt and Economic Growth in Cote d'Ivoire: is There a Threshold Effect?

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ABSTRACT

The development of Ivorian public debt in recent years has raised concerns. Is its current level capable of boosting the economy or, on the contrary, being at the source of a recession? This paper analyzes the effect of the level of indebtedness on economic growth in Côte d'Ivoire using the Threshold Autoregressive (TAR) model over the period 1970-2018. The results obtained in the short run shed light on the no relationship between public debt and economic growth. In the long run, on the other hand, there is a bi-directional granger causality between public debt and the sustainability of economic growth. The non-linearity between the variables of interest has been studied and the results show the presence of a threshold effect: beyond 48.03 percent of GDP, any increase in public debt by 1% should reduce economic growth by 0.28%. Thus, the study questions the relevance of the criterion set by the WAEMU: public debt <70% of GDP.

1. Introduction

In the past decade, the economic literature on economic growth and public debt has been the subject of numerous papers. Debt is used for spending to create wealth and stimulate the economy. However, Panizza and Presbitero [23] and Kumar and Woo [36] establish a threshold value beyond which any increase in public debt could negatively impact economic growth. For Freeman and Webber (2009) the level of public debt is not essential. Rather, it is the use of this resource that can either positively or negatively impact the economy. Indeed, according to the latter if these resources were used in productive sectors such as nutrition, education and health, its impact on the economy would be positive regardless of its level.

The level of public debt in Côte d'Ivoire has grown drastically since the 1980s. It reached its maximum in 1994. At that date (1994), the level of public debt to GDP was 173.87%, more than double of the community standard set by WAEMU. To understand the evolution of Ivorian debt, one must delve into the past of African countries. after independence, difficulties mainly arose due to a snowball effect of debt; It was in this climate that the first oil shock of 1973 occurred when the price of oil quadrupled. The huge profits made by OPEC countries are placed in private international banks. The latter lend them to developing countries at relatively attractive rates. The World Bank is also following this trend. From 1968 to 1978, it increased its loans to developing countries tenfold [18]. No control is carried out,

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and the beneficiary countries will very often embark on the construction of white elephants.

Meanwhile, the prices of agricultural export products, the main resource, of African countries are sinking, they are reaching the lowest levels ever recorded. This is largely due to continued overproduction (Dutch syndrome) and deteriorating terms of trade. Besides that, it should be remembered that the United States, wanting to revive its economy, raised interest rates in the 1980s. This considerably increased the interest burden on borrowing countries. Consequently, many African countries borrow to repay.

To deal with these financial difficulties, several measures are taken depending on the country. In Côte d'Ivoire, we are witnessing the dismantling of the Agricultural Product Price Stabilization and Support Fund (CAISTAB) in 1990; the privatization of state-owned companies and the devaluation of the FCFA in January 1994. The main purpose is to achieve economic growth of around 6% by 1996, with an increase in exports and a consolidation of public finances (primary balance objective aligned with the Community standard of the around 3%), and by reducing the harmful effects of structural adjustment on the poorest social strata [20]. It is true that contrary to pessimistic forecasts, the devaluation of the devaluation of the FCFA by 50% has had some beneficial effects on economic activity. According to Akiko *et al*. [3], in three years the increase in GDP due to devaluation would be around 4.8%. This is due to the fall in unemployment and the resulting competitiveness.

However, from 1996 onwards it became clear that not all of these measures were large enough to resolve the financial difficulty. The main international financial institutions therefore ended up implementing, in the same year, the so-called Heavily Indebted Poor Countries (HIPC) initiative. This initiative involves significantly reducing the debt burden of poor countries and making them sustainable.

Côte d'Ivoire after decades of effort has seen its external debt reduced by 24% following its eligibility for the HIPC program in 1998. In 2012, when reaching the achievement point, some macroeconomic indicators have greatly improved: external debt stocks on GDP rose from 67% to 18% for a normal ratio which should be less than 40%. The stock of external debt on total revenue, which should be less than 250%, was on the rise from 351% before the HIPC to 99% in 2012. In terms of domestic debt on exports, it went from 148% to 36.1%. When it was enough to be less than 150%. And finally, the public debt ratio, which should not be greater than 70% to GDP, fell from 79% to 36.2% after the HIPC.

However, it is a truism to assert that the level of debt, in particular public debt has been constantly increasing in recent years: from 43% in 2013%, it almost 55% in 2018 and this in less than a five-year term. This raises some questions: Is the level of public debt sustainable? Does it stimulate economic growth or, on the contrary, is it harmful for the Ivorian economy? Is there a threshold effect beyond which public debt negatively impacts economic growth?

This study aims to highlight the empirical relationship between the sustainability of public debt and economic growth with a special focus on threshold models.

The remainder of the paper is organized as follows: Section 2 is dedicated to the literature review. Section 3 describes the data and related econometric methodology. Section 4 reports and discusses the empirical results. Section 5 questions the existence of plausible threshold effects based on a further assessment. Section 6 concludes the paper.

2. Literature Review

2.1 The Theory of Over-indebtedness

Theories on public debt are very varied. Among the most important are that of Barro [31]. Indeed, the latter reveals a total neutrality of the debt on the economy. This theory, however, is attributed to 19th century English economist Ricardo and quoted "Ricardian equivalence". He hypothesizes the rationality of economic agents and shows that a deficit fiscalpolicy, financed by borrowing has no effect on economic activity, insofar as agents are no longer victims of a 'fiscal illusion' today. The agents make perfect anticipations and they will integrate this change into their decision. Consequently, they will perfectly anticipate the increase in future taxes intended to repay the initial loan and, in anticipation of these future withdrawals, they will immediately build up savings equivalent to the public debt, thus compromising the policy of fiscal stimulus.

Krugman [19], he defines over-indebtedness as the negative relationship between external debt and investment. In this sense, over-indebtedness occurs when indebted countries can no longer meet their burdens. Other researchers have also supported this theory, in particular, Chowdhury [8] and Elbadawi *et al*. (1997). In other words, the very high debt level no longer favors investment. Consequently, the rates of return on projects in progress fail to reduce the level of debt to a reasonable level.

According to Krugman [19] the high level of debt suggests an increase in future tax rates. As these rates are highly dependent on the level of investment, these new taxes are likely to create distortions in investment. The immediate consequence is that the expected return from productive investment projects will be insignificant for reviving economy; to the extent that planned debt service spending will weaken foreign and domestic investment. If

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economic agents realize rational expectations, this theory of over-indebtedness can be challenged. Irrefutably, the latter anticipating a future increase in taxes may reduce their consumption which could have negative impacts on growth. Furthermore, there is no longer any need to prove the link between savings and investment and high debt with possible tax hikes can erode savings which in turn will negatively affect growth. This theory of over-indebtedness assumes for the aforementioned reasons that it must have a maximum threshold beyond which any increase in debt can have a negative impact on economic growth. What emerges from this analysis is that the level of over-indebtedness is apparent when any increase in the level of debt reduces economic growth through investment.

2.2 Public Debt Sustainability Economic Growth

For some authors, the relationship between public debt and economic growth can be perceived in a non-linear form. Among these authors, we can cite Reinhart and Rogoff [30] and Daud *et al*. [11]; for these authors, beyond a certain value, the public debt is no longer sustainable for the economy and is experiencing economic growth. They assess the optimal value of public debt between 60% and 90% of GDP. But other authors have questioned this value. For example, Minea and Parent [4], using a Panel Smooth Transition Regression (PSTR) reassess this inflection point and set the threshold point around 115%. For them, beyond this value, the debt would become unsustainable for the economies insofar as it will have a negative impact on the economy through the investment channel.

Smyth and Hsing [32] show that the optimal level of debt is 48.9% to GDP by using a quadratic model applied to USA economy. In addition, Clements *et al*. [9] using data from a panel of 55 middle-income countries over the period 1970-1999 also observed the negative effect of the debt but on a level beyond the interval between 20% and 25 % of GDP.

Patillo *et al*. [22] they studied the relationship between public debt and economic growth through a panel of 93 countries covering a period of 30 years (1969-1998) and also highlighted a threshold effect. According to them, the positive effect of debt sustainability comes at values below 35% - 40% of GDP. But if the ratio debt to exports is beyond 160%-170%, public debt becomes unsustainable for the economy and causes distortions. According to them, at this moment, these are the negative effect of debt on growth, the effect of debt on liquidity due to the drain on debt service and finally the effect of public sector spending and deficits.

The aforementioned authors are unanimous that, depending on the state of an economy, there is a maximum value beyond which any increase in public debt seems to erode growth. This maximum value is very much dependent on the economic dynamics of the country. To understand the strong impact of the level of public debt on the economies of developing countries, we must look closely at the structure of the economies of these countries. For a long time, these countries remained dependent on their raw materials, thus constituting very extroverted economies. The debt problem of developing countries is therefore not only due to its level but more to the structure of its economy. For example, the level of public debt, ratio public debt to GDP of the OECD member countries and the USA were respectively 112.2% and 104.17% in 2015. This same year the level of public debt of Japan was largely above 200% in relation to GDP. And during these years it was seen to see growth in these aforementioned countries.

For other authors, this non-linear relationship between public debt and economic growth is not always observable. This is how Adam and Bevan [1] and Aizenman *et al*. [2] demonstrate a negative linear relationship between public debt and the rate of economic growth.

As for Greiner [16], he rather highlights the state of the economy. According to him, if in an economy wages and unemployment are flexible then in this case, any increase in the public debt can positively impact the economy because the debt will be used to finance the productivity of investments.

The issue of public debt continues to be crucial due to the upward trend in public spending. High public spending seems to accelerate economic growth. As consumption exceeds income levels, the size of the budget deficit will increase. The government can increase its borrowing to finance the deficit from local or external sources. Although the financial situation may improve, it is nevertheless very sensitive to changes in the current economic situation and the level of public debt. According to Teles and Mussolini [35], if public expenditure is directed towards unproductive expenditure such as subsidies and pensions, it will thus lead to a drop in economic growth.

The economic literature highlights this ambiguity between the level of public debt likely to generate sustainable growth and does not decide the impact of unsustainable public debt on economic growth.

3. Data and Econometric Methodology

3.1 Data

The study uses annual data covering the period 1970-2018. A log-log model is used in order to derive the elasticities to explain the differences between the coefficients of the

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study variables. The variables are the economy growth rate (LGDP), public debt (LDEBT), investments (LINV), general government consumption expenditure (LCONS), the opening rate (LOPEN) and the debt service (LDS).

3.2 Econometric Methodology

The aim of this paper is to analyze the relationship between the sustainability of public debt and economic growth in Côte d'Ivoire over the period 1970-2018. The model used is inspired by the work of Solow [33] and Baumol [6].

In order to study the non-linear relationship between public debt and economic growth, we favor the threshold effect autoregression (TAR) method of Caner and Hansen [7]. The basic model is described as follows:

$$g_t = \begin{cases} a_1 d_t + \varepsilon_{1t}, \; if \; d_t > \pi \\ a_2 d_t + \varepsilon_{2t}, \; if \; d_t \le \pi \end{cases} \quad (1)$$

where d_t=π is the threshold effect (public debt) and g_t economic growth. The above equation system presents two schemes. According to Chudik *et al*. (2015) the augmented form of the above non-linear model can be rewritten :

$$\Delta lng_t = \alpha_1 I_t\left[d_t > (\pi)\right] + \alpha_2 I_t\left[d_t \le (\pi)\right] + \sum_{i=3}^{n} \alpha_i \Delta lnx_t + \varepsilon_t \quad (2)$$

In this last equation, the usual dichotomous variables are used. The other variables alongside economic growth, public debt and dichotomous variables are used and represented by x_t: openness rate, government consumer spending, debt service, investments.

3.2.1 Unit Root Tests

As a first step in the modeling exercise, it is first necessary to determine the order of integration of the variables (LGDP, LDEBT, LGFCF, LGGFCE, LOUV, LDS). The stationarity of these variables is tested using two techniques: one without structural break, and another one which take into account the structural breaks in the series.

(1) Unit root tests without structural break - The Augmented Dickey-Fuller Test (DFA) [12,13].

In the majority of empirical studies, due to its power, the DFA test is preferred to detect the presence of unit roots. This test is an augmented version of the Dickey-Fuller (DF) test by adding lagged of the dependent variable.

$$\Delta Y_t = \mu + \alpha Y_{t-1} + \beta t + \sum_{j=1}^{k} c_j \Delta Y_{t-j} + \varepsilon_t \quad (3)$$

where Δ is the first difference operator, Y_t the variable under investigation, ε_t a white noise process with variance σ^2, ΔY_{t-j} the lagged first differences with correction for possible autocorrelation of errors. The optimal lag (k) is determined based on Akaike (AIC) and Schwarz (SBIC). The null hypothesis of the presence of unit root is tested against the alternative: the series is stationary.

The DFA test involves performing a regression on the first difference of the variable being studied, on a constant, a linear deterministic trend, a lagged prime difference and a lagged k-difference.

The common problem with conventional unit root tests such as the test we have just seen (DFA) and many others (test by Philippe Perron (PP) and Dickey Fuller generalized least square (DF-GLS)) is not taken into account the probable structural breaks in the series. This very often causes bias in the test results. For example, to say that the socio-political crisis of 2010 must have caused structural breaks in the series studied is stating the obvious. This is why Perron [26] and Rappoport and Reichlin [29] emphasize the importance of structural breaks for the implementation and interpretation of unit root tests.

(2) The tests of unit roots with structural rupture by Zivot and Andrew (ZA) [37] and by Clemente, Montañés and Reyes [10].

The importance of these tests with taking into account structural breaks is that they are more robust than ordinary tests: ADP, Perron test and so on.

① The test of unit roots with structural break by Zivot and Andrew (ZA) [37].

