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01
2020

Journal of Management Science & Engineering Research

Volume 3 | Issue 1 | March 2020 | ISSN 2630-4953 (Online)

ISSN 2630-4953 01
9 772630 495204
Price: S$30.00

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Volume 3 Issue 1 • March 2020 • ISSN 2630-4953 (Online)

Journal of Management Science & Engineering Research

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Journal of Management Science & Engineering Research
https://ojs.bilpublishing.com/index.php/jmser

ARTICLE

Commercial Credit and Corporate Productivity

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ARTICLE INFO

Article history
Received: 14 October 2020
Accepted: 18 October 2020
Published Online: 30 October 2020

Keywords:
Marketization
Ownership
Performance management
National Bureau of Statistics data
Provision of commercial credit
Access to commercial credit

ABSTRACT

As an important form of informal finance, commercial credit is widely used among enterprises. Does commercial credit promote the total factor productivity of enterprises? According to the theoretical literature and the reality, using the large sample data of Chinese industrial enterprises, the paper empirically tests the impact of commercial credit on the productivity of enterprises from three aspects: the provision and acquisition of commercial credit and the net commercial credit. The study finds that the provision of commercial credit reduces the productivity level of enterprises; the acquisition of commercial credit fails to promote productivity; while the net commercial credit as a short-term financial buffer for enterprises can alleviate the financing constraints, faced by enterprises, especially private enterprises, which help to increase their productivity levels . In addition, the study found that the higher the marketization process in the region, the more favorable the commercial credit is to the improvement of the production efficiency of private enterprises.

1. Introduction

Schumpeter [1] believes that financial development as an engine of economic growth is mainly reflected in two aspects: one is financial development reduces the transaction costs of investment, increases the liquidity of financial resources in the real economy, thus injecting financial capital resources into the entire economy. The other is the development of finance has improved the allocation efficiency of financial resources, which in turn has driven the rational flow of production factors and improved the production efficiency of the real economy. The improvement of productivity is the inexhaustible driving force and the ultimate source of economic growth. In China's more than 30 years of rapid development, a notable feature is the rapid development of economy with the lag of financial development or financial repression.

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Acknowledgment
We are grateful for the financial support from Chinese National Planning Office of Philosophy and Social Science (Project Title: Research on Trade Credit under Technology Innovation Strategy, Project No.17CJY006). Surface Project of "Social Science Found of Shandong Province" (Project Title: Study on the Mechanism of Informal Finance Promoting Innovation in Shandong Province, Project No.19CJJJ23); Key Project of "Shandong University Humanities and Social Sciences" (Project Title: the Mechanism of Commercial Credit Influencing Technological Innovation: an Empirical Study of Shandong Enterprises, Project No. J17RZ005)

 DOI: https://doi.org/10.30564/jmser.v3i1.2462

Financial development lag or financial repression has had a extremely negative impact on the development of Chinese enterprises [2-3]. Under the background that the formal financial system can not meet the development needs of enterprises, a large number of studies have discussed the important role of informal institutional arrangements to ease the financing constraints of enterprises, such as relationship networks, private lending, foreign direct investment, industry agglomeration, commercial credit and so on. Commercial credit is the short-term creditor-debt relationship formed by deferred payment or advance receipts, which is equivalent to a short-term financing given to the buyer's enterprise by the seller's enterprise. Commercial credit plays an important role in the development of Chinese enterprises. According to the statistics of industrial enterprises, the ratio of providing commercial credit to the total assets of enterprises is 10% between 2004 and 2007, and the proportion of accepting commercial credit to the total assets of enterprises is 8%.

A large number of scholars have made in-depth research on the motives and functions of commercial credit, but there are relatively few literature on the impact of commercial credit on the real economy. Fisman [4] created a precedent, based on survey data of manufacturing firms in five African countries, it found commercial credit can significantly improve production efficiency. Guariglia and Mateut [5] based on data analysis of 609 British manufacturing listed companies from 1980 to 2000, found that commercial credit has a positive effect on inventory investment, and explains the role of commercial credit in the actual operation of enterprises. Regarding China's research, Yu [6] studied the impact of commercial credit on the growth of private enterprises with the sample of private listed enterprises from 2006 to 2010. Zhang et al. [3] analyzed the effect of commercial credit on the growth of fixed assets of enterprises. Sun et al. [7] studied whether commercial credit can become an effective financing channel for enterprises. There are few studies on how commercial credit affects productivity directly in China, and the samples used are mostly based on listed companies. For example, Shi and Zhang [8] used data analysis of 176 listed companies in China from 1999 to 2006, and found that commercial credit can increase the level of input of production materials and promote the efficiency of scale by alleviating financing constraints. Since listed companies have more extensive financing channels than non-listed companies, they can obtain external funds through the issuance of stocks, which may lead to sample bias; and the sample size is limited and cannot represent most enterprises in China. In addition, similar literature have studied the impact of commercial credit gains on productivity as measured by accounts payable, and less on the impact of commercial credit supply on productivity.

Compared with the previous literature, this paper has the following innovations: Firstly, from the supply and demand of commercial credit and the net amount of commercial credit, this paper makes a comprehensive study of whether the use of commercial credit improves the productivity of enterprises, and refines the impact of different types of commercial credit on productivity. To provide some empirical evidence for understanding the role of informal finance in the development of private economy in the context of transition. Second, this paper uses a large sample of industrial enterprise databases, covering more than 300,000 enterprises in China, and nearly 40 companies in the dichotomous industry. Its output value accounts for 95% of China's total, which can be used as an effective sample for enterprises analysis in china and avoid the problem of sample selectivity deviation caused by the use of listed company data in previous literature.

2. Research Hypothesis

Commercial credit is a credit act formed by a business with business transactions due to deferred payment or advance receipts. Business credit includes two aspects of supply and demand, that is, to provide business credit and obtain business credit. In the process of production and operation, the enterprise becomes the provider of commercial credit by authorizing the downstream purchaser to delay payment, and also obtains the commercial credit provided by the upstream supplier due to the default of the account, and becomes the winner of the commercial credit. When a manufacturer provides commercial credit (measured by accounts receivable), it may also obtain commercial credit from its suppliers (measured by accounts payable). If the manufacturer provides and obtains commercial credit at the same time, the difference between obtaining commercial credit and providing commercial credit becomes the net commercial credit. From the perspective of funds, the net commercial credit can act as a short-term fund of the enterprise in a certain sense. The actual amount of funds obtained by the enterprise is the difference between the accounts payable and the accounts receivable corresponding to the credit.

2.1 Provision of Commercial Credit

Fisman and Raturi [9] proposed the competition hypothesis of commercial credit. They believe that commercial credit is a competitive means for suppliers. When encountering more competitors in the same industry, customers can easily find alternative suppliers. In order to avoid losing

DOI: https://doi.org/10.30564/jmser.v3i1.2462

customers, suppliers often lock their customers by providing commercial credit, maintain and strengthen the relationship with customers through different credit conditions to maximize their market share. The expansion of product sales has led to an increase in revenue and profits, enabling companies to upgrade their equipment, increase investment and production, and thus increase production efficiency. In addition, the provision of commercial credit as a preferential condition can expand market demand, and the increase in demand for product market is an important source of productivity improvement. Based on the above analysis, the research hypothesis 1a is proposed:

Hypothesis 1a: The provision of commercial credit by firms is conducive to raising productivity levels, that is, providing commercial credit is positively correlated with productivity.

Of course, in the face of market competition, companies with weak market power will often provide commercial credit. Providing commercial credit means that funds cannot be recovered in time, and capital turnover is hindered, which may hinder the production development of enterprises. In addition, enterprises providing commercial credit will face certain bad debt costs, resulting in the loss of bad debts due to the inability to recover the purchase price. At present, China's legal system is still not sound enough, the protection of creditors' rights in commercial credit relations is weak, the efficiency of law enforcement is low, the risk of default and breach of contract is high, causing great losses to enterprises.

Compared with state-owned enterprises, private enterprises are more difficult to obtain the preferential policies of the product market and factor market provided by the government (such as government procurement contracts), and they are in a relatively weak competitive position. Larger market competition pressure will encourage private enterprises to provide commercial credit to customers. And get a certain degree of competitiveness. For companies that have difficulty obtaining bank loans, the cost of providing commercial credit will be higher. Accordingly, the hypothesis 1b is put forward:

Hypothesis 1b: Business credit is not conducive to productivity improvement, that is, business credit is negatively correlated with productivity, and the degree of negative correlation of private enterprises is greater than that of state-owned enterprises.

2.2 Acquisition of Commercial Credit

Financing constraints affect inventory investment and R&D of enterprises. A company subject to financing cannot make optimal decisions about its operations when funds are insufficient, which may distort its resource allocation and reduce productivity. For enterprises that obtain commercial credit, commercial credit can serve as a short-term financing method for enterprises, which can alleviate the financing constraints of enterprises. Once the funds are alleviated, the company will increase fixed investment and R&D investment, expand the scale of the enterprise, and improve the production efficiency of the enterprise. In addition, obtaining commercial credit may shorten the waiting time in production, thereby increasing production capacity. Fisman [4] found that enterprises in developing countries face serious credit constraints, affecting the inventory investment of enterprises, resulting in insufficient inventory. Enterprises must wait for the completion of product sales before they enter the next production cycle to recover the purchase price and purchase raw materials. It will reduce the production efficiency of enterprises; the existence of commercial credits can allow enterprises to obtain raw materials through payables without waiting for the next production cycle, thereby improving the production efficiency of enterprises. In addition, some studies suggest that companies that establish long-term contractual relationships can use other resources for investment, increase the stability of their financing status, and reduce the cost and uncertainty of waiting for investment, if they are convinced that they can obtain commercial credit. Based on this, the research hypothesis 2a is proposed:

Hypothesis 2a: Obtaining commercial credit is conducive to increasing productivity, that is, obtaining commercial credit is positively correlated with productivity levels.

The cost of obtaining commercial credit is sometimes not lower than bank loans. Especially in the seller's market, suppliers conduct commercial credit through price discrimination. The longer the default period, the higher the amount of money the customer needs to pay, and the private enterprise in China. Under the credit discrimination of banks, in order to develop, they have to resort to higher-cost commercial credit. On the other hand, the author visited the company and learned that the commercial credits between enterprises are more for the purchasers because the funds are really tight and are unable to pay in cash. Therefore, enterprises with difficult capital turnover often use more commercial credit to maintain normal production operations. Based on this, the research hypothesis 2b is proposed:

Research hypothesis 2b: The more commercial credit obtained, the lower the productivity of the enterprise, that is, the negative correlation between commercial credit and productivity.

In addition, a company may also receive commercial credit from suppliers while providing business credit to its customers. From the perspective of capital purely, the

 DOI: https://doi.org/10.30564/jmser.v3i1.2462

net credit obtained by the company minus the commercial credit provided is the part of the enterprise that is actually relieved. In theory, the demand for funds by private enterprises is more urgent, and this part of the funds is undoubtedly a charity for private enterprises, alleviating corporate funds, accelerating the normal operation of funds, and promoting enterprise production. Based on this, the research hypothesis 3 is proposed:

Research hypothesis 3a: The net commercial credit can promote the productivity growth of enterprises, and the effect on private enterprises is more obvious than that of state-owned enterprises.

3. Models, Variables and Data Description

3.1 Model Setting

Based on the research ideas of Gatti and Love [10], this paper incorporates commercial credit into the regression model of productivity influencing factors and obtains the equation:

$$lnTFP_{it} = \alpha_i + \beta TC_{it} + \gamma X_{it} + mincat + ind + year + \varepsilon_{it}$$

Among them, I and t denote enterprise and time (year), lnTFP represents the productivity of the enterprise, TC is the commercial credit, including the provision of commercial credit (represented by AR) and the acquisition of commercial credit (represented by AP), and the net commercial credit (Represented by NTC), α_i for the individual effect of the enterpris, min cat, ind and year are the region where the enterprise is located (control system background), industry and year. X is a control variable, including: corporate free capital (CF), bank loan (Loan), company size (Scale), business time (Age).

3.2 Variable Measurement

3.2.1 Measurement of Production Efficiency TFP

This paper uses the LP [11] method to calculate the productivity of enterprises, because the method uses the intermediate product input as the adjustable factor input when the enterprise is impacted by the productivity, and solves the endogenous problem of the enterprise investment to a certain extent, and is widely used in productivity research Use industrial added value to measure output, and use factory price index of industrial products to deflated. The net asset value of the fixed assets is used to measure the capital investment. The labor is measured by the number of employees in the whole year. The total amount of intermediate goods is used as the intermediate input variable. The capital and intermediate inputs are reduced by fixed assets investment price index and raw materials, fuel and power purchase price index based on 1997 respectively.