This test is an extension of the DFA test. It is written as follows,

$$y_t = \alpha + \beta t + \gamma DU1_t + \omega DT1_t + \mu y_{t-1} + \sum_{i=1}^{k} c_i \Delta y_{t-i} + \varepsilon_t \quad (4)$$

The null hypothesis establishes that there is presence of unit root in the time series (y_t). The alternative hypothesis is that the series is stationary. DU_{1t} and DT_{1t} are indicator variables which capture the change in the constant and in the trend at the date *Tb* respectively. Explicitly,

$$DU_{1t} = \begin{cases} 1, if \; t > Tb \\ 0, otherwise \end{cases} \quad and \quad DT_{1t} = \begin{cases} t - Tb, if \; t > Tb \\ 0, otherwise \end{cases}$$

② The test of Clemente, Montañés and Reyes [10].

Baum [5] suggests using the technique based on the models of Perron and Vogelsang [27,28] for the unit root test in the presence of structural rupture. The latter propose to use the additive outlier (AO) model when the change is supposed to have an instantaneous effect and the innovative outlier (IO) model for a slow effect. In this study,

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we assume that the change created, for example, by the socio-political crisis of 2010 instantly affects all sectors of the economy. Thus, the appropriate model is the Clemente-Montañés-Reyes unit root test based on the AO model. This test is carried out in two stages. First, the deterministic part of the dependent variable is removed from the equation,

$$y_t = \mu + d_1 DU1_t + + d_2 DU2_t + \tilde{y}_t \quad (5)$$

In the second step, the following model is used to test the presence of unit roots,

$$\tilde{y}_t = \rho \tilde{y}_{t-1} + \sum_{i=0}^{k} \omega_{1i} DTB_{1t-i} + \sum_{i=0}^{k} \omega_{2i} DTB_{2t-i} + \sum_{i=1}^{k} c_i \Delta \tilde{y}_{t-i} + e_t \quad (6)$$

The IO model will not be presented. We can refer to the important paper by Perron [25].

3.2.2 Cointegration Tests

The cointegration test of Gregory and Hansen [15] is used in this study with the aim of testing the presence of structural breaks in the cointegration relationship between the variables of interest (economic growth and public debt). This test is more robust than the cointegration test of Engle and Granger [14] which tends to reject the null hypothesis of non-cointegration less if there is a cointegration relationship that has changed on a certain date (unknown) in the study period. In reality the Gregory and Hansen test is an extension of the approach of Engle and Granger and it involves testing the null hypothesis of non-cointegration against the alternative of cointegration presence with presence of a structural rupture at an unknown date; based on the extension of the usual tests ADF, Z and Z_t.

The standard cointegration approach as used by Engle and Granger [14] in the absence of structural failure is based on the following model:

$$y_t = \mu + \alpha_1 x_t + \varepsilon_t \quad (7)$$

where y_t is the dependent variable, x_t a vector of explanatory variables which are all I(1) and the error term ε_t is I(0). Based on this model and to take into account possible structural breaks, Gregory and Hansen [15] define a dichotomous variable such that:

$$\varphi_t = \begin{cases} 0, \ if \ t \le [n\tau] \\ 1, \ if \ t > [n\tau] \end{cases}$$

where $\tau \in (0,1)$ indicates the relative date of structural break and [ ] the integer part. In order to propose cointegration tests with structural breaks, the authors develop four (04) models:

(1) Model with break in the constant term, C

$$y_t = \mu_1 + \mu_2 \varphi_t + \alpha_1 x_t + \varepsilon_t \quad (8)$$

where μ_1 represents the constant term before the break and μ_2 the intersection after the structural break.

(2) Model with break in the constant term and trend, C/T

$$y_t = \mu_1 + \mu_2 \varphi_t + \beta t + \alpha_1 x_t + \varepsilon_t \quad (9)$$

where β is the trend coefficient, t.

(3) Model with break in the constant and the slope, C/S

$$y_t = \mu_1 + \mu_2 \varphi_t + \alpha_1 x_t + \alpha_{11} \varphi_t x_t + \varepsilon_t \quad (10)$$

α_1 represents the slope coefficients of cointegration of explanatory variables before the structural break and α_{11} the slope coefficients after the break.

(4) Model with break in the constant, the trend and the slope, C/S/T

$$y_t = \mu_1 + \mu_2 \varphi_t + \alpha_1 x_t + \beta t + \alpha_{11} \varphi_t x_t + \varepsilon_t \quad (11)$$

Model (4) is deduced from models (2) and (3).

3.2.3 Causality Tests

After having established that a cointegration relation is present among the variables, the vector error correction model (VECM) which combines both the short-term properties of the economic relation in the form of first difference and the long relation term (at level) is estimated from the following equation:

$$\begin{bmatrix} \mathrm{GDP}_t \\ DEBT_t \end{bmatrix} = \sum_{i=1}^{p} \begin{bmatrix} \beta_{1i} & \gamma_{1i} \\ \beta_{2i} & \gamma_{2i} \end{bmatrix} \times \begin{bmatrix} \mathrm{GDP}_{t-i} \\ DEBT_{t-i} \end{bmatrix} + \begin{bmatrix} \lambda_1 \\ \lambda_2 \end{bmatrix} ECT_{t-1} + \begin{bmatrix} \varepsilon_{1t} \\ \varepsilon_{2t} \end{bmatrix} \quad (12)$$

ECT represents the error correction term lagged by a period. The length of the lag is determined by the Schwarz Information Criterion (SBIC). The null hypothesis that GDP does not cause DEBT in the Granger sense is rejected not only if $\sum\beta$ is significant but also if the coefficient of ECT_{t-1} is significant [21]. However, in the error correction model, causal inference is obtained through the significance of λ. In other words, the null hypothesis that DEBT does not cause GDP in the Granger sense is rejected if λ is statistically significant even if $\sum\gamma$ is not significant. The direction of causation is also tested through the VEC Granger causality tests. The results of the error correction estimate and the VEC Granger causality test are presented in Table8.

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4. Econometric Results

4.1 Descriptive Analysis

In this section, the variables used in the study are all analyzed: (LGDP, LDEBT, LINV, LCONS, LOPEN, LDS). The first step in an economic study is to validate the choice of variables in the model. As for Tabachnick and Fidell [34], the independent variables with a correlation between them greater than 0.70 should not be included simultaneously in a regression and this in order to preserve their exogeneity. Thus, the first step of our analysis begins with the Pearson correlation matrix.

Based on Table 1, all the variables in the model should be kept. Definitely, the highest correlation coefficient between the explanatory variables is 0.571 which is that between debt and debt service. In addition, it is noted that the negative correlation between public debt (LDEBT) and economic growth (LGDP) on the one hand and between debt service (LDS) and economic growth (LGDP) on the other hand. This suggests a negative impact of these variables (public debt and debt service) on the Ivorian economy.

Table 1. Pearson Correlation Matrix

	LGDP	LCONS	LINV	LOPEN	LDS	LDEBT
LGDP	1					
LCONS	-0.488	1				
LINV	-0.093	0.263	1			
LOPEN	0.111	-0.438	-0.128	1		
LDS	-0.306	0.394	-0.077	-0.328	1	
LDEBT	-0.027	-0.067	-0.676	-0.223	0.571	1

Source: Author's calculation

Table 2. Main Characteristics of Explanatory Variables

Variable	Obs	Mean	Std Dev.	Min	Max
DEBT	49	77.08481	40.10907	15.53266	173.8719
GDP	49	9.75E+12	3.24E+12	4.65E+12	1.99E+13
CONS	49	14.59935	2.037536	10.45996	18.25428
INV	49	15.35327	5.82431	8.253466	29.66121
OUV	49	74.41731	10.70439	55.34852	95.06973
DS	49	8.472261	5.758578	1.580064	21.91397

Source: Author's calculation

Over the study period, it is noted that on average the level of public debt (LDEBT) represents around 77% of GDP. This value is higher than the WAEMU standard of 70% of GDP. About GDP, over the entire study period its value was almost multiplied by more than four. Furthermore, General government final consumption expenditure (CONS) are volatile: low value in 1996 (10.45996) and the maximum value in 1989 (18.25428). This fact can be explained by the devaluation of FCFA in 1994. After this date, the WAEMU countries had to reduce the consumption expenditures.

According to Figure 1, the analysis of the evolution of public debt can be done in three phases. From 1970 to 1994, the level of public debt continued to increase, reaching its maximum level (around 174% of GDP) in 1994. The level of debt had become unsustainable for the Ivorian economy this year. This can be explained by the many loans taken out with international banks during the 1st oil shock in 1973, which is one of the reasons for the devaluation of the CFA franc in the same year. In phase 2, from 1994 to 2012, the public debt continues to fall. Several reasons may explain this development. In particular, obtaining the completion point of the Heavily Indebted Poor Countries Initiative (HIPC) in 2012 and the willingness of the Ivorian authorities to comply with the Community standard. Finally, a last phase which begins after 2012. It should be noted that since this date, the Ivorian public debt has been growing. In fact, the years when the debt level is high correspond to the years of low growth. The rate of economic growth in recent years has been remarkable, but it should be noted that it has been continuously declining. At the same time, over the same period, the level of debt only increased.

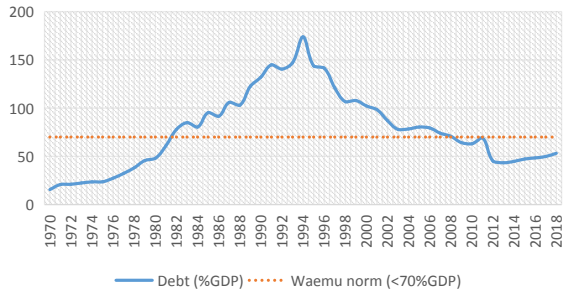

Figure 1. Evolution of Public Debt

Source: Author

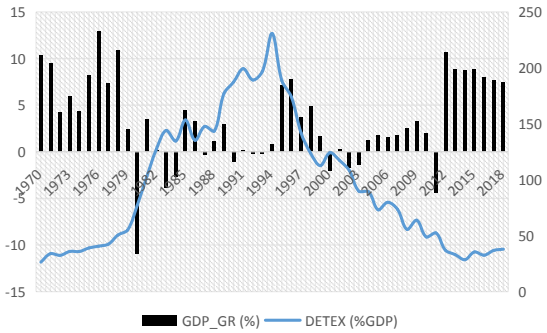

Figure 2. Relationship between GDP growth and Debt

Source: Author

Based on Figure 2, there seems to have a negative relationship between the level of indebtness (in this figure, DETEX denotes external debt) and economic growth.

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4.2 Traditional Unit Root Tests

(1) Augmented Dickey-Fuller (ADF) Test

This test is very sensitive to the length of the lag, so before going on to the calculations, it is necessary to determine the optimal delay for each variable using the information criteria of Akaike (AIC) and Schwarz (SBIC). The AIC and SBIC criteria are often written in the form [-2logL + kp]; where L is the likelihood function, p the number of parameters in the model, and k is 2 for the AIC criterion and log (n) for SBIC.

Table 3. Optimal lag series in levels

Series \ Lag		0	1	2	3	4
LGDP	AIC	60.359	56.506	56.342*	56.384	56.396
	SBIC	60.399	56.586	56.463*	56.545	56.597
LDEBT	AIC	1.500	-1.381	-1.379	-1.421*	-1.412
	SBIC	1.5405	-1.300*	-1.259	-1.261	-1.211
LINV	AIC	0.879	-0.936*	-0.933	-0.907	-0.890
	SBIC	0.919	-0.856*	-0.813	-0.747	-0.689
LCONS	AIC	4.343	3.453*	3.476	3.489	3.532
	SBIC	4.384	3.534*	3.596	3.649	3.733
LOPEN	AIC	-1.013	-2.180*	-2.140	-2.110	-2.099
	SBIC	-0.973	-2.100*	-2.019	-1.949	-1.898
LSD	AIC	2.247	0.443	0.452*	0.496	0.540
	SBIC	2.288	0.523	0.572*	0.656	0.741

Notes: * represents the number of optimal lag obtained from the information criterion used.

Source: Author

The variables LGDP and LDS have an optimal lag 2 (Table 3). while the variables LINV, LOPEN and LCONS they have the optimal lag 1. Thus the variable LDEBT, the criteria AIC and SBIC are contradictory. In this type of case, we refer to the SBIC criterion because it is more robust than the AIC criterion for a sufficient population size.

According the ADF tests in Table 4, all the variables are *I*(1). To confirm this result other tests accounting for structural breaks are performed.

Table 4. Unit Root Tests (ADF)*

Variables	ADF in levels		ADF in first differences		Conclusion
	τ_μ	τ_t	τ_μ	τ_t	
LGDP	0.042	-1.840	-3.219**	-3.225*	*I(1)*
LDEBT	-1.979	-1.380	-5.727***	--6.775***	*I(1)*
LINV	-1.588	-1.117	-5.769***	-5.916***	*I(1)*
LCONS	-2.623	-3.812**	-6.803***	-6.722***	*I(1)*
LOPEN	-1.943	-1.495	-6.714***	-6.894***	*I(1)*
LDS	-1.586	-2.254	-4.377***	-4.485***	*I(1)*

Notes: ***, ** and * indicate statistical significance at 1%, 5% and 10% respectively. τ_μ = statistic with constant ; τ_t = statistic with constant and trend.

(2) Test of Zivot and Andrew (ZA) [37]

As indicated in Table 5, the null hypthesis of the presence of unit roots for all variables is not rejected. The structural break dates are also presented. Based on first differences, the results suggest that we can reject the hypothesis of the presence of unit roots for all variables at 1%. We can conclude that the test of Zivot and Andrew [37] which gives the date of structural breaks leads to the same results as the conventional DFA test.