3.2.2 Measurement of Explanatory Variables

The key explanatory variables in this paper are commercial credit (TC), including vendor commercial credit provision (AR), commercial credit acquisition (AP), and commercial credit net (NTC). Drawing on the methods of Bougheas et al. [12] and Zhang et al. [3], using the accounts receivable/sales revenue to measure commercial credit provision, using accounts payable/sales revenue to measure commercial credit acquisition, (accounts payable - Accounts receivable) / sales revenue measures the net commercial credit.

The control variables include enterprise's own capital, bank loan, enterprise scale and operating time. Among them, the free capital (CF) variable refers to Guariglia et al. [13], using (profit + depreciation) / sales income measurement. In terms of the amount of bank loans, we use the method of Zhang et al. [3] for reference to select the annual interest expenditure of a single enterprise, because the interest rate in China fluctuates relatively small in a relatively short period of time, and the interest payment of enterprises can directly reflect the situation of enterprises getting loans, using the net interest expenditure of enterprises divided by sales. Sales are indirectly measured. Scale is the logarithmic value of total assets and Age, which is equal to the variable year minus the year of establishment plus.

3.3 Data Sources and Statistical Analysis

This paper uses the data of China's industrial enterprises published by the National Bureau of Statistics. Since the accounts payable for key variables have only been published since 2004, the data for the four years from 2004 to 2007 were selected as the final research samples, and the samples were screened preliminarily by using Cai and Liu [14] elimination methods. On the basis of this, in order to control the estimation bias caused by the outliers, the sample also excludes the 1% extreme value of the regression variable used (that is, the retention is between 1% and 99%. In addition, the focus of this paper is to compare state-owned enterprises with private enterprises, and further exclude other sample companies of ownership, and finally get 492,417 observation samples, of which 33,710 are sampled by state-owned enterprises and 458,707 are private enterprises.

Table 1 reports statistical indicators of major variables, with an average of 0.182 for accounts receivable (AR),

DOI: https://doi.org/10.30564/jmser.v3i1.2462

0.134 for accounts payable and - 0.050 for commercial credit. Table 2 further distinguishes the mean value of sample variables between state-owned enterprises and private enterprises. From table 2, we can see that the average productivity of state-owned enterprises is 6.863, which is lower than the average productivity of private enterprises 7.193, that is, the average production efficiency of state-owned enterprises in industrial enterprises is lower than that of private enterprises.

Table 1. Descriptive statistics of the main variables

	Obs	Mean	Sd.	Min.	Max.
lnTFP	492417	6.886	1.055	-1.995	13.7
AR	492417	0.182	0.174	0	0.765
AP	492417	0.134	0.155	0	0.739
NTC	492417	-0.050	0.193	-0.765	0.739
CF	492417	0.143	0.191	-0.122	1.329
Loan	492417	0.009	0.019	0	0.807
Scale	492417	9.512	1.305	4.4659	20.15
Age	492417	8.721	8.565	1	51

Table 2. Mean of the main variables

	State		Private	
	Obs	Mean	Obs	Mean
lnTFP	33710	6.863	458707	7.193
AR	33710	0.104	458707	0.187
AP	33710	0.095	458707	0.137
NTC	33710	-0.010	458707	-0.050
CF	33710	0.072	458707	0.148
Loan	33710	0.025	458707	0.008
Scale	33710	11.090	458707	9.396
Age	33710	21.550	458707	7.778

Whether providing commercial credit (AR) or obtaining commercial credit (AP), the average value of private enterprises is greater than that of state-owned enterprises. However, in the comparison of net commercial credit, the average value of private enterprises is slightly smaller than that of state-owned enterprises. According to the internal cash flow measured by CF, it can be seen that the average internal cash flow of private enterprises is higher than that of state-owned enterprises. The average bank loan value shows that state-owned enterprises have obtained more loans than private enterprises. Both the scale and the average operating years show that state-owned enterprises are higher than private enterprises.

Table 3. Commercial credit statistics of different types of enterprises

	Accounts payable		Accounts receivable	
	AP=0	AP>0	AR=0	AR>0
Private	20.12%	79.88%	8.58%	91.42%
State	20.46%	79.54%	12.67%	87.33%

In Table 3, AP=0 means no commercial credit is obtained, and AR=0 means no commercial credit is provided. It can be seen that no matter whether it is a private enterprise or a state-owned enterprise, nearly 80% of the accounts payable by the enterprise are more than zero, indicating that these enterprises in the course of operation to obtain commercial credit from suppliers, and about one-fifth of the enterprises did not obtain commercial credit. In terms of obtaining commercial credit, the difference between private enterprises and state-owned enterprises is very small. 20% of enterprises do not use commercial credit; but in providing commercial credit, private enterprises provide higher proportion of external commercial credit than state-owned enterprises. It is 91% and 87%.

Table 4. Distribution of commercial credit used by enterprises during 2004-2007

2004			**2005**		
	AP=0	AP>0		AP=0	AP>0
AR=0	5.32	5.06	AR=0	4.13	5.02
AR>0	10.93	78.69	AR>0	14.46	76.38
2006			**2007**		
	AP=0	AP>0		AP=0	AP>0
AR=0	4.53	4.86	AR=0	4.27	4.67
AR>0	15.94	74.68	AR>0	15.88	75.19

4. Empirical Results

In general, panel data regression uses fixed effects to control the endogenous problems caused by unobserved factors. However, the sample data used in this paper have a small time span and a large number of cross-sectional observations. If this kind of data is estimated with the commonly used panel data, it will overestimate the standard error and then underestimate the significance of the coefficient. Therefore, we need to adjust the standard error clustering [15]. So this paper will mainly rely on the regression results of OLS_Robust, and also report the results of

 DOI: https://doi.org/10.30564/jmser.v3i1.2462

fixed effect (FE) to increase robustness.

4.1 Total Sample Regression

The first two columns in Table 5 show the impact of providing commercial credit on productivity. The AR coefficient is significantly negative, indicating that providing commercial credit reduces the productivity level of enterprises. For suppliers, providing commercial credit will crowd out the company's own funds, which is not conducive to the effective allocation of funds; if the company is difficult to obtain support from external funds (such as bank loans), it will even affect the normal production and operation of the company. This conclusion supports the research hypothesis 1b, which is also consistent with the views of Yu and Pan [16].

The third and fourth are listed as the impact of obtaining commercial credit on productivity, and the coefficient of AP is also negative under the two regression methods, indicating that the more commercial credits used, the lower the level of production efficiency. We believe that companies will be more inclined to delay the payment due to shortage of funds. The more arrears, the greater the financial difficulties and the lower production efficiency. Danielson and Scott [17] Supporting access to commercial credit is often a manifestation of corporate financial strain. The regression results verify the hypothesis 2b.

The fifth and sixth columns are the impact of net commercial credit on productivity, and the results using fixed effects and individual cluster regression are significantly positive. We believe that the net commercial credit is measured by the short-term financing obtained through commercial credit in the same period of the enterprise. The coefficient is significantly positive, indicating that commercial credit can be used as a financing method for enterprises to ease the financing constraints of enterprises.

The coefficient of own funds and bank loans is significantly positive, and the former coefficient is smaller than the latter, indicating that the productivity of enterprises is less affected by internal funds than external bank loans.

Table 5. Effect of commercial credit on production efficiency

Var.	Ols_Robust	FE	Ols_Robust	FE	Ols_Robust	FE
AR	-1.257***	-1.215***				
	(0.009)	(0.012)				
AP			-1.206***	-0.912***		
			(0.011)	(0.012)		
NTC					0.209***	0.150***
					(0.007)	(0.010)
CF	0.708***	0.433***	0.711***	0.438***	0.763***	0.451***
	(0.021)	(0.003)	(0.021)	(0.004)	(0.023)	(0.004)
Loan	0.957***	0.619***	0.963***	0.615***	1.115***	0.639***
	(0.218)	(0.032)	(0.220)	(0.032)	(0.272)	(0.032)
Scale	0.494***	0.371***	0.495***	0.356***	0.478***	0.332***
	(0.001)	(0.003)	(0.001)	(0.003)	(0.001)	(0.003)
Age	0.046***	0.224***	0.032***	0.220***	0.034***	0.230***
	(0.001)	(0.005)	(0.002)	(0.005)	(0.002)	(0.005)
Constant	1.893***	2.727***	1.936***	3.368***	1.900***	3.271***
	(0.022)	(0.481)	(0.022)	(0.340)	(0.022)	(0.501)
Industry effect	control	control	control	control	control	control
District effect	control	control	control	control	control	control
Annual effect	control	control	control	control	control	control
Obs	492417		492417		492417	
R^2	0.513		0.507		0.488	
Within R^2		0.150		0.144		0.135
Between R^2		0.337		0.308		0.256
Overall R^2		0.333		0.304		0.253

Note: The values in parentheses are the standard deviation of the coefficients, ***, **, and * indicate significant at the 1%, 5%, and 10% levels, respectively.

DOI: https://doi.org/10.30564/jmser.v3i1.2462

That is, corporate productivity is more sensitive to bank loans. Since our accounts payable variables have only been published since 2004, the study sample interval for this section is 2004-2007, and this period is in the monetary policy tightening phase, and the number of bank loans has declined. In this case, Businesses are more sensitive to bank loans, as the impact of bank lending on productivity increases or even exceeds internal cash flows. In addition, the coefficient of the scale variable is significantly positive, indicating that the larger the company size, the higher the production efficiency. The results also show that the productivity of enterprises is less affected by the length of business hours.

4.2 Distinguishing Ownership Types

For companies with different ownership types, the productivity effects of corresponding commercial credits also differ. We further distinguish between state-owned enterprises and private enterprises, and observe how the productivity effects of commercial credit differ among different ownership companies.

Table 6 reports the results of individual cluster regression. We find that whether it is providing commercial banks or obtaining commercial credit, the coefficients of state-owned enterprises and private enterprises are significantly negative, and the absolute value of state-owned enterprises is smaller than that of private enterprises. The net commercial credit of state-owned enterprises is positive, but the significance is poor, while the private enterprises are significantly positive. This shows that commercial credit can indeed act as a financing buffer for private enterprises, and the net commercial credit obtained can be regarded as a kind of Short-term financing channels provide a certain amount of financial support for the development of private enterprises.

The coefficient of the scale variable is small between the state-owned enterprises and the private enterprises, and both are significantly positive, and the absolute value of the coefficient is large, indicating that there is a scale effect in both state-owned enterprises and private enterprises. However, the coefficient of the business life variable is quite different between the two enterprises. Among them, the coefficient of the state-owned enterprise is significantly negative, while the private enterprise is significantly positive, but the absolute values of the two factors are small. This shows that the productivity level of state-owned enterprises may not

Table 6. Differentiate ownership type (OLS_Robust regression results)

Var.	State			Private		
AR	-1.063***			-1.268***		
	(0.038)			(0.009)		
AP		-1.089***			-1.203***	
		(0.048)			(0.011)	
NTC			0.058**			0.230***
			(0.026)			(0.007)
CF	0.860***	0.845***	0.917***	0.690***	0.694***	0.743***
	(0.206)	(0.203)	(0.220)	(0.020)	(0.020)	(0.021)
Loan	0.454***	0.457***	0.487***	1.266***	1.277***	1.507***
	(0.050)	(0.051)	(0.058)	(0.116)	(0.117)	(0.133)
Scale	0.544***	0.546***	0.537***	0.491***	0.490***	0.474***
	(0.003)	(0.003)	(0.003)	(0.001)	(0.001)	(0.001)
Age	-0.032***	-0.040***	-0.037***	0.068***	0.051***	0.056***
	(0.005)	(0.005)	(0.006)	(0.002)	(0.002)	(0.002)
Constant	1.947***	1.957***	1.905***	1.852***	1.912***	1.862***
	(0.080)	(0.081)	(0.083)	(0.023)	(0.023)	(0.023)
Industry effect	control	control	control	control	control	control
District effect	control	control	control	control	control	control
Annual effect	control	control	control	control	control	control
Obs	33,710	33,710	33,710	458,707	458,707	458,707
R^2	0.619	0.618	0.605	0.497	0.490	0.472

Note: The values in parentheses are the standard deviation of the coefficients, ***, **, and * indicate significant at the 1%, 5%, and 10% levels, respectively.