Table 5. Unit Root Tests Zivot and Andrew

	Model A: Break in the constant			Model C: Break in the constant and trend			Conclusion
	t-statistic	k	T*b*	t-statistic	K	T*b*	
Levels							
LGDP	-2.136	1	2011	-3.450	1	2011	*I*(1)
LDEBT	-3.145	0	1977	-4.019	0	1990	*I*(1)
LINV	-2.879	0	1983	-2.432	0	2004	*I*(1)
LCONS	-5.230**	1	1994	-4.055	1	1979	*I*(1)
LOPEN	-2.536	0	1994	-2.357	0	2011	*I*(1)
LDS	-3.181	0	2001	-3.253	0	1981	*I*(1)
First Differences							
LGDP	-6.185***	0	1979	-5.058***	0	1981	*I*(1)
LDEBT	-8.282***	0	1995	-7.565***	0	2011	*I*(1)
LINV	-6.569***	0	1979	-6.285***	0	1984	*I*(1)
LCONS	-6.689***	1	1997	-6.027***	1	1995	*I*(1)
LOPEN	-8.377***	0	1994	-7.315***	0	2006	*I*(1)
LDS	-6.855***	0	2007	-6.105***	0	2004	*I*(1)

Notes: The critical values obtained from model A (C) are -5.34, -4.80 and 4.11 (-5.57, -5.08 and -4.82) respectively at 1, 5 and 10% levels of significance. ***, ** and * indicate rejection of the null hypothesis at 1%, 5% and 10% levels of significance respectively. Tb is the year of the structural break and k the optimal lag selected to conduct unit root tests ADF. As in the ADF, the SBIC is used to select the optimal lag.

(3) Unit Root Tests Clemente, Montañés and Reyes [10]

In the Table below is presented the results of the unit root test of Clemente, Montañés and Reyes [10] with a structural rupture in the AO model. In Table 6, du1 and rho-1 respectively represent the date of the structural rupture and the unit root. Despite the presence of structural rupture in all the series, we cannot reject the null hypothesis of a unit root in the variables studied at 5%. In other words, as demonstrated by all of the previous unit root tests, all six (06) variables are not stationary at level, although the presence of structural break has been taken into account. Figure 3 shows the dates of structural break.

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Table 6. Results of the Model AO

	LGDP	LDEBT	LINV	LCONS	LOPEN	LDS
Niveau						
du1	0.684*** (6.207)	-0.366* (-1.399)	-0.560*** (-6.898)	-0.192*** (-6.22)	0.100** (2.528)	-1.002*** (-6.038)
rho-1	-0.156 (-2.142)	-0.229 (-3.088)	-0.167 (-1.771)	-0.573 (-1.868)	-0.901* (-4.459)	-0.405 (-2.505)
Point optimal of break	2013	2012	1985	1990	1991	2000

Notes: ***, ** and * indicate statistical significance at 1%, 5% et 10% respectively. The number is parentheses is the t statistic.

4.3 Cointegration Tests

Results of the estimation of the cointegration test of Gregory-Hansen [15] with structural break are presented in Table 7. The test is carried out by controlling the variables GFCF, GGFCE, OUV and SD. All the statistics (ADF, Zt and Zα) are obtained for the four (04) models for comparison: the C; C / T; C / S and C / S / T models. The results indicate the rejection of the null hypothesis of non-cointegration at 1% in the C; C / T and C / S / T models and at 5% in the C / S model.

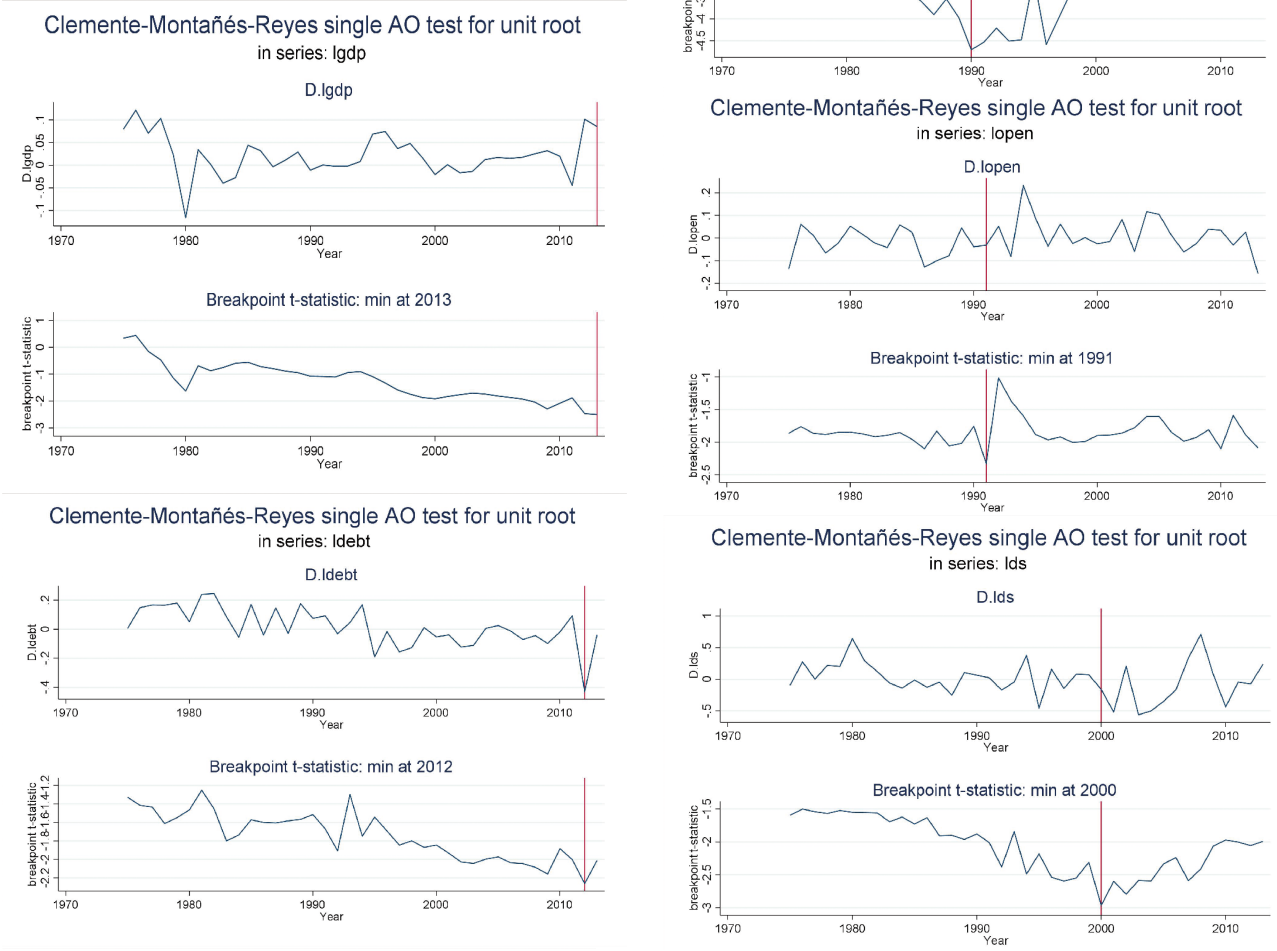

Figure 3. Results of Unit Roots Tests [10], AO Model

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The existence of a cointegrating relationship between debt and economic growth indicates that the series evolve together in the presence of a structural break and share common stochastic trends.

Table 7. Cointegration Results of Gregory-Hansen [15] (Growth – Public Debt)

Test statistic	Estimated Value of the test statistic	Break Point	Break Date	Asymptotic Critical Values (CV)		
				CV at 1%	CV at 5%	CV at 10%
(1) Break in the constant term, C						
ADF	-5.32***	41	2010	-5.13	-4.61	-4.34
Z_t	-5.38***	41	2010	-5.13	-4.61	-4.34
Z_α	-36.65	41	2010	-50.07	-40.48	-36.19
(2) Break in the constant and trend terms, C/T						
ADF	-6.12***	30	1999	-5.45	-4.99	-4.72
Z_t	-6.18***	30	1999	-5.45	-4.99	-4.72
Z_α	-43.32	30	1999	-57.28	-47.96	-43.22
(3) Break in the constant term and slope, C/S						
ADF	-5.40**	31	2000	-5.47	-4.95	-4.68
Z_t	-5.46**	31	2000	-5.47	-4.95	-4.68
Z_α	-37.34	31	2000	-57.17	-47.04	-41.85
(4) Break in the constant, trend and slope, C/S/T						
ADF	-6.14***	29	1998	-6.02	-5.5	-5.24
Z_t	-6.69***	28	1997	-6.02	-5.5	-5.24
Z_α	-47.56	28	1997	-69.37	-58.58	-53.31

Notes: Asymptotic critical values are taken from Gregory and Hansen [15]. The length of the lag is chosen based on the AIC criterion with a maximum lag of 5. The asterisks ***, ** and * indicate the rejection of the null hypothesis at significance levels of 1%, 5% and 10% respectively.

Using model C, the structural break date identified is 2010. This date is confirmed by ADF and Zt statistics and corresponds to the start date of the Ivorian socio-political crisis. The dates 1997 and 1998 indicated in the C / S / T model, they correspond to the period of the difficult succession of President Félix Houphouët-Boigny who died in 1993. This period characterized by a deleterious political climate will reach its peak in 1999 and 2000: date corresponding to the first coup d'tat carried out in Cote d'Ivoire. This date is clearly indicated by the C / T and C / S models.

4.4 Causality Tests

In order to analyze the causality between public debt and economic growth we carry out the causation test in the sense of Granger. The results summarized in Table 8 indicate the absence of causality, in the Granger sense, between the variables of interest: economic growth does not cause public debt and public debt does not cause economic growth. The point estimates of the error correction terms show a long-term bidirectional causality between economic growth and the level of debt (DEBT → GDP and GDP → DEBT).

Table 8. Granger Causality Test Results (Growth – Public Debt)

Dependent Variable	Lag	Causal Variable in the Short Run		Causality in the Long Run
		GDP	DEBT	ECT_{t-1}=0
GDP	1	---	3.940 (0.268)	-0.011** [0.006]
DEBT	1	1.210 (0.751)	---	-0.031** [0.016]

Notes: Statistics for short-term causation are Chi-square with p-values in parentheses. As for the statistics relating to long-term causality, these are the coefficients of ECTt-1 with the standard errors in brackets. The asterisk ** indicates rejection of the null hypothesis at 5% significance levels.

5. A Further Assessment

To determine the threshold effect of public debt on economic growth; the procedure of Caner and Hansen [7] was followed. According to Table 9, the LM statistic is estimated at 18.00 and significant at 1%. Furthermore, the threshold effect is estimated at 48.03% for a confidence interval of [48%; 53%].

Table 9. Non linearity Tests

Hypothesis Test	LM test	Bootstrap P-Value	Estimating the threshold effect (%)	Confidence Interval at 95%
H_0: Absence of threshold effect	18.00***	0.002	48.03	[48%; 53%]

Notes: The null hypothesis is the absence of the threshold effect against the alternative hypothesis of the presence of threshold effect. *** indicates statistical significance at 1% level.

The existence of the threshold effect is tested and it is confirmed by the F (Gamma) test (see Figure 4). Indeed, the value of the F (Gamma) statistic exceeds the critical value. Thus, the null hypothesis of linear relationship between the variables is rejected in favor of the alternative hypothesis: presence of threshold effect.

The results of the estimates of the economic growth and public debt model of Côte d'Ivoire over the period 1970-2018 are presented in Table 10. In column (2) of this table is presented a regression not taking into account the threshold effect. The last two columns highlight the two regimes of the TAR model.

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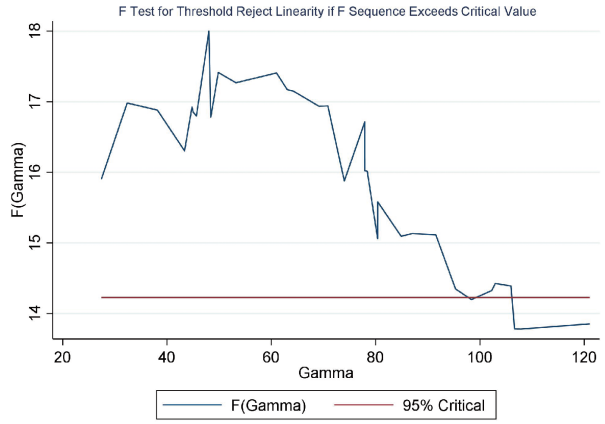

Figure 4. Non linearity Test

Built on the linear model estimated by the Ordinary Least Square (OLS) technique, it is established that public debt (LDEBT) has a positive effect on the economy (LGDP). according to the value of the estimated coefficient of the public debt (= 0.5884) if the latter increases by 1%, the GDP would increase by 0.5884%. The estimated coefficient is significant at 1%. Given that all the previous tests indicate the presence of a threshold effect, the two regimes obtained with the regression of the TAR model will be taken into account. This model updated a threshold effect estimated at 48.03% of GDP. In the low regime (public debt ≤ 48.03%), public debt has a positive effect on the Ivorian economy with an estimated coefficient of 0.9973 significant at 1%. In other words, a 1% increase in public debt under this regime would induce a GDP increase of 0.9973%. In the high regime (public debt> 48.03%), public debt has a negative effect on economic growth with a coefficient of -0.2815 which is significant at 1%. This means that any 1% increase in public debt in this high regime would lead to a drop in GDP of 0.28%. In the low regime, the opening rate has a positive impact on GDP but is not statistically significant. In the high regime, the opening rate has a negative and significant impact on the economy. This suggests that the opening rate contributes to an increase in economic growth if the debt level is contained (low model).

Table 10. Regression economic growth and public debt

Variables (Logarithme)	Linear Model	Model with threshold	
	(OLS without threshold effect)	Regime 1 ≤ 48.03%	Regime 2 > 48.03%
Constant	28.5946*** (1.9180)	26.8471*** (0.9386)	36.6196*** (1.1782)
LDEBT	0.5884*** (0.1339)	0.9973*** (0.0521)	-0.2815*** (0.0933)
LINV	0.5172* (0.1571)	0.1874 (0.1541)	0.2247*** (0.0862)
LCONS	-0.5183* (0.3391)	-0.5123** (0.2222)	-0.6686*** (0.1268)
LOPEN	-0.1342 (0.3085)	0.1654 (0.2048)	-0.8791*** (0.1380)
LDS	-0.3253*** (0.0751)	-0.3332*** (0.0403)	-0.2020*** (0.0329)
Observations	49	15	34
R^2	0.49	0.97	0.84

Notes: The dependent variable is the logarithm of GDP over the study period (1970-2018). Standard deviations are listed in parentheses. ***, ** and * indicate statistical significance at 1%, 5% and 10% levels respectively.