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show a significant improvement trend with the growth of enterprises, but it has a slightly weaker trend; while private enterprises have the opposite performance, the coefficient of business years is significantly positive. However, the absolute value is small, and there is a weak learning growth trend in the productivity changes of private enterprises. Companies with longer operating periods may have higher productivity, because private enterprises have stronger learning ability and can continuously improve productivity over time. In contrast, state-owned enterprises do not grow with business hours. And significantly improve the level of production efficiency.

Table 7 reports the results of the regression of the sample of state-owned enterprises and private enterprises by the fixed-effect panel model. Regardless of whether it is providing commercial banks or obtaining commercial credit, the coefficients of state-owned enterprises and private enterprises are significantly negative, and the absolute value of state-owned enterprises is smaller than that of private enterprises. Consistent with the results of using individual cluster analysis. The coefficient of net commercial credit of state-owned enterprises has not passed the 1% significance level, and the coefficient is very small (0.008), while the coefficient of private enterprises is still significantly positive (0.171), indicating that the fixed-effect regression results also indicate commercial credit. As a short-term financing method, it can alleviate the financing constraints of enterprises. This effect is more reflected in private enterprises, while the performance of state-owned enterprises is not obvious.

4.3 Analysis of the Role of the Marketization Process

Will this positive impact of commercial credit on the productivity of private enterprises change with the development of marketization? In this regard, this section ranks the average marketization process indices of each region from 2004 to 2007, which are marked as high, medium and low marketization processes (including those with high marketization process including Guangdong, Zhejiang, Shanghai, Ten regions in Jiangsu, Fujian, Tianjin, Beijing, Shandong, Liaoning, and Chongqing; the

Table 7. The impact of commercial credit on production efficiency (FE regression results)

Var.	State			Private		
AR	-0.743***			-1.265***		
	(0.046)			(0.013)		
AP		-0.678***			-0.932***	
		(0.044)			(0.013)	
NTC			0.008			0.171***
			(0.0355)			(0.011)
CF	0.539***	0.531***	0.552***	0.422***	0.429***	0.441***
	(0.026)	(0.026)	(0.026)	(0.004)	(0.004)	(0.004)
Loan	0.270***	0.269***	0.268***	1.039***	1.035***	1.097***
	(0.046)	(0.046)	(0.046)	(0.049)	(0.049)	(0.049)
Scale	0.295***	0.295***	0.272***	0.372***	0.355***	0.332***
	(0.015)	(0.015)	(0.015)	(0.003)	(0.003)	(0.003)
Age	0.030*	0.024	0.030*	0.232***	0.231***	0.240***
	(0.017)	(0.017)	(0.017)	(0.005)	(0.005)	(0.005)
Constant	4.910***	4.898***	5.069***	3.159***	3.220***	3.455***
	(0.342)	(0.342)	(0.344)	(0.319)	(0.502)	(0.324)
Industry effect	control	control	control	control	control	control
District effect	control	control	control	control	control	control
Annual effect	control	control	control	control	control	control
Obs	33,710	33,710	33,710	458,707	458,707	458,707
firms	18,239	18,239	18,239	226,200	226,200	226,200
Within R^2	0.114	0.113	0.102	0.197	0.186	0.170
Overall R^2	0.334	0.340	0.301	0.183	0.191	0.192

Note: The values in parentheses are the standard deviation of the coefficients, ***, **, and * indicate significant at the 1%, 5%, and 10% levels, respectively.

DOI: https://doi.org/10.30564/jmser.v3i1.2462

regions in the middle of the marketization process include Sichuan, Hebei, Anhui, Hubei, Hainan, Henan, Hunan, Jiangxi, Guangxi, and Jilin; the rest are Areas with relatively backward marketization, including Heilongjiang, Inner Mongolia, Shanxi, Yunnan, Shaanxi, Guizhou, Ningxia, Gansu, Xinjiang, Qinghai and Tibet, eleven regions.), and then according to equation (1) for each group Returning to test the difference in the impact of commercial credit on the productivity of state-owned enterprises and private enterprises in different institutional contexts.

Table 8 reports the groupings of different marketization processes. The productivity of the two types of ownership is affected by the net commercial credit. The results of state-owned enterprises show that the coefficient of commercial credit is not significant in the three regions; while the results of private enterprises show that the middle and high regions of the commercial credit marketization process can significantly promote productivity, only in the low region is not significant, and The absolute value of the coefficient of the high area is greater than that of the middle area, indicating that the positive promotion effect of commercial credit on the productivity of private enterprises will be enhanced with the development of the marketization process. This finding is similar to the conclusions of Zhang et al. [18]. They believe that the development of the marketization process has led to the shift of corporate R&D investment sources to commercial credit. In other words, the more developed the marketization process, the commercial credit between enterprises is more conducive to the improvement of the production efficiency of private enterprises.

In addition, in areas with low marketization, corporate productivity is more sensitive to bank loans, especially for private enterprises. The relative performance of state-owned enterprises is not obvious. In addition, under different marketization levels, the influence of enterprise age factors on firm productivity is also different. The more the marketization process is, the more significant the coefficient of the variable Age is, and the larger the absolute value is. Among them, the coefficient of state-owned enterprises in the high area Age is 0.066, and the 5% significance level is 0.005 in the central area and not significant, and -0.024 in the low area is not significant; similarly, the private enterprise in the high area of Age The coefficient is 0.236, the middle zone is 0.155, and the high zone is 0.189, both of which pass the 1% significance level. It shows that the productivity of enterprises will increase with the increase of business time. Such changes are more obvious in areas with high marketization, especially in private enterprises.

5. Conclusions and Implications

Financing difficulties have become the bottleneck of enterprise development, but the private economy can maintain rapid development at a high level of production efficiency in the case of financing discrimination. How to solve this mystery? This paper attempts to analyze the impact of commer-

Table 8. Grouping regression in different marketization process areas

	State			Private		
	High	Medium	Low	High	Medium	Low
NTC	0.065	0.099	-0.074	0.206***	0.105***	0.018
	(0.065)	(0.063)	(0.068)	(0.012)	(0.026)	(0.046)
CF	1.395***	1.145***	1.511***	1.452***	1.044***	1.146***
	(0.091)	(0.081)	(0.107)	(0.011)	(0.016)	(0.043)
Loan	1.837**	1.030	1.972**	1.906***	2.374***	3.881***
	(0.897)	(0.828)	(0.975)	(0.125)	(0.213)	(0.605)
Scale	0.321***	0.272***	0.293***	0.399***	0.315***	0.394***
	(0.028)	(0.028)	(0.034)	(0.003)	(0.006)	(0.017)
Age	0.066**	0.005	-0.024	0.236***	0.155***	0.189***
	(0.033)	(0.030)	(0.033)	(0.006)	(0.009)	(0.022)
Constant	2.626***	5.385***	4.590***	1.941***	3.300***	2.568***
	(0.901)	(0.502)	(0.770)	(0.220)	(0.179)	(0.327)
Obs	12,673	12,985	8,052	329,819	104,228	24,660
Within R^2	0.135	0.102	0.145	0.211	0.239	0.163
Overall R^2	0.116	0.136	0.355	0.459	0.378	0.313
Number of firms	6,384	6,332	3,881	152,557	52,670	13,419

Note: The values in parentheses are the standard deviation of the coefficients, ***, **, and * indicate significant at the 1%, 5%, and 10% levels, respectively.

 DOI: https://doi.org/10.30564/jmser.v3i1.2462

cial credit on the production efficiency of enterprises from the perspective of informal credit channel of commercial credit and the sample of Chinese industrial enterprises from 2004 to 2007. In the research, this paper specifically distinguishes the mechanism of providing the supply and acquisition of commercial credit and the net effect of commercial credit on productivity, and draws the following conclusions:

For the total sample, the unilateral provision of business credit or the unilateral acquisition of business credit in 2004-2007 are not conducive to the improvement of production efficiency. We believe that in the short term, enterprises provide commercial credit to the outside world, resulting in a certain degree of capital occupation, thus hindering the improvement of their own production efficiency; the acquisition of commercial credit caused by deferred payment is often the performance of enterprise capital shortage and then inhibit the improvement of enterprise production efficiency. At the same time, the study found that the negative impact of the provision of commercial credit or the productivity of private enterprises is significantly greater than that of state-owned enterprises. However, as a short-term financing method for enterprises, the net commercial credit can alleviate the financing dilemma faced by enterprises to a certain extent, and thus improve their production efficiency. This phenomenon occurs more in private enterprises. In addition, the promotion of commercial credit to the productivity of private enterprises can show an increasing trend with the development of marketization process, indicating that the development of marketization process will help commercial credit play a positive role in the development of enterprises.

Generally speaking, under the circumstances of financing difficulties, the net commercial credit obtained from obtaining and providing commercial credit plays an effective buffer role for the financial constraints of enterprises, which is conducive to the development of enterprises' operation, and the improvement of institutional environment has further promoted this positive role. This study provides a reference for understanding the role of commercial credit in private enterprises, and also provides some empirical evidence for the role of informal finance in the development of enterprises to a certain extent.

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DOI: https://doi.org/10.30564/jmser.v3i1.2462

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Journal of Management Science & Engineering Research
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ARTICLE

Research on the Change of GDP Growth, Monetary Growth and Price Index based on VAR and IRF

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ARTICLE INFO

Article history
Received: 14 October 2020
Accepted: 18 October 2020
Published Online: 30 October 2020

Keywords:
GDP growth variation
Broad money growth rate
Consumer price index

ABSTRACT

In this paper, we use the macro data from the first quarter of 2001 to the first quarter of 2015, through vector autoregressive (VAR) model, Granger causality analysis, impulse response function (RFI) and variance decomposition analysis of quantitative analysis methods, to research on the relationship among China's real growth variation of gross domestic product(GDP), Money supply growth rate and consumer price index. We find that the money supply growth has impact on China's real growth variation of GDP in short-term, but there is no long-term significant effect. Economic growth is the main factor to promote the consumer price index growth, money growth is not the main factor driving the change in the price index. China's currency growth is affected significantly by the change of the economic growth.

1. Introduction

From 1984, the people's Bank of China began to exercise the functions of the central bank and the Chinese government's intervention on economy has been changing from the simple administrative intervention to adjustment of the monetary policy based on market regulation. However, the international economic environment is becoming more and more complex and China is in the special period of economic restructuring, the effect of China's monetary policy does not reflect the intuitive and simple predictability. And along with the explosive growth of the global virtual economy, the Proportion that virtual economy in China's economic aggregate also increased significantly [1]. The development of virtual economy makes the operating mechanism of monetary policy more complicated. In some extent virtual economy dilutes the effects of monetary policy on the real economy. In 2008, in response to the global financial crisis, the Chinese government launched a series of economic stimulating plan as well as the loose monetary policy to rescue the market. However, results is that some money is directly absorbed by virtual economy, leading to the real estate and related industries, stock prices, but the benefit on real economy is limited [2-4]. It is an urgent question to be solved that how Chinese monetary policy affects Chinese economy.

For more than a decade, the inflation of China has been maintained at a high level. At the same time, the growth M2 is nearly ten times. General view is that monetary policy caused persistent high inflation, namely inflation dynamics are completely explained by expansionary monetary policy decision. However, the debate whether the fact is that logic has never stopped. Based on the view

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 DOI: https://doi.org/10.30564/jmser.v3i1.2396

of general dynamic equilibrium, currency issuance will change the expectation of consumers and manufacturers on future inflation, thus it affects household consumption and pricing of manufacturers. The former has the impact on the demand side, the latter affects the supply side. Monetary policy will have an impact on the macro economy by changing the expectation. So to understand the monetary policy, the basic starting point is to understand people's expectations of inflation formation process [5-7]. From the beginning of the first quarter of 2010, China's GDP growth rate continuous to decline. With drastic slowdown in the economic growth of our country recently, the market orientation of future monetary policy is debate endlessly, which focus on whether monetary policy should be fully relaxed.

In view of the above questions, this paper will have empirical analysis on the variation of China's economic growth, money supply m2 and CPI, and to explore how our country should control the money supply.to balance relationship between economic growth and rising prices.

2. Model Building and Data Processing

2.1 Model Constructing

(1) The vector auto regression (VAR) is commonly used for prediction of time series system and analysis of stochastic disturbances affecting the system variables the benefits of VAR model is that it doesn't need to make assumptions that which variables in the model of is endogenous or exogenous. It directly considered the relationship between the various economic variables of time series. The matrix form of the model VAR is as follows:

$$X\ t=A0+A1X\ t\text{-}1+\ldots+ApXt\text{-}P+B0\ Zt+B1Zt\text{-}1+\ldots+BrZt\ \text{-}r+\varepsilon t \quad (1)$$

The A0 is the intercept, which is an n*1 vector. A1, … , Ap is the n*n coefficient matrix, which is related to the lag value of endogenous variable and its current value. B0, … , Br are n*m coefficient matrix of current value and lag value of exogenous variable and current value of endogenous variable. εt is error, which is a n*1 vector.

(2) Granger causality test is an attempt to analyze the causal relationship between the variables, which is developed by the economist. Clive W. J. Granger. In the case of time series, Granger causality between the two economic variables X, Y is defined: if X,Y have been included in the model a, which use the past information of variables X and Y to predict the future value of variable y, the model b only includes the past information of variables Y. If the results of model a are superior to that of b, X is the Granger cause of the variables Y.

(3) The impulse response function (IRF) of vector autoregressive model (VAR) model is offen used to explore response of the system to newborn innovation of a variable. When the disturbance of a variable is changed in period t, it will produce a series of chain reactions through dynamic relationship among variables in the model after period t. The impulse response function will describe the dynamic response of the system to the new disturbance [8-11].

(4) The forecast error variance decomposition of vector autoregressive model is used to do analysis of the contribution rate. The impulse response function is to track the system impact effect of a variable in the model. And variance decomposition is that squared error of the system is decomposed into contributions of each variable to the system impact, it is the contribution ratio of impact each variable accounted for the total contribution. In 1980, Sims proposed the variance decomposition method, which was used to quantitatively analyze the relationship between variables.

2.2 Variable Selection and Data Processing

2.2.1 GDP Growth Variation (d2rgdp)

Due to nominal GDP contains the inflation factors, this paper is going to analysis monetary policy on the economy of real growth effect, so firstly, removing the effects of inflation. The calculation method is rgdp=gdp/ (1+CPI). For quarterly data, we often need to adjust it and remove seasonal factors before using it. In China's real GDP growth, due to the first quarter includes the Spring Festival, it is generally low in the first quarter. If we directly compare the data of second quarter with that of first quarter, we will overestimate the growth rate of second quarter GDP; if we directly compare the data of the first quarter with that of the fourth quarter, we will underestimate GDP growth rate in the first quarter. In short, the data which contains the seasonal effect cannot be directly carried out. From the graph 1, we clearly see that there is a clear seasonal effect on the line of the actual GDP. In this paper, the regression analysis method is used to adjust the seasonal effect. First we generate seasonal variables, then use the GDP time series to do regression with these variables, the residuals is the sequence after seasonal adjustment. Rgdp represents real sequences which don't exclude seasonal effect, and mv_gdp represents sequences which excludes seasonal effect. We can see clearly that GDP series become more smoothed after seasonal Adjustment.

2.2.2 Consumer Price Index (CPI)

The direct effect of inflation is the price rise of goods. The price rise causes the reduce on true values of the public

DOI: https://doi.org/10.30564/jmser.v3i1.2396

revenue and decline living standards. In view of this, this article choose the CPI as the measure of inflation which people generally pay close attention to.

2.2.3 Broad Money Growth Rate (inr_m2)

The ultimate goal of monetary policy implemented by the central bank is to control the development of the macro economy. The key to the success of monetary policy depends largely on the choice of intermediate targets. The choice of intermediate target is not unified. According to the classical monetary theory, the intermediate target of the monetary policy is the interest rate and the money supply. Due to the current interest rate of our country have not yet been fully liberalized, interest rate formation mechanism is not perfect, the money supply is an important tool of monetary policy. So in this paper, we use the growth rate of broad money supply to represent monetary policy [12-13].

2.2.4 Stationary

The first restrictive condition to use VAR model is to ensure that the time series are stationary. Therefore, this paper will test the time series variables through the unit root (ADF) test. table 1 is the results that we get.The consumer price index CPI and seasonal growth rate of M2, inr_m2 is stationary time series, but GDP is not the stationary time series. We make the first order difference with it, the increment of GDP is still not stable.We make the second order difference with mv_gdp, we obtain the stationary time series, namely GDP growth variation.

2.3 Model Analysis and Data Preprocessing

2.3.1 Determine the Lag Order of the Model

In order to use the VAR model to analyze the relationship among the GDP growth variation (d2rgdp), consumer price index (CPI) and broad money growth rate (inr_m2), we first need to determine the order of the VAR model according to the information criterion. The table 2 shows various information criteria which are used to select the number of lag order, but they are not consistent. According to the simple SBIC criteria, there is no lag effect, According to the LR, we should select 10 lag order; according to the FPE, AIC, HQIC criterion, we should select 6 lag order. We finally choose the FPE, AIC, HQIC criteria as the standard, and use the VAR model with 6 lags behind.

2.3.2 Test Validity of the Model

Table 2

lag	d2rgdp		inr_m2		CPI		all	
	chi2	Pro	chi2	Pro	chi2	Pro	chi2	Pro
1	11.570	0.009	1.603	0.659	20.917	0.000	45.02666	0.000
2	4.572	0.206	12.142	0.007	0.873	0.832	27.13711	0.001
3	17.821	0.000	11.114	0.011	6.238	0.101	41.86853	0.000
4	1.027	0.795	8.716	0.033	30.006	0.000	46.04701	0.000
5	6.956	0.073	3.979	0.264	10.292	0.016	26.84189	0.001
6	9.215	0.027	1.743	0.628	12.084	0.007	34.85924	0.000

Due to using a lag period of 6 and three variable VAR model, model, the coefficients of model are too many that cannot be explained with economic implications. And later we will do impulse response function analysis and Granger causality test, so here we only test the joint significance. Table 3 shows that although the coefficients of the some order in single equation are not significant, but as a whole of three equations, the coefficients are highly

Table 1

lag	LL	LR	df	P	FPE	AIC	HQIC	SBIC
0	-504.212				474433	21.5835	21.6279	21.7016
1	-497.734	12.957	9	0.165	528816	21.6908	21.8685	22.132
2	-481.635	32.179	9	0	393087	21.3887	21.6998	22.2154
3	-469.011	25.248	9	0.003	341355	21.2345	21.6789	22.4155
4	-453.385	31.252	9	0	263894	20.9526	21.5303	22.4878
5	-442.021	22.729	9	0.007	248502	20.8519	21.563	22.7415
6	-423.177	37.687	9	0	173906	20.4331	21.2774	22.6769
7	-415.129	16.097	9	0.065	198217	20.4736	21.4512	23.0716
8	-408.531	13.195	9	0.154	249583	20.5758	21.6868	23.5282
9	-405.752	5.559	9	0.783	389083	20.8405	22.0848	24.1471
10	-391.566	28.372*	9	0.001	400757	20.6198	21.9975	24.2808
Selection-order criteria Sample: 11-57 Number of obs=47								

 DOI: https://doi.org/10.30564/jmser.v3i1.2396

significant.

Table 3

	Prob>chi2	Prob_skewness	Prob_kurtosis
d2rgdp	0.188	0.096	0.452
CPI	0.315	0.134	0.810
inr_m2	0.004	0.007	0.047

Checking whether the residuals in the model obey normal distribution, the results are shown in table 5, so we can accept the original hypothesis at the 5% significance level, that the disturbance of three variables obeys normal distribution. We further examine the stability of the VAR system (for the stationary process). All eigenvalues are in the unit circle, so the VAR is stable. But some eigenvalues is very close to the edge of the unit circle, which means that some shocks have strong continuity.Through the examination of random and normal distribution of the residuals, and system stability of the VAR model, we can make sure that 6 lag order VAR model can be well used to analysis the The relationship among the GDP growth variation (d2rgdp), consumer price index (CPI) and broad money growth rate (inr_m2).

3. Empirical Analysis

3.1 Grainger Causality Analysis

Table 4. Grainger causality Test

Equation	excluded	chi2	df	Prob
d2rgdp	d2rgdp	21.437	6	0.002
	CPI	17.345	6	0.008
	inr_m2	59.086	12	0.000
CPI	d2rgdp	33.715	6	0.000
	CPI	10.658	6	0.100
	inr_m2	48.049	12	0.000
inr_m2	d2rgdp	21.453	6	0.002
	CPI	1.7438	6	0.941
	inr_m2	28.386	12	0.005

The table 4 shows: when we set GDP growth variation (d2rgdp) as explanatory variables in the equation, the Chi2 which corresponds to the CPI is 21.437, the corresponding p value is 0.002. So we think inflation is a Granger cause of the GDP growth variation. Corresponding values of the chi2 of Inr_M2 is 17.345 and corresponding P value is 0.008. So we think monetary growth rate (Inr_M2) is also a Granger of the GDP growth variation.

When we set consumer price index (CPI) as explanatory variables in the equation, the Chi2 which corresponds to GDP growth variation (d2rgdp) is 33.72., the corresponding p value is 0.000. So we think that GDP growth variation (d2rgdp) is a Granger cause of the consumer price index (CPI). The corresponding p value of broad money growth rate (inr_m2) is 0.10. So at the 10% significance level, we think that broad money growth rate (inr_m2) is not a Granger cause of the consumer price index (CPI).

When we set the broad money growth rate (inr_m2) as explanatory variables in the equation, the Chi2 which corresponds to GDP growth variation (d2rgdp) is 21.45., the corresponding p value is 0.002. So at the 1% significance level, we think that GDP growth variation (d2rgdp) is a Granger cause of the broad money growth rate (inr_m2). The corresponding p value of the consumer price index (CPI) is 0.94. So at the 10% significance level, we think that the consumer price index (CPI) is not a Granger cause of the broad money growth rate (inr_m2).

3.2 Pulse Function Result Analysis

Through the impulse response function, we know that monetary growth in the short term will cause continuous fluctuations in the rate of economic growth. It can accelerate economic growth in short-term, the effects of the broad money growth rate (inr_m2) on the economic growth rate was not significant in long-term [14-15].

The broad money growth rate (inr_m2) only causes fluctuations on consumer price index (CPI). However, it does not have a significant impact on the mean of CPI. This paper explain this phenomenon from two aspects: the one is that the majority of market participants predicted the money supply almost correctly. The other is that China's money supply is used to regulate the economy, so currency supply, economic development demand and the market supply of goods is consistent.

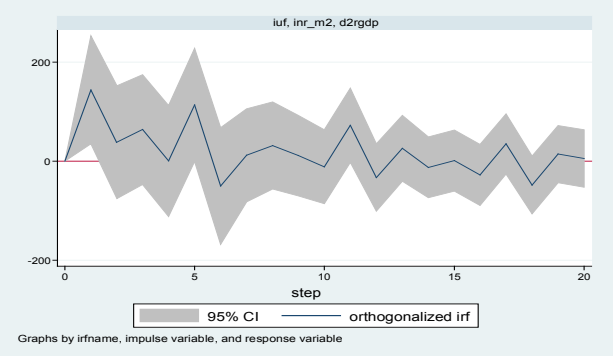

Figure 1

DOI: https://doi.org/10.30564/jmser.v3i1.2396

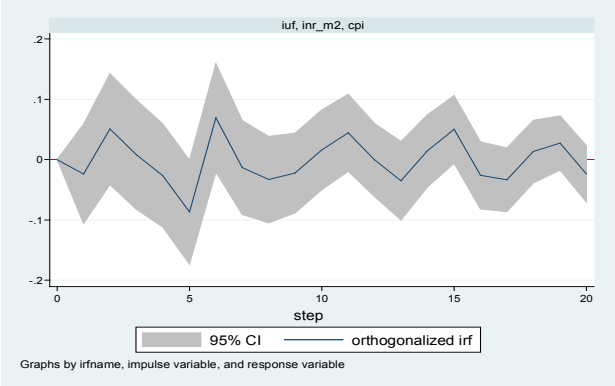

Figure 2

The change of China's economic growth rate (d2rgdp) will cause the sharp fluctuation of the consumer price index (CPI). To a certain extent, the fluctuation shows a periodic trend. Market participants reflect optimism and pessimism. When economic growth accelerate, market participants are generally optimistic, consumer spend more, short-term price rise. Then consumers find economic growth doesn't meet expectations, and reduce consumption, the demand decrease, price index rise slow down or decline.