Regardless of the level of debt, investment has a positive impact on economic growth. In the low model, the investment effect is not significant compared to the high model where the coefficient is significant at 1%. The level of debt seems to have no negative effect on economic growth. Despite the negative effect of public debt on economic growth, there is no evidence to support the presence of the phenomenon of public debt sustainability so that any increase in public debt will distort investment when the public debt of the country is in the high regime.

In both regimes, final consumption expenditure by general government (GGFCE) in relation to GDP has a negative and significant impact at 1% on economic growth. But in the high model, this negative impact is greater than in the low model. Debt service (DS) also has a negative impact on economic growth regardless of the regime in which we find ourselves. Unlike government final consumption expenditure, debt service has a much greater negative effect in the high regime than in the low regime. This can be explained by the fact that a highly indebted country benefits from certain favors (rescheduling and / or reduction of public debt).

6. Final Remarks

The purpose of this study was to analyze the effect of public debt sustainability on Ivorian economic growth. The results highlight the short-term non-causality between the variables of interest. On the other hand, in the long term there is a bi-directional causality between public debt and economic growth. This suggests that the level of debt can impact the sustainability of long-term economic growth. This is why it would be wise to borrow within responsible limits so that in the future these loans do not constitute obstacles to development.

The study determines the threshold effect beyond which the authorities must not exceed. Indeed, in the low regime [debt ≤ 48.03%] any increase in GDP of 1% boosted the economy by around 0.99%. In the high regime [debt> 48.03%], any 1% increase in the level of debt reduces growth by 0.28%; This value calls into question the value

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of the WAEMU standard set at 70% of GDP. This value should be understood in the context of a panel (eight countries), which may suggest the existence of several threshold effects if we take the specificity of each country; and that it would be the highest threshold effect that would have been chosen as the standard. In addition, it should be pointed out that no matter what the regime in which the Ivorian economy finds itself in, any increase in public debt does not seem to have any negative impact on investments. As the latter have a positive impact on economic growth, following Krugman's [19] definition that there is no effect of over-indebtedness in Côte d'Ivoire and that economic growth is sustainable. These results are partly due to the fact that the Ivorian debt is under control by the authorities and that the investments made are productive.

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REVIEW

A Literature Review of the "Burning Money" Behavior of Internet Products

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ABSTRACT

This article mainly studies the current status of the operation of the "burning money model" of Internet products, expounds and analyzes the disadvantages of this operating model, studies the practical effects brought by the "burning money model", and explores the development direction of future Internet products. Domestic scholars have done a lot of research on the development of Internet products in the future and have achieved certain results. This article aims to discuss the development model of China 's Internet products, summarize the current "burning money" behavior in the operation process of Internet products, and combine the development situation of China 's Internet in the new era to make suggestions for the future development of Internet products.

1. Introduction

The "burning money" behavior is in the early stage of the operation of Internet products. In order to win a large number of customers for this product, Internet companies invest a lot of money for their products, which will bring attractive benefits to consumers, grasp consumer spending habits, and make others Competitors are difficult to insert, so they have the opportunity to win a large number of customers for them. In short, it is to sacrifice profits in exchange for rapid market share and scale expansion. In recent years, with the close connection between the mobile Internet and people's lives, various convenient APPs have sprung up in the smartphones of the public. However, most APPs acquire users through the behavior of "burning money" in the early stages of operation. "Burning money" is the only way for Internet products to obtain traffic. However, the business model that only relies on "burning money" must not be a permanent one. So, where will these Internet products develop after "burning money"? This article will conduct an in-depth study of "burning money" behavior, explore the development model of China's Internet companies, solve the development problem of Internet products after "burning money", and provide suggestions for the future operation mode of China's Internet products. In this paper, I searched for the keyword "burning money" on the China Internet, and found a total of 7,871 results. By referring to more than 30 documents, this article summarized the literature review on the "burning money" behavior of Internet products.

2. Evaluation of Domestic Scholars on "Burning Money Model" Operation

2016 is the first year for the development of Internet

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products similar to bicycle sharing. After that, investors have aimed at the market. Nowadays, as new competitors continue to raise funds, investors' investment in bicycle sharing has gradually become rational, but Derivatives of the Internet similar to bicycle sharing still use "burning money" as the main operating method.

At present, domestic scholars have not paid enough attention and confirmed whether this "burning money" behavior can bring expected profit growth.

Ph.D. student Junchen Wang of Guanghua School of Management, Peking University researched in "Myth of Burning Money: The Growth Strategy Choice of the Initial Stage of the IPO of the Company", and pointed out that nearly half of the Internet companies adopt the strategy of burning money. Such "burning money" companies focus on investing in new areas.

Long cycle, slow profit, the accumulation of market risk often makes the later efficiency lower than expected. At the same time, the original business will stagnate due to insufficient investment and even lose money, forcing capital to be continuously refinanced. Only a small number of companies can pass the follow-up and have been huge success, but most companies are in trouble because of refinancing obstacles. Therefore, the "burning money" strategy will cause the company's growth rate to be significantly discrete. Junyi Wang concluded that the current "burning money" expansion is not a universally effective growth strategy. Although the burn-in subsidy seems to be unsatisfactory, if it is effective at the beginning of the development of the industry, in the long run, this development model is not permanent.

Peng Zhang of Tuoda Network Technology also mentioned in a post: Because each emerging Internet product crosses the river by feeling the stones, the loyalty of users has not yet been established, and it is easy to burn users to their own platforms by burning money. However, when users have a habit of using a product or even rely on it, it will be difficult to dig a wall with a small cost. In addition, blindly relying on subsidies to ignore the serviceability of the product itself will still lead to the loss of a large number of users. Similarly, most domestic scholars' research also holds a similar point of view, and believes that the customer source obtained through the "burning money model" has a strong instability. The premise of most consumers using a platform is to enjoy benefits.

If another platform offers a more preferential model, these consumers will immediately transfer.This shows that the "burning money model" has not achieved the purpose of the operator. Domestic scholars' current research on "burning money model" has proved that the business model of "burning money" must not be a long-term solution.Admittedly, the "burning money model" attracted a lot of user traffic, but it is not a long-term strategy to retain customers [1].

3. Problems in the Development of China's Current Internet Products

"Beijing Business Daily" reported in August 2018 that there are currently a large number of companies burning money to confirm that there are losses. Seeing that the number of users is increasing, they are willing to invest in capital. This model seems to be developing rapidly, but once the subsidy funds cannot keep up, the entire chain will not be able to operate. It is true that at the initial stage of APP operation, Internet companies can indeed bring huge user traffic at the expense of their own profits by subsidizing users. When the money-burning company has developed to a certain stage, it needs Greater capital investment. Compared with those start-up money-burning companies, the investment required is still relatively small. When the money-burning companies get the IPO funds, they can subsidize users again, but the marginal utility is diminishing. The growth rate of benefits brought by burning money will slow down and even enter a recession period. When capital no longer plays a role in the company's performance, a large amount of capital will not be invested in "burning money" companies. In the long run, those companies that rely on burning money to survive will eventually fail the debt of too much debt and bankruptcy [2].

"Shenzhen Special Economic Zone News" reported the comment of well-known commentator Shen Bin, "Internet +" industry is fiercely competitive, blindly burning money, jockeying, and unscrupulously increasing market share, which may provoke unfair competition and cause distortions in the industry. confusion. This view has brought the adverse effects of the "burning money model" to a wider level. China has always been committed to establishing a free, equal, and fair socialist market economic system with Chinese characteristics, and this approach is clearly inconsistent with our goals. On the other hand, the crazy burning of land and expansion of the market has lowered the barriers for enterprises to enter. The true quality of products and services have been ignored. Consumers have paid more attention to subsidies and forgot their real needs. In order to bring huge disadvantages to the competitive market.

The editor of "Modern Commerce" mentioned that: Both sides seem to invest a lot of money, but a detailed analysis of each subsidy is used. Burning money is a reward behavior in itself. It is commendable that this feed-

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back is 100% accurate, so that every customer involved has a good user experience. This experience will be infinitely amplified in the continuous word of mouth. Bring immeasurable leads. Scholars with this view obviously only see the short-term effects of the "burning money model". At the same time, what are the Internet products that blindly burn money without understanding the real needs of customers? Can this feedback be 100% accurate? Obviously not. After all, the user experience still falls on the quality and service of the product itself. When studying the effects of an operating model, we must not focus on immediate interests [3].

4. Survey of Internet Product Investors

Xiaohu Zhu, founding partner of Jinshajiang Capital, once mentioned that for investors, the value-added space of the enterprise is very important. Investors pay special attention to long-term customer retention, that is, customer retention after six months, and 20% of customers can stay after six months, which is what investors think is a very promising company. Even if user retention does not reach 20% after six months, if the company's update of each operating strategy makes its customer retention curve continue to improve, this company is worth investing in. Xiaohu Zhu believes that revenue retention can be a measure of what kind of users you leave. For good products, revenue retention is 40% -50%. Therefore, how can an Internet company launch a new product to win the favor of investors? After all, it depends on long-term customer retention, and the short-term peak user traffic brought by the "burning money model" will not have much financing effect at all. Therefore, from the perspective of financing, the products launched by Internet companies should also start with changing the operating model and polish the product quality and service. Rational investors focus on the value-added space of the enterprise. Therefore, the development of Internet companies should also focus on the development of the product itself [4].

5. The Development Direction of China's Internet Products in the Future

We must acknowledge that if any kind of Internet product operation model raises the transaction cost of the industry, reduces the industry's operating efficiency, and runs counter to commercial common sense, then this product will be doomed to be eliminated. Therefore, by analyzing the disadvantages brought by the "burning money model", the "burning money model" is by no means a long-term solution. We must point out the correct direction for the future development of Internet products.

Our government must strengthen scientific macro-control and cannot blindly lower the barriers to entry for Internet companies. In addition, related policies have been used to curb capital inflows to "burning money" companies. The government must be aware that the support for the Internet industry will ultimately fall on the quality and services of the Internet product itself. It is not true that with the financial support, the industry will be promoted. Promote online and offline integration, and improve the service chain and supply chain system of Internet products. Let users' needs be reflected in the growth of stable user volume, not just in the growth of traffic. Only by improving the service level of these Internet products and truly meeting the needs of users, can they retain users and maintain their user traffic [5].

At the same time, Internet companies should also intensify innovation and try to combine online and offline. The size of corporate benefits is not only the growth of user traffic as the sole criterion, but also actively conduct market research offline to improve product services and quality. The goal is to retain real users as the main purpose. Enterprises should also pay attention to finding ideas from reducing costs. The "burning money model" continues to increase operating costs. In the Internet era, reducing costs, compressing expenses, and increasing customer stickiness are important ideas for its development. Nowadays, the pursuit of maximizing product value is in line with the trend of social development. For example, the development of Qu Toutiao APP, a large amount of advertising investment, users can only get cash by swiping the news, users just swipe to complete tasks, the user viscosity is very low, as the amount of cash back decreases, the Lost a large number of users. In contrast to Xiaomi's operating model, after having a certain user base through fan marketing, Xiaomi used the platform of Weibo to attract new users, which reduced the cost of publicity. After attracting fans through Weibo, they then screened through forums to cultivate some fans, thereby strengthening the stickiness of users and Xiaomi-related products. Therefore, it is said that the real cost investment does not depend on the amount of investment, but on the economic benefits obtained after the investment [6].

6. Concluding Remarks

Through a series of studies, it was found that a good business model does not rely solely on burning money. In the early days, Didi did not want to subsidize customers, but WeChat wanted to subsidize it, thereby gaining more WeChat users. , So a "didi" grant was given. So Didi didn't spend a penny when it was on the rise. The same is true for "Hungry?" In the early days, its figures were

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very good [7]. More than 50 people from a hundred people would place orders, and the repeat purchasing power of these people was very good, so that the "Meituan" could not catch up with "Hungry" through subsidies "Are you there?". Therefore, the really good business model does not depend on burning money.

The needs brought about by subsidies are "pseudo-demands". If the subsidies are stopped, customers can retain valuable operating models. Therefore, the research and development of Internet products must meet the "pain points" of users. Development of service chains and service chains [8].

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REVIEW

The Contribution and Prospect of 5G Technology to China's Economic Development

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ABSTRACT

Since the birth of 5G, it has attracted much attention from all countries in the world. The development of 5G industry is particularly important for domestic economic development. 4G changes life, 5G changes society. 5G will not only accelerate the speed of people surfing the Internet, but also bring revolutionary changes to all aspects of social life, making people's lives, work and entertainment more convenient and diverse. The economic impact of the development of the 5G industry on China cannot be underestimated. Nowadays, information and communication technology has increasingly become a new driving force for economic development. 5G technology has already become a key technology pursuit for countries to compete for the status of world power, and it has also become an indispensable part of contemporary economic and social development. We should give full play to the government's guiding role, and work with network giants to build a new platform for cooperation, promote coordinated industrial development, achieve win-win results, and promote economic and social prosperity and development.

1. 5G Applications Accelerate Economic and Social Transformation

In last year's "two sessions", 5G was the focus of attention. At the same time, the operator's 5G signal also appeared in the two sessions for the first time. The full coverage of 5G signals and the 4K high-definition video broadcasted in real time made people feel 5G. charm.