3.3 The Forecast Error Variance Decomposition of VAR

As table 4 shows, when we make a quarterly forecast of the GDP growth variation (d2rgdp), the forecast variance is completely from d2gdp. Even if in the 20 previous forecast, there are still 67% of the forecast variance from its own. This means that consumer price index (CPI) and broad money growth rate (inr_m2) are not factors that influence d2gdp. With the increase of the lag order, the proportions from CPI and inr_m2 are higher and higher. It means that consumer price index (CPI) and broad money growth rate (inr_m2) both have a significant lag effect on GDP growth variation [16-17].

As table 4 shows: When we make a quarterly forecast

Table 5

Step	1.fevd	2.fevd	3.fevd	1.fevd	2.fevd	3.fevd	1.fevd	2.fevd	3.fevd
0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1	1.000	0.000	0.000	0.117	0.883	0.000	1.000	0.000	0.000
2	0.881	0.010	0.109	0.362	0.634	0.004	0.881	0.010	0.109
3	0.843	0.046	0.110	0.365	0.612	0.023	0.843	0.046	0.110
4	0.765	0.116	0.119	0.364	0.613	0.023	0.765	0.116	0.119
5	0.780	0.110	0.109	0.345	0.628	0.027	0.780	0.110	0.109
6	0.746	0.105	0.148	0.326	0.603	0.072	0.746	0.106	0.148
7	0.740	0.107	0.153	0.313	0.592	0.095	0.740	0.107	0.153
8	0.729	0.126	0.146	0.310	0.601	0.090	0.729	0.126	0.145
9	0.717	0.136	0.146	0.320	0.590	0.091	0.717	0.136	0.147
10	0.719	0.135	0.146	0.330	0.578	0.091	0.718	0.135	0.146
11	0.706	0.151	0.144	0.342	0.568	0.090	0.705	0.151	0.144
12	0.694	0.149	0.157	0.341	0.561	0.098	0.694	0.149	0.158
13	0.694	0.149	0.157	0.331	0.578	0.091	0.694	0.149	0.158
14	0.694	0.148	0.158	0.330	0.574	0.096	0.694	0.148	0.158
15	0.686	0.158	0.156	0.331	0.566	0.096	0.686	0.158	0.156
16	0.679	0.167	0.154	0.328	0.571	0.106	0.680	0.167	0.154
17	0.678	0.166	0.156	0.321	0.565	0.107	0.678	0.166	0.156
18	0.678	0.165	0.158	0.324	0.566	0.111	0.678	0.165	0.158
19	0.674	0.163	0.163	0.323	0.566	0.111	0.674	0.163	0.163
20	0.670	0.168	0.162	0.325	0.563	0.112	0.670	0.168	0.162
	1.irfname=iuf,impulse=d2rgdp,and response=d2rgdp			1.irfname=iuf,impulse=d2rgdp,and response=CPI			1.irfname=iuf,impulse=d2rgdp,andresponse=d2rgdp		
	2.irfname=iuf,impulse=CPI,and response=d2rgdp			2.irfname=iuf,impulse=CPI,and response=CPI			2.irfname=iuf,impulse=CPI,and response=d2rgdp		
	3.irfname=iuf,impulse=inr_m2,and response=d2rgdp			3.irfname=iuf,impulse=inr_m2,and response=CPI			3.irfname=iuf,impulse=inr_m2,and response=d2rgdp		

 DOI: https://doi.org/10.30564/jmser.v3i1.2396

of the consumer price index (CPI), there are 88.32% of the forecast variance completely from its own. In the 20 previous forecast of CPI, there are still 56% of the forecast variance from its own, but 32.52% of the forecast variance come from d2rgdp, only 11.21% of the forecast variance is from inr_m2. This means that the GDP growth variation is the significant factors that influence the CPI, but broad money growth rate (inr_m2) is not a main factor that influence CPI. With the increase of the lag order, the proportions from d2rgdp and inr_m2 are higher and higher. It means that d2rgdp and inr_m2 both have a lag effect on CPI.

As table 4 shows: When we make a quarterly forecast of the broad money growth rate (inr_m2), there are 77.81% of the forecast variance completely from its own. In the 20 previous forecast of CPI, there are still 51% of the forecast variance from its own, but 42.73% of the forecast variance come from d2rgdp, only 5.92% of the forecast variance is from CPI. This means that the GDP growth variation is the significant factors that influence the the broad money growth rate (inr_m2), but the CPI is not a main factor that influence the broad money growth rate (inr_m2). With the increase of the lag order, the proportions from d2rgdp is higher and higher. It means that d2rgdp have a lag effect on inr_m2.

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DOI: https://doi.org/10.30564/jmser.v3i1.2396

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ARTICLE

Portrait of Online Lecture Issue on Accounting Students of Faculty of Economics and Business during COVID-19 Pandemic at Muhammadiyah Unversity of North Sumatra

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ARTICLE INFO

Article history
Received: 19 November 2020
Accepted: 30 November 2020
Published Online: 30 December 2020

Keywords:
Portrait
Online lecture issues
During a pandemic

ABSTRACT

The general purpose of this study is to formulate a portrait of the issue of online lectures on accounting students of the Faculty of Economics and Business during the covid-19 pandemic at the Muhammadiyah University of North Sumatra. The research was conducted at the Faculty of Economics and Business. This type of research is survey research. The research sample is Grade 6/B Accounting Student of the Faculty of Economics and Business at the Muhammadiyah University of North Sumatra. Data collection using interviews and question lists. Furthermore, data analysis is used i.e. SPSS statistics. The results showed, The media used by lecturers is very helpful to students in the learning process, related to the learning materials students agree each lecturer provides material following RPS, For every lecturer who conveys the material turns out that students do not understand what has been conveyed, even though students are given regular assignments, some lecturers are less respect for students who have impaired connections or networks, And this online lecture system makes students very complain about data packages. Students are more respect to face-to-face learning, and it turns out that the online lecture system has not been implemented to the maximum.

1. Introduction

Online learning creation in the world is increasing. Indonesia is currently in the top 10 countries that are currently in the market for the creation of online learning systems in the world, making it 25% more likely to create an online learning system in Indonesia [1]. There is no denying the use of technology from online learning systems in the covid-19 pandemic certainly has a positive or negative side. The positive side of online learning is that it opens up the freedom of expression from student ideas that do not appear during face-to-face lectures because of shame, reluctance, fear, or even lack of good verbal ability. Online learning can also help students living in remote areas who have difficulty access to campus or clash time, especially students who go to work [2.3].

Blended Learning lecture submission is prioritized to develop a distance learning system in universities to support the expansion of opportunities and deepen students' understanding of teaching topics and materials. Information and communication technology will be utilized optimally in its function as a learning medium, and also to

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 DOI: https://doi.org/10.30564/jmser.v3i1.2588

facilitate the learning process [4]. Therefore, it is necessary to create a Blended Learning lesson, which is learning that combines face-to-face learning activities and e-learning (online lectures) organized for internal students of the teaching college so that students can access learning materials and resources without the time and place constraints, anytime and anywhere. Online learning and working from home to prevent the spread of COVID-19 to ensure that the control, vigilance, and handling of covid-19 spread in its work unit has been implemented properly following the Circular Letter of the Minister of Education and Culture No. 2 year 2O2O and Number 3 of 2O2O on the Prevention and Treatment of Coronavirus Disease (Covid-19), dated March 9, 2020., dated March 9, 2020 [5,6].

Online learning and working from home to prevent the spread of COVID-19 is the Circular Letter of the Minister of Education Number: 36962/MPK. A/HK/2020 on learning online and working from home to prevent the spread of Corona Virus Disease (COVID-19) [6]. Some questions that prompted the research, among others, what was the online learning system during the COVID-19 pandemic, when viewed from a positive point of view and negative side viewpoint? The results of this study are expected to have implications for the commitment of lecturers as well as the faculty of economics and business at the Muhammadiyah University of Sumatra Utara. So the purpose of this research is to look at portraits of online lecture issues, at the Accounting Students of the Faculty of Economics and Business during the covid-19 pandemic at the Muhammadiyah University of North Sumatra [7].

2. Literature Review

Through the Circular Letter of the Minister of Education of the Republic of Indonesia No. 3 of 2020 on covid-19 prevention in the education unit, all higher education in Indonesia is no exception, Bina Sarana informatics university (UBSI) took decisive steps on the government's call to conduct learning activities from home. All academic activities that are common on campus, during this pandemic period must be done from home. Not only students, lecturers, and tender (education personnel) were forced to work from home for the prevention and acceleration of the covid-19 outbreak. Pandemic policies and phenomena whose impact is extraordinary and happening so quickly have forced the world of higher education to change the working patterns of services from conventional to online-based services. To prevent the spread of Covid-19, who gave an exhortation to stop events that could cause crowds to swarm. Therefore, face-to-face learning that gathers many students in the classroom is reviewed. Lectures should be held with scenarios that can prevent physical contact between students and lecturers and students (Firman, F., & Rahayu, S.). According to Milman , the use of digital technology can allow students and lecturers to carry out the learning process even if they are in different places. The form of lectures that can be used as a solution in the covid-19 pandemic is online learning. According to Moore, Dickson-Deane, & Galyen.

Online learning is learning that uses the internet network with accessibility, connectivity, flexibility, and the ability to bring forth different types of learning interactions. Research conducted by Zhang et al., shows that the use of the internet and multimedia technology can overhaul the way knowledge is delivered and can be an alternative to learning implemented in traditional classrooms. Online learning is learning that can bring students and lecturers together to carry out learning interactions with the help of the internet (Kuntarto, E.). The implementation state of online learning requires the support of mobile devices such as smartphones or android phones, laptops, computers, tablets, and iPhones that can be used to access information anytime and anywhere (Gikas & Grant). Universities during the WFH period need to implement online learning strengthening (Darmalaksana). Online learning has been the demand for the education world for the last few years (He, Xu, & Kruck). Online learning is needed in learning in the era of industrial revolution 4.0 [11].

The use of mobile technology has a large contribution to educational institutions, including the achievement of distance learning goals (Korucu & Alkan). Various media can also be used to support the implementation of online learning. For example, virtual classes use Google Classroom, Edmodo, and Schoology services (Enriquez; Sicat; Iftakhar), and instant messaging apps like What's App. Online learning can even be done through social media such as Facebook and Instagram (Kumar & Nanda). Online learning connects students with their learning resources (databases, experts/instructors, libraries) that are physically separate or even distant but can communicate, interact or collaborate (directly/synchronously and indirectly/asynchronously). Online learning is a form of distance learning that utilizes telecommunications and information technology, such as the internet, CD-ROOM [2]. The purpose of this research is to obtain online learning at the FKIP biology education study program, University of Jambi during the covid-19 pandemic.

3. Research Method

This type of research is included in this type of research survey, because it takes samples from one population using questionnaires. This research was conducted in the accounting program of the Faculty of Economics and

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Business at Muhammadiyah University of North Sumatra, online learning referred to in this study is learning using learning media that can be used using internet services. Research is done by first surveying students on the application of online learning. Surveys are distributed using google forms given to students via WhatsApp messages. 30 subjects have responded to the disseminated survey. The survey results are then grouped into five categories of student responses: (1) Strongly agree; (2) agree; (3) Doubt (4) Disagree; (5) Strongly disagree. Population and Samples. The research population is all Students of the Faculty of Economics and Business. While the sample withdrawal technique uses non-probability sampling. The key to determining the sample size is from the size of the indicator multiplied by 5. This is because this study used 2 (two) constructed variables with a total number of indicators of 6, so the sample needed in this study was 5 x 6 = 30 people. So the minimum sample count in the study was 30 people.

Data Collection Techniques. Research in data collection uses interviews and questionnaires to obtain primary data. The use of questionnaires aims to obtain data from respondents as a research subject relating to the variables to be measured. The aspects asked in the interview are: (1) the facilities and infrastructure that students have to carry out online learning; (2) Student response to the effectiveness of online learning; (3) Implementation of online learning in breaking the link of covid-19 spread in the college environment. Analysis of research data is carried out using SPSS.

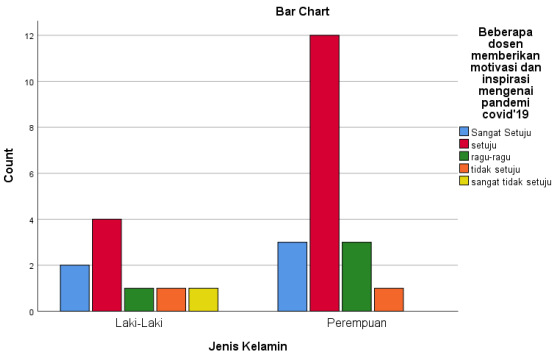
Analysis of the data reduction stage research is the stage of collecting all the information needed from the results of the interview and then in the grouped data. The data display stage is the exposure of data required in research and that does not need to be discarded. The withdrawal and verification phase of conclusions is the interpretation stage of research data to draw conclusions based on the phenomenon obtained [9].

4. Results and Analysis

Based on the results of data processing obtained output:

Some lecturers provide motivation and inspiration about the Covid-19 pandemic

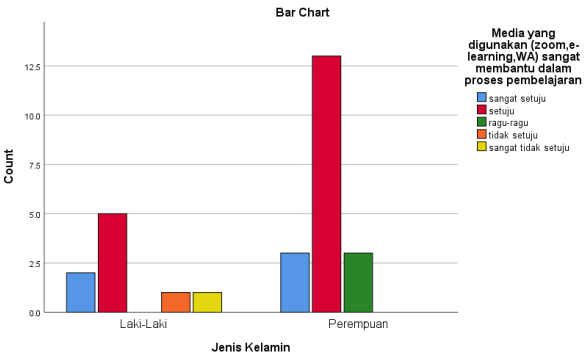
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly Agree	5	17.9	17.9	17.9
	Agree	16	57.1	57.1	75.0
	Undecided	4	14.3	14.3	89.3
	Disagree	2	7.1	7.1	96.4
	Strongly disagree	1	3.6	3.6	100.0
	Total	28	100.0	100.0	



Judging by the tables and bar charts, respondents agreed with the questions asked by 16 male and female student respondents with 57.1%, lecturers providing motivation and inspiration about the covid-19 pandemic

The media used (zoom,e-learning,WA) is very helpful in the learning process.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly Agree	5	17.9	17.9	17.9
	Agree	18	64.3	64.3	82.1
	Undecided	3	10.7	10.7	92.9
	disagree	1	3.6	3.6	96.4
	Strongly disagree	1	3.6	3.6	100.0
	Total	28	100.0	100.0	

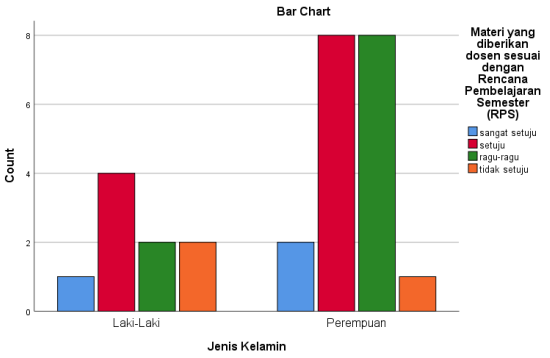


Judging from the table and bar chart, respondents agreed with the question asked by 18 male and female student respondents with 64.3%, Media used (zoom, e-learning, WA) is very helpful in the learning process

Materials provided by lecturers in accordance with semester learning plan (RPS).

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly Agree	3	10.7	10.7	10.7
	Agree	12	42.9	42.9	53.6
	Undecided	10	35.7	35.7	89.3
	disagree	3	10.7	10.7	100.0
	Total	28	100.0	100.0	

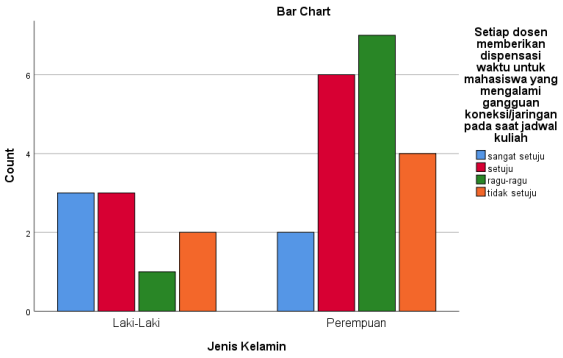
DOI: https://doi.org/10.30564/jmser.v3i1.2588



Judging from the tables and bars of the chart, respondents agreed with the question asked by 12 and doubted 10 male and female student respondents with 42.9%, and 35.7%, The material provided by lecturers in accordance with the Semester Learning Plan (RPS), uniquely male respondents were more dominant in agreeing than women expressed agreeing and hesitation balanced when viewed in the bar chart.

Each lecturer provides time dispensation for students who experience connection / network interference during the course schedule.

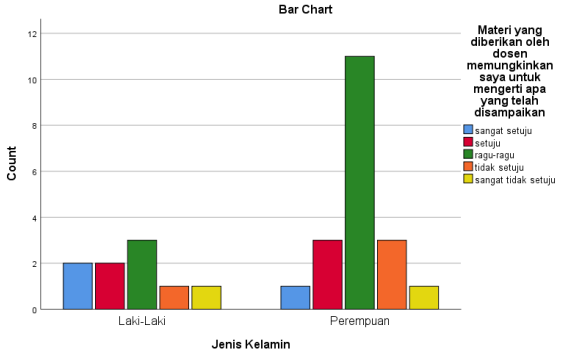
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly Agree	5	17.9	17.9	17.9
	Agree	9	32.1	32.1	50.0
	Undecided	8	28.6	28.6	78.6
	disagree	6	21.4	21.4	100.0
	Total	28	100.0	100.0	



Judging by the tables and bar charts, respondents agreed with the question asked by 9 and hesitant 8 male and female student respondents with 32.1%, and 28.6%, Each lecturer gave a time dispensation, for students who experienced connection /network interference at the time of the lecture schedule, uniquely male respondents balanced with a strongly agreed statement, then women expressed hesitation more dominant when compared to agreeing when viewed on the bar chart.

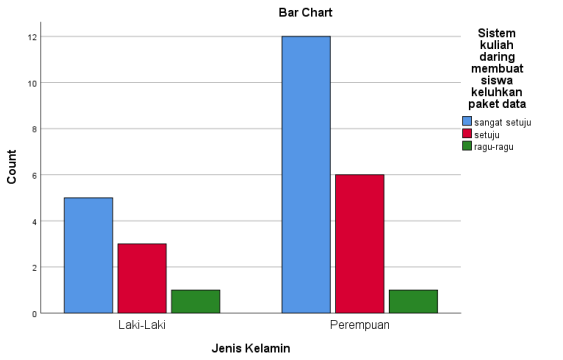
The material provided by the lecturer allows me to understand what has been conveyed.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly Agree	3	10.7	10.7	10.7
	Agree	5	17.9	17.9	28.6
	Undecided	14	50.0	50.0	78.6
	disagree	4	14.3	14.3	92.9
	Strongly Agree	2	7.1	7.1	100.0
	Total	28	100.0	100.0	



Judging by the tables and bar charts, respondents were hesitant with the questions asked by 14 male and female student respondents with 50%, The material provided by the lecturer allowed me to understand what had been conveyed

Online lecture system makes students complain about data packages					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly Agree	17	60.7	60.7	60.7
	Agree	9	32.1	32.1	92.9
	Undecided	2	7.1	7.1	100.0
	Total	28	100.0	100.0	



Judging from the tables and bar charts, respondents strongly agree with the question asked by 17 male and female student respondents with 60.7%, the online lecture system makes students complain about data packages.

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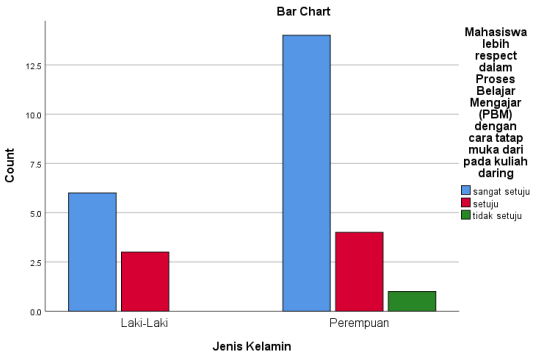


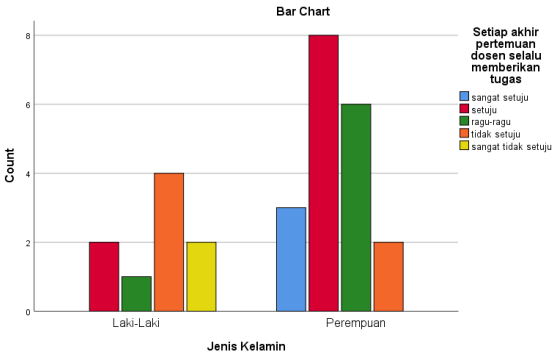
Students are more respected in the Teaching Learning Process (PBM) by face-to-face than online lectures

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly Agree	20	71.4	71.4	71.4
	Agree	7	25.0	25.0	96.4
	Undecided	1	3.6	3.6	100.0
	Total	28	100.0	100.0	

Judging from the table and bar chart, respondents strongly agree with the question asked by 20 male and female student respondents with 71.4%, Students are more respected in the Teaching Learning Process (PBM) by way of face-to-face than in online lectures.

At the end of each meeting the lecturer always gives the task of:

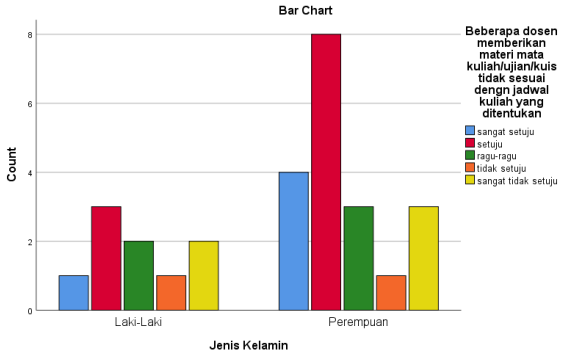
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly Agree	3	10.7	10.7	10.7
	Agree	10	35.7	35.7	46.4
	Undecided	7	25.0	25.0	71.4
	Disagree	6	21.4	21.4	92.9
	Strongly Agree	2	7.1	7.1	100.0
	Total	28	100.0	100.0	



Judging from the table and bar chart, respondents agreed with the question asked by 10 male and female student respondents with 35.7 %, Each end of the meeting the lecturer always gave the task, uniquely more male respondents who expressed dissrove of the end of the meeting of lecturers giving assignments.

Some lecturers provide courses/quizzes incompatible with the specified course schedule:

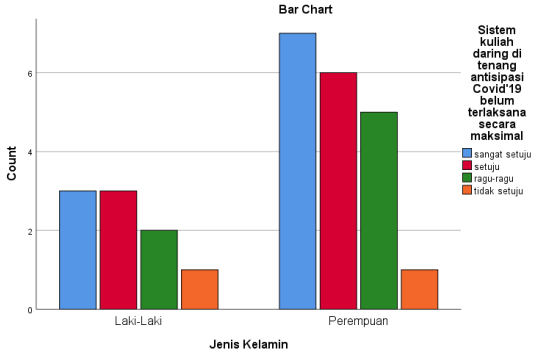
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	very agreeable	5	17.9	17.9	17.9
	Agree	11	39.3	39.3	57.1
	hesitant	5	17.9	17.9	75.0
	disagree	2	7.1	7.1	82.1
	strongly disagree	5	17.9	17.9	100.0
	Total	28	100.0	100.0	



Judging from the table and bar chart, respondents agreed with the question asked by 11 male and female student respondents with 39.3 %, Some lecturers gave course materials /quizzes incompatible with the specified course schedule

Online lecture system in anticipation of Covid-19 has not been implemented to the maximum.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	very agreeable	10	35.7	35.7	35.7
	Agree	9	32.1	32.1	67.9
	hesitant	7	25.0	25.0	92.9
	disagree	2	7.1	7.1	100.0
	Total	28	100.0	100.0	



Judging by the tables and bar chart, respondents strongly agree with the question asked by 10 male and female student respondents with 35.7%, The online lecture system in anticipation of Covid-19 has not been implemented to

the maximum, male respondents give a statement strongly agreeing and agreeing equally compared to women

5. Conclusion

The results of the study showed "an overview of the issue of online lectures during the Covid-19 pandemic', showing students have the means and infrastructure to carry out online learning. The media used by lecturers is very helpful to students in the learning process, related to student learning materials agree that each lecturer provides materials following RPS, Online learning can make students self-study and motivation increases. Students are more respectful to face-to-face learning, however, there are weaknesses in online learning students are not well watched during the online learning process. Weak internet signal and high cost of quota become a challenge of online learning and some lecturers lack respect for Students who experience connection or network disruption because the results of the data above students agree until hesitant. for every lecturer who conveys the material turns out that students do not understand what has been conveyed, even though students are given regular assignments, and it turns out that the online lecture system has not been implemented to the maximum.