5G is a key weapon in the digital transformation of the economy and society. In the future, the deep integration of 5G with cloud computing, big data, artificial intelligence, VR and other technologies will become the key infrastructure for digital transformation in various industries. On the one hand, 5G will provide users with ultra-high-definition video to bring a super-sensuous service experience to customers, and it will surely promote the upgrade of people's experience. On the other hand, 5G will support massive amounts of machine communication, and APPs and cooperation goals represented by smart cities and smart homes will make mobile communications play a greater role. It is expected that 100 billion devices will access 5G networks. More importantly, 5G will also exist in all aspects of social life and become an integral part of it with its superior performance. Generally speaking, the widespread appli-

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cation of 5G will further deepen people's awareness of innovation, which is conducive to "mass entrepreneurship and innovation for all." In the 21st century, 5G commercialization will occupy a dominant position, and China will become the pioneer and leader of 5G technology, and guide all countries in the world to participate in building a manufacturing power and a network power [1].

2. Stimulate Increased Digital Investment in Various Fields and Promote the Steady and Healthy Development of the Macro Economy

Economic growth theory shows that capital accumulation is a key factor in promoting economic growth. Compared with other factors, capital accumulation has a more direct and significant role in driving economic and social development. As an important component of aggregate demand, the increase in investment will directly drive the expansion of aggregate demand, increase aggregate output, and promote economic development. From the perspective of investment fields, the total investment absorbed by 5G will be much higher than that of 4G network construction. The large-scale application of 5G technology and the operator's investment in 5G networks and related supporting facilities will effectively promote the national demand for network equipment. Conducive to the development of related industries. Investment will also form new capital in various forms, promote technological progress and increase production efficiency, and provide inexhaustible power for sustainable development of the economy and society. From the perspective of consumption, 5G's high efficiency and low cost will attract various industries in the national economy to expand 5G investment, which will help improve the digitalization of the industry, and then achieve the purpose of stimulating consumption and promoting economic growth. In terms of exports, the arrival of the 5G era is conducive to exports. Huawei has signed 5G commercial contracts with many countries around the world, ranking first in the world.

3. Promote Industrial Innovation and Stimulate Consumption

At present, China's economic and social development has entered a new era of consumption-led growth. 5G plays an important role in expanding consumption and releasing domestic demand. The application of 5G will effectively promote industry innovation, and enable new information products such as smart homes and wearable devices to effectively serve everyone in the society, so that millions of households can experience the convenience and speed of 5G, increase the awareness of the public and promote economic development of. At the same time, 5G can even drive "Internet +" related consumption. 5G technology will be able to penetrate into all areas of people's life, and give customers a brand-new fruitful experience in all aspects, effectively promote the development of virtual reality shopping, the Internet and other fields, so that people's consumption is no longer limited by time and place, and real Freedom of consumption [2]. In this epidemic, we can know a few things. The supply of vegetables in the supermarket is in short supply, and there are a large number of people who cannot afford fresh vegetables. Moreover, I believe that with the advancement of technology, 5G will make people's lives easier and faster. Therefore, I think the application of 5G will effectively promote the socio-economic development and stimulate consumption.

4. Expand International Market Space and Enhance China's Comprehensive Advantage

Under the conditions of an open economy, the role of international trade and international investment in a country's economic growth has become increasingly significant. The expansion of 5G internationalization has played a significant role in driving China's economy. Despite the obstruction of various parties, Huawei has signed 5G commercial contracts with more than 30 countries around the world. The number of 5G base stations is also increasing. This helps to expand the scale of China's foreign trade, helps China occupy more market shares in the international market, and plays an important role in promoting rapid economic growth and optimizing and upgrading the economic structure. In terms of investment, the rapid development of 5G has promoted the export of communication equipment. We should make full use of and tap foreign resources and foreign markets, increase total net exports, promote domestic demand expansion, and then drive domestic economic growth [3].

5G not only means to continue to innovate in the consumer Internet market and bring new service experiences to consumers. It is also more important to open the door to Internet markets in various industries around the world, enabling every industry and industry to implement cloud-based office and help digital Economic development has an irreplaceable acceleration of social and economic development.

5. 5G's Contribution to Employment Growth

The widespread application of 5G will on the one hand improve the working efficiency of enterprises and force some people to leave their jobs. On the other hand, the development of 5G technology will create a large number

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of high-skilled employment opportunities. The linkages between them expand the scope of employment.

The deployment of 5G can effectively drive the rapid development of the industrial chain. 5G needs to purchase a large amount of network equipment during the construction process, which will drive China's equipment manufacturing enterprises to research and develop more advanced electronic equipment, master the core technology themselves, and no longer be subject to people. 5G can effectively promote the upgrading of mobile phone terminals, and will promote mobile phone manufacturers to manufacture more advanced and richer products. 5G will also promote the Internet and other related companies to develop more and better APPs, and promote the improvement of the overall information service industry. 5G will create a large number of highly knowledgeable jobs. While 5G will drive employment in the mobile communications industry, it will also spawn a number of new electronic information service positions related to cloud computing and intelligent algorithm development, creating more job opportunities and making it more flexible, convenient and fast.

It is estimated that 5G will create more than 8 million jobs in 2030, and 5G formal commercial use will directly create about 540,000 jobs in 2020. With the expansion of the scope of 5G applications and the deepening of the application field, 5G will provide about 3.5 million employment opportunities in 2025.

6. Prospects for Economic Development in the 5G Era

With the connection of 5G networks, smart factories have become the general trend. The combination of smart factories and many advanced technologies in the future will maximize resource utilization, production efficiency and economic benefits. For example, with the help of 5G high-speed networks, the use of big data and cloud computing technology to integrate information and manage and analyze related data, identify problems and make adjustments in a timely manner. Under the premise of ensuring normal production, the production process, equipment, and energy should be correspondingly handled Supply and personnel adjustments to minimize costs and maximize returns are the ultimate goals pursued by each enterprise; when managing raw material inventory, when a customer order is placed, the system automatically calculates the required raw materials, and according to the supply The supplier information calculates the purchase time of raw materials in real time to ensure that the inventory cost is the lowest or even zero while meeting the delivery time. With the advent of the 5G era, these are no longer heaven and earth, it is helping the realization of the Chinese dream with an unstoppable momentum.

Therefore, smart factories in the 5G era will greatly improve labor conditions, realize mechanization and intelligence, liberate labor, and improve the controllability of the production process. The most important thing is that we should use network tools to make intelligence penetrate all aspects of enterprise development. The realization of all links from design, production, sales and after-sales service is conducive to the integration of resources and maximizes the utilization of resources, thereby further improving the production efficiency and product quality of enterprises [4].

7. Seizing the Opportunity, China is Leading the New Trend of 5G Industry Development

"China's mobile industry has been led by following in many ways, and the development of 5G is a clear representative of it." China is very advanced in thinking about the economic and social development that 5G will bring, and is leading in the world. Not only is China technologically advanced, it is also very open-minded and is at the forefront. China will be a leader, not a follower, of the mobile communications industry in the future [5].

7.1 Consolidate the Foundation and Strive to Achieve Full 5G Coverage

Promote the coordinated development of 5G networks and 4G networks, accelerate the construction of 5G infrastructure, achieve effective coverage from urban to rural areas, further strengthen the co-construction and sharing of networks, and strive to build 5G networks with complete coverage, stable quality, and resource conservation. The government cooperates with the public and related enterprises, and focuses on strengthening investment in 5G network infrastructure construction in the central and western regions and rural poor areas.

7.2 Close Integration of Industries to Accelerate Industrial Intelligent Upgrade

The coordinated development of 5G technology and the Internet + breaks traditional manufacturing barriers and promotes the intelligent upgrade of related products. Promote the establishment of enterprise demonstration models and innovation platforms, improve innovation awareness, school-enterprise cooperation, and mutual benefit and win-win. Drive the development of related industries, let machines replace labor, achieve intelligent control, and improve production efficiency [6].

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7.3 Strengthen International Cooperation and Share Global Development

Build an international 5G test platform and promote global unification of 5G standards. Strengthen China's global technology exchanges and build a win-win global 5G industry ecosystem. Seizing the opportunity of historical development, actively fostering the awareness of international cooperation among domestic enterprises, the government has stepped up incentives to promote the global development of 5G technology services for domestic enterprises [7].

8. Concluding Remarks

In a word, the widespread application of 5G will provide solid support for mass entrepreneurship and innovation, help build a manufacturing power and a network power, and make the new generation of mobile communications a key technology leading the country's digital transformation. It is expected that in the future, 5G will become a key infrastructure for building a digital transformation of the economy and society [6]. From online to offline and from consumption to production, it will support the rapid development of China's online medical and artificial intelligence industries and promote the development of China's digital economy Take new steps to continuously promote the emergence of new models and new industries, and cultivate more new ideas for economic development [8].

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ARTICLE

Modeling of Economic Cost Distribution in Screw Thread

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ABSTRACT

The screw threading produce is a important process course. The economics modeling is established in this paper so this process will be investigated. In this paper modeling of process is analyzed. The Q and cost decreases with the increasing quantity while the same turn as AC>AFC>MC is found. AC and AFC is main factors to affect quantity then MC do. It fits to concept of them well. The cost AC and AFC is higher upon L=4 than L=6 while MC is higher upon L=6 than L=4. Meantime the TC and VC is higher upon L=6 than that upon L=4, is the near parallel line. The TC>VC is turn to affect cost. There is a difference for them. TC and VC is main effective costs to compare with AC, AFC & MC. The TC and VC become bigger upon K=5 than K=7.

1. Introduction

In motor thread process the screw will be granted thread which is a important process to form complete profile good. The cost evaluation is a important one to save person and capital. So model is established that includes function of cost and quantity to solve the cheapest cost. It lets L is a independent variable and L and K is constant to find the cheapest cost. In economics the cost may be calculated according to define different parameter so it is solved by the correspondent formula to each parameter. The establishment of fact parameter is based on the thread process only and it is found that the every cost changes in a course with independent variable. The cost is significant in economics which may draw every curve to evaluate the whole trend in quantity [1-6]. Only in this way can we find the optimum path to choose and solve our cost aim. Certainly in this computation it is optimum original parameters to ensure the reality and optimum. By comparison it is found the whole data fit to well. So it is thought that the establishment is successful by this path. We can compute the formula through a certain parameter and adopt optimum resolution to obtain constant for our cost evaluation. We looks forwards to making a role in our cost and quantity calculation in this paper [7-9].

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2. The Economics Non Linear Modeling

Production quantity Q is defined as below

$$f(L,K) = Q = \gamma L^{\alpha} K^{\beta} \tag{1}$$

γ is technique coefficient; α is producing labour; β is capital elasticity. It has

$$LN\gamma = LNQ - \alpha LNL - \beta LNK \tag{2}$$

Due to equation (1) it obtains

$$LN(Q_1 / Q_2) = \alpha LN(L_1 / L_2) + \beta LN(K_1 / K_2) \tag{3}$$

Here, 1 and 2 is two coordinate.

$$LN(Q_2 / Q_3) = \alpha LN(L_2 / L_3) + \beta LN(K_2 / K_3) \tag{4}$$

α is solved in terms of (3) and it can be gotten

$$\alpha = \frac{LN(Q_1 / Q_2)}{LN(L_1 / L_2)} - \beta LN(K_1 / K_2) \tag{5}$$

And $$\alpha = \frac{LN(Q_2 / Q_3)}{LN(L_2 / L_3)} - \beta LN(K_2 / K_3) \tag{6}$$

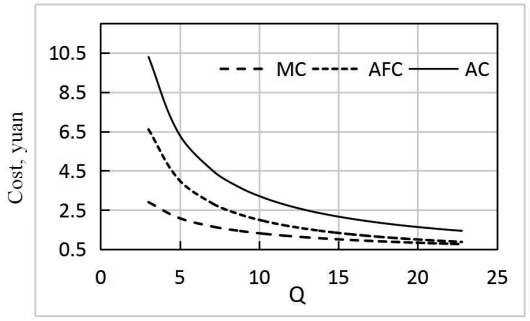
In terms of above equation below can be gotten

$$\beta = \frac{LN(Q_2 / Q_3) - LN(Q_1 / Q_2) LN(L_2 / L_3) / LN(L_1 / L_2)}{LN(K_2 / K_3) - LN(L_2 / L_3) LN(K_1 / K_2) / LN(L_1 / L_2)} \tag{7}$$

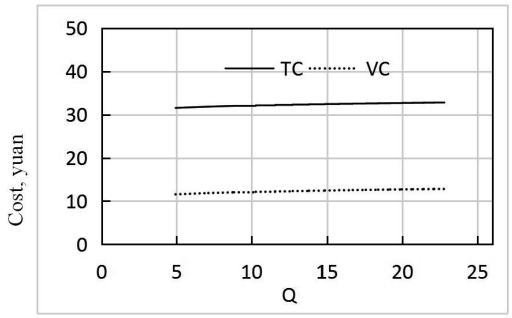
Here, TC is total cost;VC is variable cost. AC is average cost; MC is marginal cost; AFC is average fixed cost.

3. Discussion & Analysis

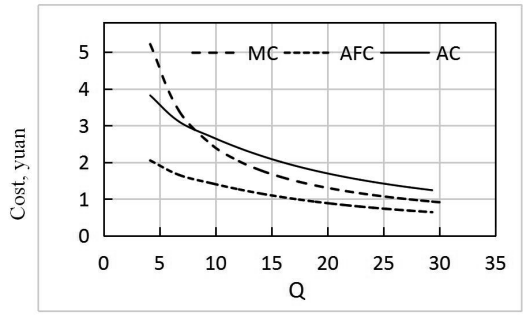
As to cost and quantity in Figure 2(a~d), it is found that the cost will decrease with the increasing quantity while AC is the highest cost then AFC the last MC. Meantime the cost AC and AFC is higher upon L=4 than L=6 while MC is higher upon L=6 than L=4. On the other hand the TC and VC is higher upon L=6 than that upon L=4, is the near parallel line they have. But their differences are a certain of several Yuans to save compare them each other. It explains that with the increasing labor to 6 the cost is slight high of several Yuans than 4. It is found that relationship of Q and cost in Figure 3(a &b) decreases with the increasing quantity while the same turn as Figure 2 above is owned ie. AC>AFC>MC. The AC and AFC decreases sharply when quantity decreases to 5 while MC decreases slowly until 5. It explains that AC and AFC is main factors to affect quantity then MC do. It fits to concept of them well. However TC and VC increases from 20 and 0 to 80 and 60 with increasing quantity from 0 to 77. TC>VC is turn of them, it fits to concept of them well. The difference is 20 for them. TC and VC is main effective costs to compare with AC, AFC & MC.