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DOI: https://doi.org/10.30564/jmser.v3i1.2588

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Journal of Management Science & Engineering Research
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ARTICLE

Transient Simulation on Dynamic Response of Liquid Annular Seals

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ARTICLE INFO

Article history
Received: 19 November 2020
Accepted: 28 November 2020
Published Online: 30 December 2020

Keywords:
Annular seals
Transient impact load
6DOF
Axis trajectory
Seal pressure

ABSTRACT

Transient change of the operating parameters has a serious influence on the stability of liquid annular seals. Take the liquid annular seals as a research object, a numerical method based on six-degree-of-freedom (6DOF) to analyze the dynamic response of liquid annular seals under gravity impact load. The variations of the force of liquid seal and pressure as well as the axis trajectory in time history are investigated. The influence of different sealing clearance, different liquid viscosity and different rotor speed is also studied. The results show that the maximum sealing pressure and sealing force of gravity direction will increase greatly in a very short time and then reduce rapidly. When sealing clearance increases, the displacement response amplitudes of axis trajectory, the maximum sealing force of gravity direction and maximum sealing pressure also increase. When liquid viscosity increases, the displacement response amplitudes of axis trajectory, the maximum sealing force of gravity direction and maximum sealing pressure decrease. We also found that different rotor speed has almost no influence on the maximum sealing force of gravity direction and maximum sealing pressure.

1. Introduction

As an important part of the multi-stage Centrifugal pump, hydraulic turbine and other rotating power machinery, the annular seal plays an important role in restraining the internal leakage of the machinery and balancing the axial force, common Structure of the annular seal is generally located in the impeller annular seal, inter-stage seal. A lot of research has been done in the area of the annular seal as well as the Rotor Dynamics [1-4]. In the process of starting and stopping of the rotor, the rotor and seal will bear a great impact force. A lot of scientific research has also been carried out on the characteristics of fluids under transient impact force, for example, Ma Jinkui studied the variation of the minimum oil film thickness, the maximum oil film pressure and the Axis trajectory of the rotor under different pulse [5], Rao calculated the axial trajectory of the rotor under critical speed and unstable speed, and calculated the dynamic analysis of the rotor-bearing under shock excitation [6], TICHY analyzed the influence of the transverse impact load and the impact load time on the axial trajectory of the rotor [7], Li Zhen et al. investigated the resonance of a rotor-bearing system under different kinds of loads [8], Yan et al. [9] studied flow field analysis using the CFX software,and the fluid-solid coupling analysis of the

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 DOI: https://doi.org/10.30564/jmser.v3i1.2597

annular seal structure and the Jeffcott Rotor. was done.

In this paper, the dynamic response of the annular seal is studied The sealing force, axial trajectory and fluid pressure under different sealing clearance, fluid viscosity and rotating speed were analyzed and compared.

2. Computational Model

The sealing structure of the annular seal is shown in Figure 1, and the calculation model is shown in Figure 2.

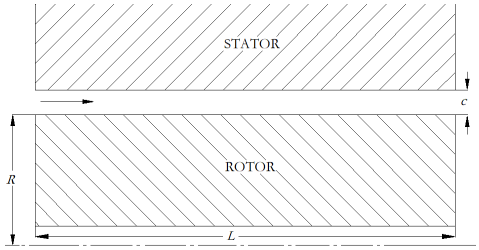

Figure 1. The annular seal structure

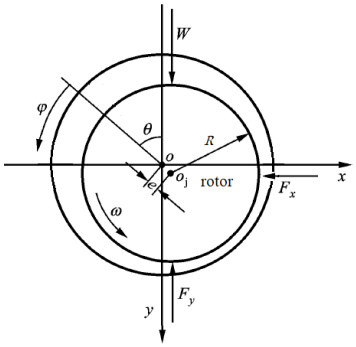

Figure 2. The calculation model

The dynamic equation of the seal is:

$$M\ddot{x} = F_x + Q_x$$

$$M\ddot{y} = F_y + Q_y + Mg$$

$\ddot{x}$ is the horizontal acceleration at the center of the rotor, $\ddot{y}$ is the vertical acceleration at the center of the rotor;

F_x is the sealing force in horizontal Direction, F_y is the sealing force in vertical Direction. Q_x is the Impact load in horizontal Direction, Q_y is the Impact load in vertical Direction; M is the mass of rotor; g is gravitational acceleration.To solve the above dynamic equations, step-by-step integration method is needed to obtain the position of the axis.position.

$$\dot{x}(\tau+\Delta\tau) = \dot{x}(\tau) + \ddot{x}(\tau)\Delta\tau$$

$$\dot{y}(\tau+\Delta\tau) = \dot{y}(\tau) + \ddot{y}(\tau)\Delta\tau$$

$$x(\tau+\Delta\tau) = x(\tau) + \dot{x}(\tau+\Delta\tau)\Delta\tau$$

$$y(\tau+\Delta\tau) = y(\tau) + \dot{y}(\tau+\Delta\tau)\Delta\tau$$

$\Delta\tau$ is time step, τ is total time, The new sealing thickness can be obtained by using the new axial position. The iteration cycle is repeated until the total solution time is over.

3. Calculation Result

In the finite element model,the sealing radius gap c=0.25mm, the Sealing length L=50mm, Rotor radius R=50mm, The fluid is water, and the Viscosity is 0.001Pa. s, density is 1000kg/m^3,the pressure change due to the transient impact load is not significant, the change of density is 10^{-5} order of magnitude, so is not considered in this article. The equivalent rotor mass is 25kg,the rotor speed is 3000r/min, in Fluent [10] software,The finite element model of the annular seal is shown in Figure 3, The grid of thickness is shown in Figure 4, Hexahedron element is used in the model, and the number of Mesh is about 1.8 million, It is verified that the further refinement of the grid has little effect on the calculation results. $k-\varepsilon$ turbulence Model is used, The inlet and outlet boundary is the pressure inlet and outlet condition, The inlet pressure is 0.2Mpa, the outlet pressure 0.1Mpa, The Wall surfaces are all set to adiabatic boundaries, The fluid and the wall adopt the smooth non-slip boundary condition.

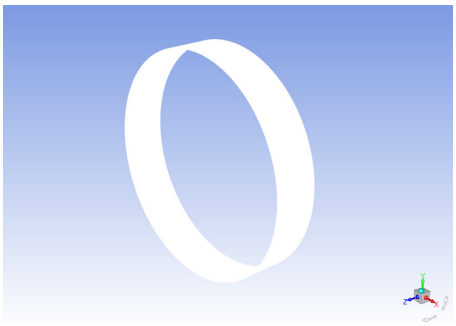

Figure 3. The finite element model

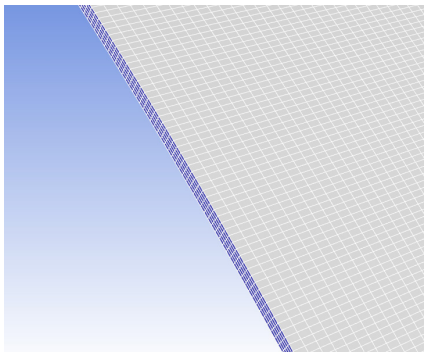

Figure 4. Local Grid

DOI: https://doi.org/10.30564/jmser.v3i1.2597

3.1 Dynamic Response under Different Radius Clearance

The axial trajectory, seal force in horizontal direction and gravity direction and seal pressure changing with impact time were calculated under the conditions of radius clearance 0.15 mm, 0.25 mm and 0.35 mm, respectively. see Figure 5-8 below. It is found that with the increase of the radius clearance, the amplitude of axial trajectory displacement response increases, the maximum value of sealing force in horizontal and gravity direction also increase, and the longer the time is needed. At the same time, with the increase of sealing radius clearance, the transient value of the maximum sealing pressure is also increase.

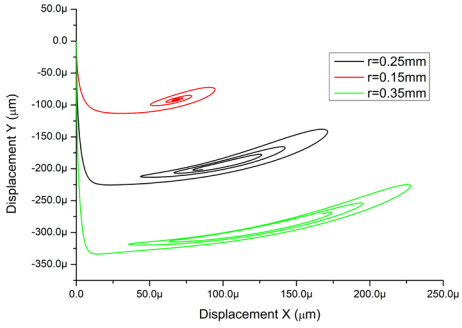

Figure 5. Axial trajectory under different radius clearance

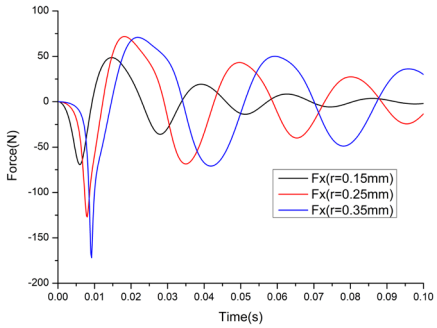

Figure 6. The horizontal sealing force changes with time under different radius clearance

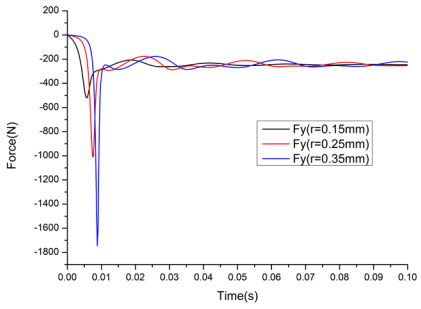

Figure 7. The sealing force of gravity direction changes with time under different radius clearance

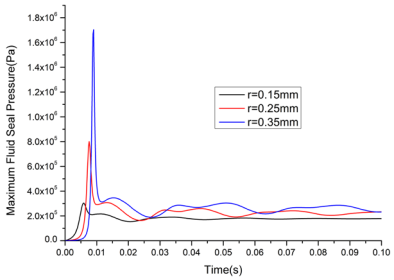

Figure 8. The maximum sealing pressure changes with time under different radius clearance

3.2 Dynamic Response under Different Fluid Viscosity

The axial trajectory, seal force in horizontal direction and gravity direction and seal pressure changing with impact time were calculated under the conditions of fluid viscosity 0.001Pa.s, 0.01Pa.s and 0.06Pa.s, respectively.see Figure 9-12 below. It is found that with the increase of the fluid viscosity, the amplitude of axial trajectory displacement response decreases, the maximum value of sealing force in horizontal and gravity direction also decrease, and the less time is needed. At the same time, with the increase of sealing radius clearance, the transient value of the maximum sealing pressure is also decrease.

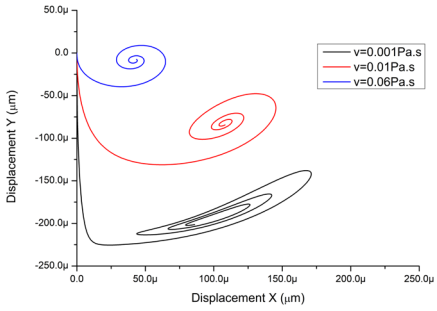

Figure 9. Axial trajectory under different fluid viscosity

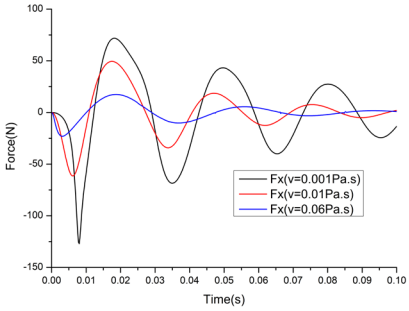

Figure 10. The horizontal sealing force changes with time under different fluid viscosity

DOI: https://doi.org/10.30564/jmser.v3i1.2597

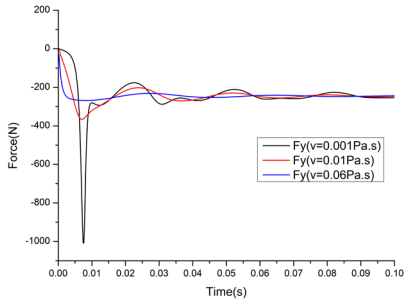

Figure 11. The sealing force of gravity direction changes with time under different fluid viscosity

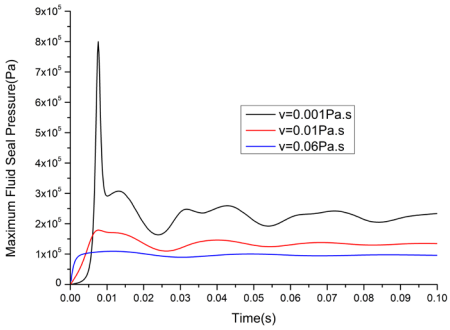

Figure 12. The maximum sealing pressure changes with time under different fluid viscosity

3.3 Dynamic Response under Different Rotational Speed

The axial trajectory, seal force in horizontal direction and gravity direction and seal pressure changing with impact time were calculated under the conditions of rotational speed 1000r/min, 3000r/min, 5000r/min, respectively.see Figure 13-16 below.It is found that with the increase of the rotational speed, the amplitude of axial trajectory displacement response decreases. The maximum value of the sealing force in the gravity direction is basically the same and the time is the same. At the same time, with the increase of the rotational speed, the transient value of the maximum sealing pressure is also the same and the time is the same.It shows that this phenomenon has little to do with the rotational speed.