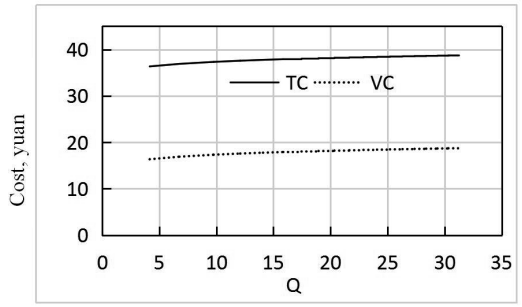
(a) L=4



(b) L=4



(c) L=6



(d) L=6

Figure 2. Relationship between cost and quantity in screw thread with different parameters L

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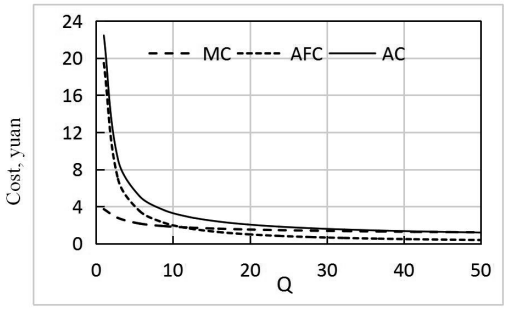
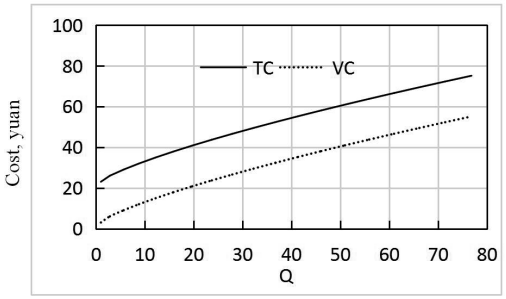


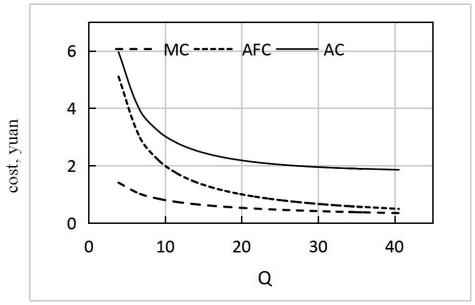
(a) L=1, 2, ⋯10



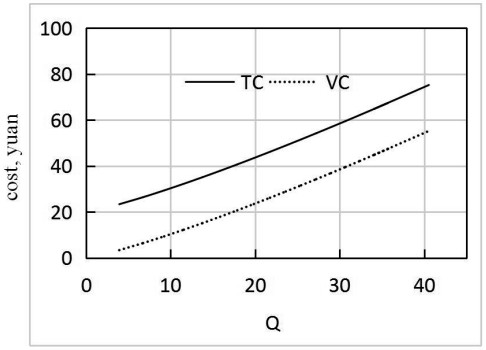
(b) L=1, 2, ⋯10

Figure 3. Relationship between cost & quantity in thread

As shown in Figure 4(a-d) it is found that AC, AFC & MC have the same behavior as discussed above two Figures.Whereas in Figure 4(c) the MC is found to increase with Q upon K=7. The TC and VC become bigger upon K=5 than K=7 while their difference is 15 and 20 respectively. It explains that with the increasing K to 5 the TC and VC will increase a certain too.



(a) K=5



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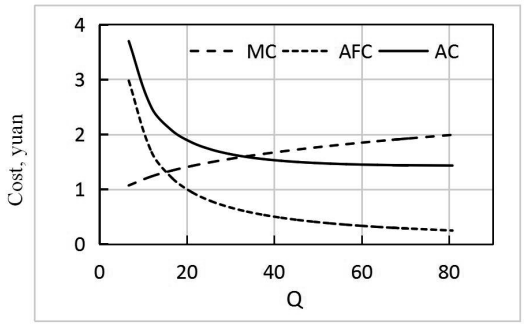
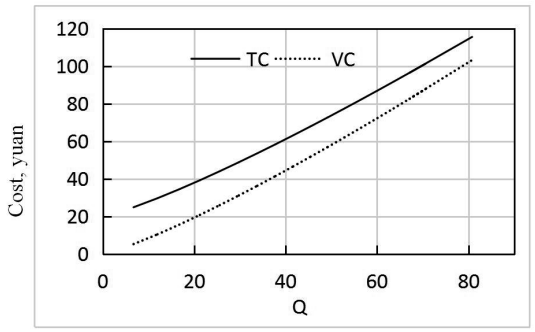


(c) K=7



(d) K=7

Figure 4. Relations between cost & quantity in thread

4. Conclusions

(1) Overviews, the Q and cost decreases with the increasing quantity while the same turn as AC>AFC>MC is found. AC and AFC is main factors to affect quantity then MC do. It fits to concept of them well. The cost AC and AFC is higher upon L=4 than L=6 while MC is higher upon L=6 than L=4. Meantime the TC and VC is higher upon L=6 than that upon L=4, is the near parallel line.

(2) The TC>VC is turned to affect cost. There is a difference for them. TC and VC is main effective costs to compare with AC, AFC & MC. The TC and VC become bigger upon K=5 than K=7.

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ARTICLE

Research on the Economic Vitality of the Northeast China

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ABSTRACT

Economic vitality is an important indicator of regional competitiveness. The demand for talents and the vitality of enterprises in different regions are obvious to all and have practical significance. Therefore, it is necessary to establish a survey data model and conduct in-depth study on improving regional economic vitality from the perspective of policy. Based on a variety of forecasting methods, this paper analyzes the short-term and long-term impact of economic policies in Northeast China, and finally puts forward the factors that affect the economic vitality of northeast policies. Finally, the paper puts forward the feasibility and targeted suggestions of strengthening regional economic vitality, obtaining long-term development and building a more competitive city in the new era.

1. Introduction

In recent years, different regions have introduced relevant economic policies for different regional resources to enhance regional economic vitality and regional competitiveness. This paper analyzes the short-term and long-term impact of economic policy transformation on economic vitality, and further studies the influencing factors of improving regional economic vitality.

The title requires an analysis of the short- and long-term effects of economic policy transition on the economic vitality of a region. Choose two indicators that have more impact on economic vitality: household consumption level, GDP, and sort out the annual indicator data in Northeast China to analyze the impact, that is, analyze how the economic vitality has changed after the policy was introduced. Therefore, we first look for economic policies issued by the state in recent years, and then use the forecasting method to predict the short-term and long-term economic vitality changes after the policy is issued, and explain the related impacts according to the changes.

2. Apply Forecasting Methods to Analyze Impact

2.1 Policy Background

The Trinity of the traditional economic system is the reason for adopting the planned economy in a capital-poor economy. The main shortcomings of the economic system are economic inefficiency caused by structural imbalances and incentives, and the transformation of economic policies affects regional economic vitality.

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2.2 Short-term Impact

The short-term forecast method is used to compare the data of a certain short-term indicator in a future year with the actual data to obtain a comparison result, which illustrates the impact of the introduction of policy on economic vitality. This forecast comparison uses the level of household consumption as an indicator of changes in economic vitality.

Based on the short-term forecasting method of residents' consumption level in Northeast China from 2000 to 2004: the method of combining adaptive filtering and gray forecasting is used to analyze the short-term impact of economic policy transition on the economic vitality of Northeast China [1]. The adaptive filtering method was used to predict the residents' consumption levels in 2005 and 2006, and the actual results were compared based on the prediction results. The grey prediction method was used to predict the residents' consumption levels in 17 years to verify the short-term impact of economic policies on economic vitality. Here is the specific analysis:

2.2.1 Adaptive Filtering

Theoretical Basis

The adaptive filtering method is to use the formula from a set of initial estimates of the autoregressive coefficients:

$$\varphi'_{it} = \varphi_{i(t-1)} + 2ke_i x_{t-i}(i = 1,2,3\ldots,P)$$

Successive iterations, through the residual e value, continue to adjust the iteration until the appropriate coefficients are obtained to optimize the autoregressive coefficients.

Model Building

(1) Based on selected data of residents' consumption levels in Northeast China in 00-04, the model weights and initial coefficients were determined as:

$$\text{N=2，}\ \varphi_1 = \varphi_2 = \frac{1}{\text{N}} = \frac{1}{2} \tag{1}$$

Based Box-JenkinsBasic knowledge of method

$$k \le \frac{1}{\left[\sum_{i=1}^{2} Y_i\right]_{max}} = \frac{1}{18347+17200} = 0.000028 \tag{2}$$

Take the learning constant here k=0.000028.

(2) Based on known data x_i={ 13628, 14641, 15821, 17200, 18347} After standardization:

$$x_i^* = \{-1.21074, -0.67735, -0.05602, 0.67008, 1.27403\} \tag{3}$$

Calculate the forecast value for t + 1 period at t = 2:

$$\hat{x}_{t+1} = \hat{x}_3 = \varphi_1 x_2 + \varphi_2 x_1 = 0.94405 \tag{4}$$

(3) Residual:

$$e_{t+1} = e_3 = x_3 - \widehat{x_3} = 0.888025 \tag{5}$$

(4) according to $\varphi'_i = \varphi_i + 2ke_{t+1}x_{t-i+1}$ adjustment coefficient:

$$\varphi'_1 = 0.499966\ ,\quad \varphi'_2 = 0.49994 \tag{6}$$

The above steps are both an iterative adjustment, and then use the new weights Calculate the forecast value of t+1 period at t=3:

$$\begin{aligned} &\hat{x}_{t+1} = \hat{x}_4 = \varphi'_1 x_3 + \varphi'_2 x_2 = -0.36664 \\ &e_{t+1} = e_4 = x_4 - \hat{x}_4 = 1.036722 \\ &\varphi''_1 = 0.499963 \qquad \varphi''_2 = 0.4999 \end{aligned} \tag{7}$$

Then use the new weight to calculate the forecast value of t+1 period at t=4.

This repeated iterations until the prediction error did not improve significantly, it was considered that a set of optimal weights were obtained [2], which could be used to actually predict the average annual consumption level of the residents in Northeast China in 2005 and 2006.which is:$x6$, $x7$.

During the adjustment process, after 137 rounds of iteration, the error can be reduced to zero (rounded up), and the weights have reached a constant value:

$$\begin{aligned} &\varphi_1 = 0.56434, \varphi_2 = 0.48934 \\ &x_6 = \varphi_1 x_5 = 21500, x_7 = \varphi_2 x_4 = 23561 \end{aligned} \tag{8}$$

In Conclusion:

The calculated predicted value is not much different from the true value x6 = 21427, x7 = 23523, and it shows a short-term growth trend, indicating that under the premise of no change in policy and no other market changes, Policy 1 for the Vitality has the effect of driving its growth, and we can see that the economic effect of policy regulation is remarkable.

2.2.2 Grey GM (1, 1) Prediction Model

(1) data processing: make $x^{(0)}(1)$={$x^{(0)}(1)$,$x^{(0)}(2)$,$x^{(0)}$

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(3),$x^{(0)}$(4)}

Corresponds to the observations of the original sequence data time series from 2000 to 2004. For raw data columns $x^{(0)}$(t) Do cumulative generation, which is $x^{(1)}(t)=\sum_{i=1}^{t}x^{(0)}(i)$,among the t=1,2,3,4,

Get a new sequence, $x^{(1)}$(1)={$x^{(1)}$(1), $x^{(1)}$(2), $x^{(1)}$(3), $x^{(1)}$(4)} Bring in raw data $x^{(0)}$(t)={14641,15821,17200,18347} is $x^{(1)}$(t)={14641,30462,46283,63483}

(2) GM (1, 1) 1 model of dynamic differential equations: $\frac{dx^{(1)}}{dt}+ax^{(1)}=u$

(3) Form data matrix B and data columns: $Y_n:\hat{a}=\begin{bmatrix}a\\u\end{bmatrix}$,

Solved using the least squares method: $\hat{a}=\left(B^TB\right)^{-1}B^TY_n$ among them:

$$B=\begin{bmatrix}-\frac{1}{2}\left[x^{(1)}(1)+x^{(1)}(2)\right]\ldots 1\\-\frac{1}{2}\left[x^{(1)}(2)+x^{(1)}(3)\right]\ldots 1\end{bmatrix},\quad Y_n=\left[x^{(0)}(2),x^{(0)}(3)\right]^T \tag{9}$$

Calculated:

$$\hat{a}=\begin{bmatrix}-0.3821\\97.2491\end{bmatrix} \tag{10}$$

(4) Building a time response model:

$$\hat{x}^{(1)}(t)=(x^{(0)}(1)-\frac{u}{a})e^{-at}+\frac{u}{a}$$

(5) Discretize the time response:

$$\hat{x}^{(1)}(k+1)=(x^{(0)}(1)-\frac{u}{a})e^{-at}+\frac{u}{a}$$

Calculated by MATLAB:

$$\hat{x}^{(1)}(k+1)=14836.4878e^{k}-254.5122 \tag{11}$$

(6) Substituting the k value into a discrete model to calculate the predicted cumulative value: $\hat{x}^{(1)}(t)$

Calculated by MATLAB:

$$\hat{x}^{(1)}(t)\{14641,30245,47892,62718,83215\} \tag{12}$$

(7) Restore the predicted cumulative value to the predicted value: $\hat{x}^{(0)}(k)=\hat{x}^{(0)}(k)-\hat{x}^{(0)}(k-1)$,

Calculated by MATLAB:

$$\hat{x}^{(0)}(k)=\{14641,15234,16822,18592,20541\} \tag{13}$$

Through matlab, the consumption level of residents in Northeast China in 2005 is predicted. According to the predicted value obtained by theoretical analysis and gray prediction method, the relative error of the prediction is about 0.0079%, indicating that the model is extremely sensitive [2]. Comparing the predicted value with the real value, it can be seen that the predicted result is more accurate, and the trend of analysis has also increased year by year, indicating that policiy have promoted economic vitality in the short term, and also proved that the economic effect of policy regulation is significant.

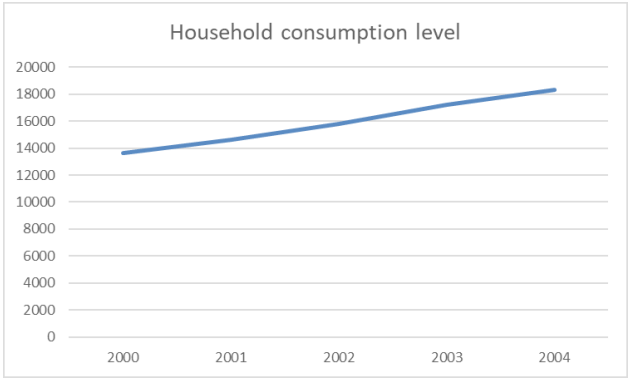

Figure 1. Forecast chart

By plotting the time series of residents' consumption levels in 00-04 in excel, it can be seen intuitively that the residents' consumption levels are increasing year by year. After using the adaptive filtering method and the gray prediction method and calculating through matlab and excel, it can be concluded that using the short-term prediction method, the predicted value is basically the same as the actual value, and the trends are gradually rising, which proves that economic policy reform for the Northeast region is With obvious effects of economic vitality, the release of the policy has increased the economic vitality of the Northeast year by year, and the economic effects of policy regulation have been remarkable.

2.3 Long-term Impact

The long-term forecast method is used to compare the data of a certain long-term indicator in the future with the actual data to obtain a comparison result, which illustrates the impact of the introduction of policy on economic vitality [3]. In this comparison, the GDP of Northeast China was selected as an indicator representing the changes in economic vitality.

According to the long-term forecasting method of GDP

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of Northeast China from 2000 to 200115: trend extrapolation method. Analyze the long-term impact of economic policy transition on the economic vitality of the Northeast. The trend extrapolation method is used to predict the 17-year resident consumption level, and the prediction result is compared with the actual value, and the gray prediction method is used to predict the 17-year resident consumption level to verify the long-term impact of economic policies on economic vitality. Here is the specific analysis:

Trend extrapolation

That is, the trend limit is a method of inferring future trends based on past and current time series. After comprehensive analysis of the research object's past and present development, a model is used to describe the change law of a parameter, and then this law is used to infer. To fit the data points, the most commonly used are simple functional models, such as linear models, exponential curves, and growth curves [4]. When the economic vitality changes with time in this paper, there is a certain upward or downward trend, there is no obvious seasonal fluctuation, and a suitable curve can be found to reflect this trend. Meet the conditions for using trend extrapolation. Establish a trend extrapolation model with time t and time series value y as independent and dependent variables, respective :y=f (t)

Using the extended time as a known condition, the predicted value can be obtained from the fitted model diagram.

In this paper, we use Northeast China's GDP data from 2000 to 2015 to draw a time series diagram of Northeast China's GDP from 2000 to 2015 (see the figure below).

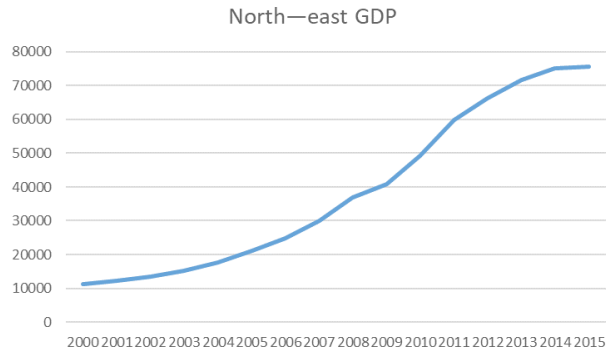

Figure 2. Forecast chart

Observing Figure 2, it can be seen that the per capita GDP has a significant growth trend over time, which is similar to the growth trend of the quadratic curve and the cubic term curve, and similar to the trend of the annual growth curve. Therefore, considering the number of time periods as the independent variable and Northeast China's GDP as the dependent variable, a prediction model such as a quadratic curve, a cubic curve, and a growth curve are established.

2.4 Model Establishment and Prediction

Linear trend models, nonlinear trend models, and curve trend models with growth caps are trend extrapolation models commonly used in time series [5]. Among them, the non-linear trend model is usually a quadratic curve model, a cubic term curve model, a power function curve model, a logarithmic curve model, a hyperbolic model, an exponential curve model, and so on. Model, Gompertz curve model and Logistic curve model. In this article, the data of Northeast China's GDP from 2000 to 2015 is used for analysis and elaboration. Six models of linear curve, quadratic curve, cubic term curve, compound type, growth type, and exponential type are considered for the applicable test. The effect of model fitting is shown below

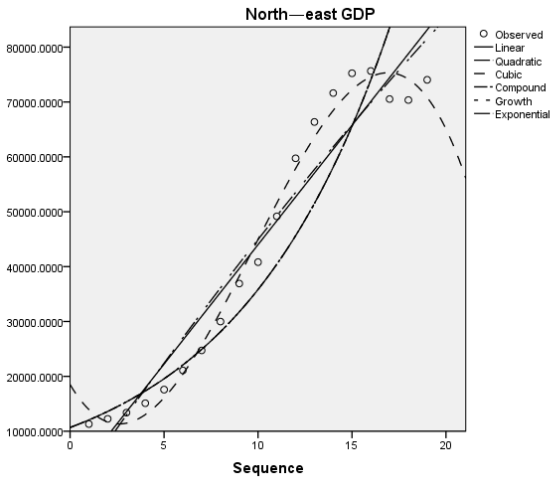

Figure 3. Curve Fitting

As can be seen from the figure above, the linear model fits the actual value with a very low degree of fit. The cubic term curve model has the highest fit with the actual value, which is better than the growth curve model. This is the lowest in the determination coefficient R of the linear curve in Figure 3. Are consistent. Figure 3 shows that among the six fitting models, the determination coefficients of the regression equations of the various curve models are all above 0.95, and the determination coefficients of the regression equations of the cubic term model are closest to 1, and the cubic term curve model can be seen [6]. Regression equations work best for sample data points. From the coefficient test, the P-value of each curve model coefficient is less than 0.001, which is statistically significant. Considering the two aspects of fitting test and coefficient test, the cubic curve model is the most ideal. The test of the fit of the regression equation and the sig-

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nificance test of the regression coefficient have statistical significance, and the model selection is reasonable. The final regression equation is:

$$GDP=17055.670-4679.701t+1085.516t^2-34.571t^3.$$

In the formula, t is the number of time periods, and the GDP of Northeast China in 2016 is forecasted, and t is taken to be 17. The forecast result is 81367.544 billion yuan.

However, the actual GDP of the Northeast region in 2016 is 70,537.89 billion yuan, which indicates that the changes in economic policies over time have little effect on the regulation and control of economic changes over time. May be affected by other factors.

3. Countermeasures and Suggestions

According to the analysis results, a certain policy will play a positive role in promoting the economy in the short term. By combining the predicted results with the actual results after the implementation of the policy, it is found that: in 2006, the GDP after the implementation of the policy is compared with the predicted results without the implementation of the assumed policy, and in the annual prediction, the gap between the predicted results and the actual results is reduced. This proves that the effect of the policy will be reduced in the long run. In the process of extrapolation according to the trend, it is found that the degree of coincidence in the third power is the highest, but in fact, GDP does not always decrease with time, which reflects that the long-term effect of an economic policy will decrease.

The economic policy in Northeast China should be adjusted with time and in combination with the actual situation, because now is the most important time for economic reform. Once the development opportunity is missed, the economy will decline. We will further straighten out the relationship between the government and the market, clarify the responsibilities of the government, and accelerate the transformation of government functions [7]. Give full play to the ability of economic self recovery and reduce the intervention behavior. Reduce support for zombie enterprises and high energy consumption enterprises. One belt, one road, is open to expand and expand the market. Connect to the Internet to reduce overcapacity.

Therefore, the short-term impact of policy release on urban economic vitality is significant. The government should adjust and control in time according to the market situation, change the corresponding policies in time, enhance the economic vitality of the city and enhance the regional competitiveness.

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ARTICLE

An Approach of Reducing Overall Level of Export Fluctuations of the Export-oriented Countries

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ABSTRACT

Overall level of export fluctuations of the export-oriented countries with rising export volume partly stem from the market failure caused by free choice of export enterprises, some government intervention thus may be necessary. To reduce the level of fluctuations of the export growth rates in these countries, this paper, taking the significant differences of the exports among various markets into account and thus using a new index named relative variance to measure the export volatility risks, proposes a model of merchandise market portfolio, a modified version of Markowitz model, available to provide explicit guidelines for the firms, the industries and even the whole country to optimize the structure of their export markets. An application of this model to the case of China's apple is then discussed. The results show that the market share of China's apple in 7 sub-markets should be redistributed drastically.

JEL Code: F14

1. Introduction

Many export-oriented countries such as Asian Tigers and China, in recent decades have experienced rapid economic growth, in which the export trade based on their comparative advantages played vital roles. With a rapid growth rate, however, the export trade of these countries undergone a high level of volatility, and further adversely affected the national income and employment. Take China as an example, its export enjoyed a high average yearly export growth rate, that is, 13.8% between 2001 and 2017, but the annual growth rates varied significantly. The highest annual growth rates were as high as 35.4% in 2004, while the lowest rates were -16% in 2009. Therefore, it is of great practical significance to reduce the export risks that the export-oriented countries face.

With the goal of reducing the level of export fluctuations, many earlier studies generally suggested to "enter new markets". But they did not recommend any practical solutions on how to open and assign the explicit export proportion in every market [1,5,12,21,23]. Geographic concentration is an important index to measure the degree of market diversification. The viewpoint that too high geographic concentration would cause export instability, has become an important basis of the export market diversification strategy made by many countries' policy makers [1,21]. However, the relation between geographic concentration and export stability is uncertain, theoretical-

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ly.① In fact, some empirical analyses showed that lower geographic concentration contributed to the stability of export earnings [6,10,19,20], while other studies demonstrated that the relation between them was not significant or even negative correlation [11,16,17,18,22].

Theoretically, the export growth rate of a product will be affected by many systematic and non-systematic factors. In terms of the non-systematic factors, Cai [4] found that due to incomplete information, externalities and high coordination costs, in the "free choice" of export destinations, export enterprises caused the market failure, which will aggravate the overall fluctuation level of the whole industry's exports. In other words, for an export-oriented country, the overall level of export fluctuations partly stem from separate and free choices made by export enterprises.

Hence, to reduce the overall level of export fluctuations, the government of the export-oriented country needs to optimize the structure of their export markets, namely, to determine the optimal export share of each market. This goal is quite similar to the one of stock investors who try to choose optimal portfolio that may minimize return volatility. Further, the modern portfolio theory developed by Markowitz [13,14] may provide a solution on this optimization, theoretically. The work by Hirsch and Lev [6], first linking Markowitz's theory to the question of export market diversification, just tested and supported the point that the diversification would be conducive to the stability of export earnings. Then, Board et al. [2,3], Kennedy [9], Jang and Chen [7] used different "return" variables such as the bed-night, the growth rate of tourism revenue and the number of tourists, to study Spain, Ireland and Taiwan's efficient portfolioes of tourist markets respectively. These earlier studies, ether didn't take the striking differences between "returns" from various tourist markets into account, resulting that the levels of fluctuations measured by variance are not comparable, or failed to classify various markets according to their fluctuation characteristics, resulting that risks in some markets are overestimated.②

This paper, taking the significant differences of exports among various markets into account and then using a new index named relative variance to measure export volatility risk, first proposes a merchandise market portfolio model, that is, a modified version of Markowitz model which has been published more than half a century, and been applied to so many fields except the diversification of merchandise export markets. This model is a practical tool to offer the policy makers of export-oriented countries explicit guidelines for risk management in the export trade. Moreover, we make a case study of China's apples. In detail, we divide all export markets of China's apples into 7 sub-markets, and explore the growth rates of export quantity in these markets during 2001-2017, then apply our model to estimate the efficient market portfolio. Each market portfolio is associated with a given expected export growth rate and a corresponding lowest level of instability.

This paper is organized in the following sections: The next section introduces a new index named relative variance measuring volatility risks in export markets, and proposes a model of export market portfolio aiming to stabilize the growth rate of export volume. Section 3 shows a process of empirical study about the optimal market structure of China's apple based on the model in the section 2. The final section concludes this study and offers some further discussion.

2. Relative Variance and a Model of Export Market Portfolio

As discussed in section 1, quite similar to choosing the optimal portfolio in finance investment is assigning the market share in each export market to minimize volatility risks. Thus, borrowing the modern portfolio theory for selecting the optimal export market portfolio is theoretically feasible.

If simply copying the approach of Markowitz - measuring volatility risks by variance, the following three problems would occur: Firstly, it is generally held that the concept of variance is not suitable to measure and compare the degree of volatility of data series with significant different levels. However, the mean values of export volume (or export growth rate) among export markets, often show significant differences. Hence, in order to correctly compare the degree of volatility of data series with significant different levels, the influences from the different levels of mean values should be eliminated. Secondly, the significant differences of exports among various markets, undoubtedly resulting in the significant differences of risks measured by the variance among export markets, are likely to lead to the variances of market portfolio trending upwards even unbounded, theoretically ;③ Thirdly, for

① If demand in each market remains fairly constant, even high geographic concentration would not cause significant fluctuations in export earnings. If demand in each market is so volatile and highly positive correlation with each other, even low geographic concentration would lead to significant export fluctuations.

② For Instance, in Jang and Chen's study, the number of tourist arrivals from some countries fluctuated around a certain mean value, while others had obvious increasing or decreasing trends. For the former kind of fluctuation, choosing the number of tourist arrivals as "return" variable as authors did is reasonable. But for the latter two kinds, if still choosing the same variable, export risks would be overestimated.

③ Markowitz (1959) suggested that, if variances of all securites are sorted according to their numeric values, the variance of the 100th kind security is not much larger than the 50th kind, and the 200th kind not than the 100th kind. Thus, it rarely happens that the security portfolio variance tends to rise even be unbounded.

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a certain stability goal associated with a given expected export volume (or export growth rate), the export market with larger variance will be assigned less market share, while the market with smaller variance more market share. However, the scale of market with smaller variance is often too small to import this share. Thus, it is not appropriate to use variance to measure the volatility risks faced by exporting country. To solve these problems mentioned above, we will propose a new index named relative variance, as an alternative to variance, to measure export risks.

2.1 The Relative Variance

Unlike the concept of variance that simply measures the degree of dispersal of a data series around its mean value, the coefficient of standard deviation, equal to the standard deviation divided by its mean value, measures relative dispersal of a data series around its mean value, and eliminates the influences from the different levels of mean values. Similar to the implication of coefficient of standard deviation, we define a new index, that is, relative variance as following:

$$S\ (r) = E(\frac{r-\bar{r}}{\bar{r}})^2,$$

Where $S(r)$ represents the relative variance of the data series r, $\bar{r}$ is the mean value of series r, and $\bar{r} \neq 0$. In the numerical aspect, relative variance is equal to the square of coefficient of standard deviation, avoiding the complex situation of comparing the degree of relative dispersal between series with two kinds of mean values: positive and negative. Clearly, greater relative variance means greater degree of relative dispersal. In addition, according to the definition of relative variance, we can get a proposition as following:

Proposition 1: *$\sum_{i=1}^{N} r_i X_i$ is the weighted sum of N data series, where r_i represents series i, X_i the weigh, let $S(\sum_{i=1}^{N} r_i X_i)$ and $V(\sum_{i=1}^{N} r_i X_i)$ denote relative variance and variance of this weighted sum, respectively. If $\sum_{i=1}^{N} X_i \bar{r}_i = A$, where A is a constant not equal to 0, then $S(\sum_{i=1}^{N} r_i X_i) = \frac{1}{A^2} V(\sum_{i=1}^{N} r_i X_i)$.*

This proposition, revealing the connection between relative variance and variance, is an important step towards proposing the following export market portfolio model. By the inductive method, a formal proof of this proposition is not complicated, so we ignore it.

The nature of relative variance, coupled with significant differences of exports among various markets, makes us view relative variance rather than variance as a more suitable index to measure the volatility risks. The reasons are as following: relative variance provides a more meaningful basis for comparison of risks through eliminating the influences from the different levels of mean values; the differences of risks measured by relative variance, on the other hand, will be lower than by variance, which theoretically reduces the likelihood that the variance of market portfolio tends to rise even be unbounded.

2.2 The Model of Export market Portfolio

With obvious rising tendency of the export volume, the risks facing the export-oriented countries mainly come from the fluctuations in the growth rate of exports rather than the fluctuations in the export earnings or the level of exports. Moreover, there often are significant differences of average yearly export growth rates among various markets. Therefore, different with the modern portfolio theory where Markowitz viewed return rate as expected return variable, here we view the growth rate of exports as expected variable,[①] and measure export risks by its relative variance.

According to Proposition 1, to minimize risks of fluctuations of expected export growth rate, the objective function of the export-oriented country and its constraint conditions can be expressed as:

$$Min\ \mathrm{M_p} = \frac{1}{R_p^{\ 2}}(\sum_{i=1}^{N} X_i^2 \sigma_i^2 + \sum_{i=1}^{N} \sum_{\substack{k=1 \\ k \neq i}}^{N} X_i X_k \sigma_{ik})$$

$$s.t\ R_P = \sum_{i=1}^{N} X_i \overline{R_i}$$

$$\sum_{i=1}^{N} X_i = 1$$

$$b_i \geq X_i(1+\overline{R_i})/(1+R_p) \geq 0 \quad (i=1, 2, \ldots N)$$

Where M_P is the risk level of export market portfolio based on relative variance; X_i the share of market i in the portfolio when calculating the expected growth rate of ex-

① If we view the export volume with obvious tendency as expected variable, and measure the risks by its fluctuations, the outcome would be clearly overestimated.

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port market portfolio; σ_i^2 the variance of export growth rate in market i; σ_{ik} the covariance of growth rate between market i and market k; $\overline{R_i}$ the average growth rate in market i; R_p the expected growth rate of export market portfolio.

With X_i not involving export increment, the optimal share in market i needs to be computed. Suppose that B refers to all expected export volume, among which C is the expected incremental export volume. Then, the expected growth rate R_p can be expressed as C/(B-C), and the form of expected export volume in market i is $X_i(B\text{-}C)+X_i\overline{R_i}$ $(B\text{-}C)$. Hence, the optimal share in market i is $Y_i=X_i(1+\overline{R_i})/(1+R_p)$. Similar to the restriction on short selling in financial markets, we impose nonnegative condition on Y_i, meaning the situation that exporting country acts as trade intermediary has not been taken into account. Finally, b_i refers to the highest possible share in market i.

3. The Efficient Portfolio of China's Apple Export Markets

As the largest country of producing apple and one of main exporters all over the world, China has seen a rapid growth trend of its export volume since the 1990s. Total apple export quantity increased from 304 thousand tons in 2001 to 1,340 thousand tons in 2017, with an average growth rate of 9.7%. Across the world are the destinations of China's apple, the amount of which has been close to 100 countries (regions) in 2017. Nonetheless, a large market share of China's apple was still concentrated on a handful of destinations. For example, since 2001, the market share in 15 economies consisting of the 10 ASEAN countries, Japan, Korea, Macao, Hong Kong and Taiwan has long been more than 45%. On the other hand, the exports of China's apple have undergone a high level of volatility.

From the perspectives of both geography and trade relationship, all export markets of China's apple can be divided into 7 sub-markets, which include 15 Asian economies, Rest of Asia, the European Union (EU), Rest of Europe, Latin America, Africa, and Oceania plus North America. Among them, 15 Asian economies refer to the 10 ASEAN countries, Japan, Korea, Hong Kong, Taiwan and Macao, Rest of Asia other countries (regions) except this 15 economies in Asia, Rest of Europe other countries (regions) except the European Union in Europe. Given Oceania and North America, both consisting of few countries with similar level of economic development and both importing small quantity of China's apple, we combine them in the following analysis to calculate the optimal structure of the above 7sub- markets by using the model of export market portfolio.

To make sure the typical meaning of following analysis, we select the period from 2002 to 2017as the sample time, in which the growth rates in all sub-markets showed at least one complete cycle of fluctuations. Meanwhile, to make sure the practical sense of our results, it is reasonable to impose upper and lower limits on expected share in each sub-market. All lower constrains are the same as 0. Given both market maturity and past share of 15 Asian economies, Rest of Asia, EU and Rest of Europe, we set their upper constrains by the highest market share in the sample time times 1.5, that is, assuming 50% growth in their highest share. For other three sub-markets, based on their market scale and growth potential, we set their upper constrains by the highest market share in the sample time times 2. Obviously, these assumptions about constrains are subjective, so other researchers may reset the limits depending on their own judgment and prospects.

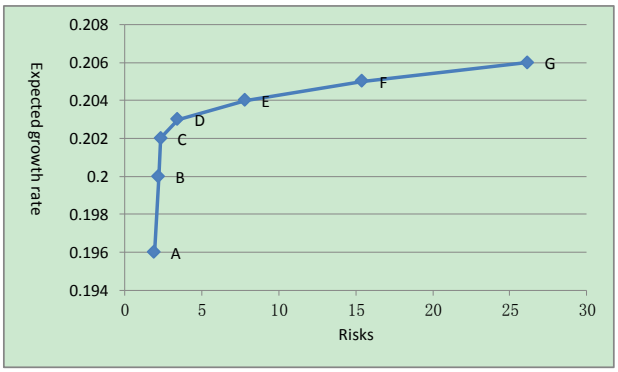

Figure 1. The efficient frontier for China's apple export markets

Figure 1. shows the efficient frontier of China's apple export markets. The shape of the frontier indicates that the risks level of the market portfolio will increase when expected growth rate rises, meaning that the higher expected growth rate, the more risks must be taken. Every point on the frontier, such as A, B, C, D, E, F and G, has the lowest relative variance for a specified level of expected growth rate, and represents an efficient market portfolio reported in Table 1.

Point A offers the minimum relative variance of 1.916 and an expected growth rate of 19.6%, the corresponding portfolio of which is composed mainly of two markets in Asia, these two markets accounting for 95% share of the overall markets due to their lowest relative variance and relatively low covariance with other markets (See Table 2). Compared with point A, in the corresponding portfolio of point G, the share of Rest of Europe rapidly becomes the second largest (30.9%), with a rapid drop to 4.1% for 15 Asian economies. The reason is that Rest of Europe, although with a higher relative variance, has a higher average yearly growth rate than 15 Asian economies and

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negative covariance with other four markets.

Interestingly, the optimal share of four markets including Rest of Asia, EU, Africa and Latin America remains the same. Due to a negative average yearly growth rate, the share of EU decreases down to its bottom constrain, that is 0. The share of other three markets is equal to their own upper constrains. The reason is that, with higher average yearly growth rates and smaller variance and covariance, these markets all are ideal export markets in 7 efficient portfolio, in other words, the more share, the better.

Further, to make the exports of China's apple stable, after comparing the actual portfolio in the sample time to the efficient portfolio, several important and clear policy implications can be found: Firstly, China's apple should completely withdraw from the EU markets; Secondly, the share in 15 Asian economies should be sharply reduced, the pace of reduction depending on the policy makers' preference on the efficient market portfolio; Thirdly, the share of exports going to Latin American, Rest of Asia, Africa, Oceania & North America should be increased. In addition, whether increasing or reducing the share in Rest of Europe will depend on the policy makers' attitude toward risks. For example, if the policy makers are extreme risk-averse, they will choose the market portfolio at point A, meaning that the share in Rest of Europe should be decreased. Conversely, if the policy makers are extreme risk-loving, they will choose the market portfolio at point G, meaning opposite implications.

4. Conclusions and further discussion

From the perspective of non-systematic risk, the overall fluctuation level of a country's exports is partly derived from the export enterprises' free choice of the export destinations. Therefore, the government can take necessary interventions to reduce these risks. For those export-oriented countries, the export stability is crucial to their national income and employment. Hence, the intervention of their governments is more urgent. On the optimal structure of merchandise export markets, earlier studies failed to provide quantitative solutions to minimize export instability. No less obvious is the fact that the goal of the modern portfolio theory developed by Markowitz is similar to the diversification of export markets. However, the significant differences of the mean values of the export growth rates among various export markets make the risks measured by variance not comparable. This paper, using a new index named relative variance to measure export volatility risks, proposes a modified version of Markowitz model to diversify the export markets of the export-oriented countries. In fact, our model can provide explicit guidelines for firms, industries other than the whole country to optimize their ex-

Table 1. The efficient portfolio of China's apple export markets

Point		A	B	C	D	E	F	G	The upper limit of share
The expected growth rate		0.196	0.200	0.202	0.203	0.204	0.205	0.206	
The relative variance		1.916	2.182	2.320	3.434	7.806	15.418	26.175	
Optimal share	15 Asian economies	0.348	0.338	0.333	0.272	0.195	0.118	0.041	0.951
	Rest of Asia	0.604	0.604	0.604	0.604	0.604	0.604	0.604	0.604
	EU	0	0	0	0	0	0	0	0.145
	Rest of Europe	0.014	0.016	0.017	0.078	0.155	0.232	0.309	0.394
	Africa	0.030	0.030	0.030	0.030	0.030	0.030	0.030	0.030
	Oceania & North America	0	0.008	0.012	0.012	0.012	0.012	0.012	0.012
	Latin America	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005

Note: Share for any given year do not sum to 100% because of rounding.

Table 2. The variance and covariance of the export growth rates from 7 sub-markets

Sub-market	15 Asian economies	Rest of Asia	EU	Rest of Europe	Africa	Oceania & North America	Latin America
15 Asian economies	0.025						
Rest of Asia	0.039	0.146					
EU	0.078	0.207	0.554				
Rest of Europe	0.137	-0.323	-0.290	10.125			
Africa	0.132	-0.006	0.136	1.310	1.641		
Oceania & North America	0.598	1.741	2.963	-1.959	0.204	28.162	
Latin America	0.176	0.225	0.408	-0.549	1.418	4.211	2.216

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port market structures. According to this model, the market share of China's apple in 7 sub-markets in the world should be redistributed drastically. The upper and low share limits imposed on each market are important assumptions in our model, but we cannot take for granted that the composition of any market portfolio would certainly rely heavily on those assumptions. In the case of China's apple, our results appear fairly robust, as other reasonable limits would not change outcomes significantly.

It is necessary to note that in practice, the classification of export markets will directly affect the specific composition of any efficient portfolio and the corresponding policy implications. Given high costs of market conversion, government should implement supportive polices to motivate those firms engaging in export businesses to enter new markets in efficient portfolio. Hence, we need to view efficient market portfolio as a long-term objective due to the low probability of instantly adjusting the share of all markets according to the efficient portfolio. Finally, if an exporting country causes serious trade friction with the certain country in the efficient portfolio, the share assigned to this country would not be achieved. But theoretically, we can find a group of markets to replace this country, maintaining the same risk level as well as expected growth rate.

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