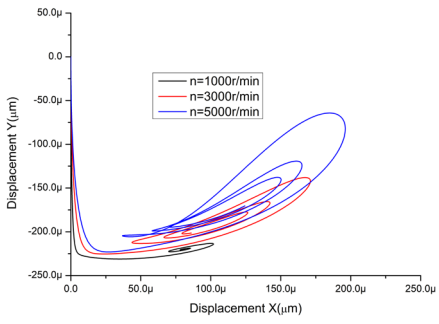

Figure 13. Axial trajectory under different rotational speed

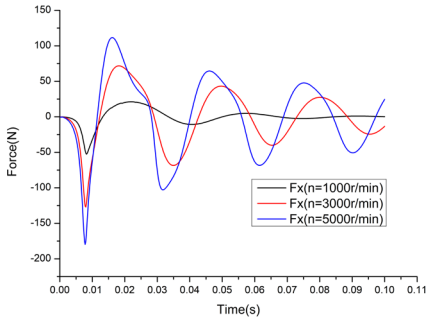

Figure 14. The horizontal sealing force changes with time under different rotational speed

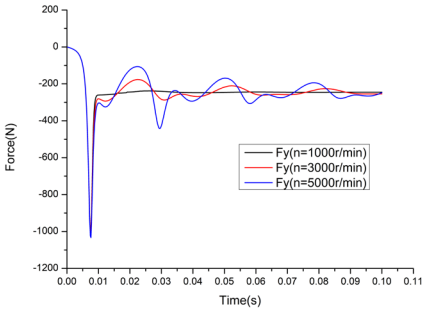

Figure 15. The sealing force of gravity direction changes with time under different rotational speed

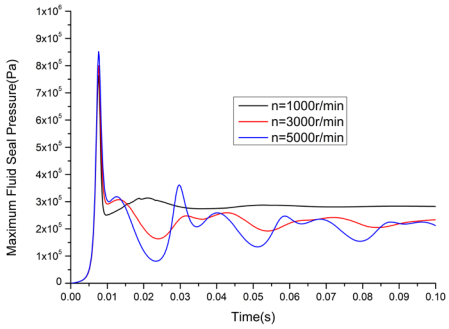

Figure 16. The maximum sealing pressure changes with time under different rotational speed

4. Conclusion

The results show that the maximum sealing pressure and sealing force of gravity direction will increase greatly in a very short time and then reduce rapidly. When sealing clearance increases, the displacement response amplitudes of axis trajectory, the maximum sealing force of gravity direction and maximum sealing pressure also increase. When liquid viscosity increases, the displace-

DOI: https://doi.org/10.30564/jmser.v3i1.2597

ment response amplitudes of axis trajectory, the maximum sealing force of gravity direction and maximum sealing pressure decrease. We also found that different rotor speed has almost no influence on the maximum sealing force of gravity direction and maximum sealing pressure.

Acknowledgment

This study has been funded by Key projects of technological innovation and application development of Chongqing, China (Grant NO.cstc2018jszx-cyzd0729).

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ARTICLE

A Study into the Wealth of Successful Technology Entrepreneurs in the UK

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ARTICLE INFO

Article history
Received: 24 November 2020
Accepted: 7 December 2020
Published Online: 30 December 2020

Keywords:
Wealth
Technology
Entrepreneurs
Net worth
Resources
Assets
Capital

ABSTRACT

This paper describes an academic study into the wealth of successful technology entrepreneurs in the United Kingdom. Here we are concerned with the dimensions of wealth in terms of its measurement. The methodology used involved three stages to determine the nature of the wealth involved. Initial sources (predominantly literature) and further sources (mainly business information) were considered in stage one to understand the measurement of the wealth of successful technology entrepreneurs. Analysis and synthesis of data undertaken in stage two determined the net wealth for technology entrepreneurs in different areas of activity. The nature and importance of the measurement of the wealth of technology entrepreneurs were examined in stage three to formulate conclusions. The research question investigated "what is the average net wealth of successful technology entrepreneurs in the United Kingdom?" The contribution of the study is to bring together findings of the research in terms of the measurement of the wealth of successful technology entrepreneurs.

1. Introduction

This paper describes a contemporary study into the wealth of successful technology entrepreneurs in the United Kingdom. Dimensions of wealth in terms of its measurement have been investigated. The methodology for the study was undertaken in three stages. In order to obtain an understanding of the measurement of the wealth of technology entrepreneurs initial sources (literature) and further sources (business information) were investigated in stage one. Analysis and synthesis of data were undertaken in stage two to determine the wealth of technology entrepreneurs in different areas of activity. A coding process was used to identify areas and enable the measurement of activity for comparison purposes. In stage three the nature and importance of the measurement of the wealth of technology entrepreneurs was examined in detail to formulate conclusions.

Overall objectives and mission of the paper are to compile an up-to-date and academic study into the wealth of successful technology entrepreneurs. The research question considered "what is the average net wealth of successful technology entrepreneurs in the United Kingdom?" Here we are concerned with the dimensions of wealth using data obtained from the Rich List [1] includ-

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DOI: https://doi.org/10.30564/jmser.v3i1.2607

ing the number of entrepreneurs in each area, their rank (highest and lowest), the total wealth for the area in terms of the number of billionaires and millionaires, increase in wealth since 2018 for entrepreneurs in the area, and the number of entrepreneurs who have increased or decreased wealth, those with no change and new entries since 2018.

The findings of the research show the average net worth of technology entrepreneurs in terms of their annual wealth. This is according to the technology areas of Chemicals, Technology, Pharmaceuticals, Industry, Internet, Plastics, Software, Aviation, Computers, Engineering, Telecoms, Biotechnology, Electronics, Energy and Mobile phones. It takes into account the ranked order according to calculated wealth. In answer to the research question it was established that the extent of wealth of individuals in different technology areas was dependent on the amount of activity and development of the area and also the accumulation of wealth by individuals.

The paper has a structure with sections on background, research methodology involving the three stages of the research, findings in terms of the wealth of technology entrepreneurs in the different areas of their activities, analysis, discussion of the findings and conclusions for the study. The following section provides the background to the study.

2. Background

Wealth can be described as the amount of financial assets or possessions that can be transferred into a means for transactions to be made. The core meaning originates from the old English word "weal" from an Indo-European word stem [2]. In modern society wealth is important in all economies especially in terms of growth and development. Indeed, a person who possesses a substantial net worth of wealth is commonly known as "wealthy". The definition of net worth is the current value of assets less their liabilities, exclusive of trust accounts [3]. In this research we express Net Worth (NW) as follows:

$$NW = CVA\text{-}L,$$

where CVA is the Current Value of Assets of technology entrepreneurs and L is the Liabilities of technology entrepreneurs.

At a general level wealth can be defined as "anything that is of value", and various definitions have been given for different contexts [4]. The process of defining wealth can have ethical implications since wealth maximisation is often seen as a goal [5,6]. A country, region or community that is seen to possess a large amount of resources or possessions of benefit to the good of those involved is perceived as "wealthy".

Inclusive wealth has been defined by the United Nations as a monetary measure including physical, human and natural assets [7]. In terms of capital this includes natural capital (land, forests, energy resources and minerals), human capital (skills and education) and physical capital (infrastructure, buildings and machinery).

This study considers the wealth of successful technology entrepreneurs which forms part of the academic field of technology entrepreneurship. Technology entrepreneurship (TE) in the entrepreneurship literature is referred to in several ways including technology-based entrepreneurship and technical entrepreneurship [8]. Bailetti [9] reports that technology entrepreneurship is based on economic development and the growth of firms and involves the selection of stakeholders to take ideas to market and to educate scientists, engineers and managers. Further, Bailetti [9] describes technology entrepreneurship as "an investment in a project that assembles and deploys specialised individuals and heterogeneous assets to create value for the firm" [9].

In terms of definitions Bailetti [9] observes that technology entrepreneurship concerns (1) operation of enterprises by scientists and engineers, (2) identification of applications or problems with a technology, (3) setting-up new ventures, starting new applications or exploiting opportunities involving scientific and technical knowledge and (4) technical change collaboration (p.9). Moreover, Bailetti [9] comments that the field of technology entrepreneurship, when compared to other fields such as entrepreneurship, economics and management, is in its early development and provides the following definition "technology entrepreneurship is an investment in a project that assembles and deploys specialised individuals and heterogeneous assets that are intricately related to advances in scientific and technological knowledge for the purpose of creating and capturing value for a firm" (p.10). Overall, Bailetti [9] has noted that technology entrepreneurship in the past four decades has become an international phenomenon and is considered to be important for the growth of the firm, differentiation and competitive advantage at firm, regional and national levels (p.14).

A broad spectrum of business issues concerning technology entrepreneurship is apparent. These include issues at various stages of enterprise development involving growth and business success, strategy, resources and origins of the venture. There is growing awareness of the importance of technology entrepreneurship by business academics as a consequence.

Preston [10] (p.2) relates the success factors for technology entrepreneurship include clusters of excellence,

 DOI: https://doi.org/10.30564/jmser.v3i1.2607

location, attitudes, management talent, patents, passionate behaviour, quality investors, speed of innovation, high quality products to market quickly, and flexibility. Regarding attitudes radical innovations will not originate from a market leader [11]. Where a top management team with an average technology is evident this tends to be better than a lesser management team with a leading technology since top managers have a higher rate of success [10] (p.5). The basis of sustainable advantage for technology entrepreneurship is provided by patents and previously there have been incremental patents from laboratories' radical breakthrough patents [10] (p.6). Industries with creativity appear to have greater achievements (for example software) whereas industries exhibiting improvement appear to perform better (as evidenced by consumer electronics with improved manufacturing techniques) [10] (p.12). In order to shorten the time to market product development cycles repeated rapidly led to successful companies in semiconductor, computer, software and electronics industries, and speed to market has been an important determinant of success and profitability of products (also the case for those industries not dominated by intellectual property with patents given less importance) [10] (12-13). Lastly, location clusters create competitive advantage, and regional advantage can be attained by clustering enterprises with complementary and competitive skills leading to regional excellence [12].

In order to accelerate technology entrepreneurship for regional economic development and growth strategies for success include collaboration, technology alliances and partnerships with business, academia and government [13] (p.1). This is achievable through emerging industry clusters with growth potential involving intellectual property, incubators, innovation based growth, research and development (R&D) based growth, and business know-how (also important are knowledge-intensive new businesses, high tech companies, networks, company spinout activity, partnerships for research excellence, new technology-based organic growth ventures, collaboration and technology education) [13] (p.5).

A constructivist approach for technology entrepreneurship can be followed in order to achieve these strategies for success [14] (p.1). Although support of technology entrepreneurship has been prioritised by governments involving success initiatives to help technology ventures the results have not inevitably delivered expected returns [15]. Alvarez and Barney [16] reported there is a need for objective opportunities to encourage technology entrepreneurship involving dynamic environments [17]. In actual fact, technology entrepreneurship is seen as a process of plan, design and action as activities which are sequential and separate [18]. In the exploitation of technology there are also uncertainties [19] and in the initial stages of conceptualisation of technology opportunity, and by moving to an objective opportunity from a subjective idea [20]. Such iterative interaction has also seen other theoretical perspectives involving effectuation, creation theory and bricolage [16,18,21]. With such uncertain contexts there is incomplete knowledge about the processes and activities that develop the conceptualisation for technology enterprises [22] and the mechanisms used for the conceptualisation of opportunity to develop opportunity from human ideas [14]. Technology entrepreneurship can therefore be seen as a process concerning technology entrepreneurs facing a high degree of uncertainty [23] with business ideas involving disruptive market solutions and undetected technologies.

In terms of this study, in order to provide a clear understanding of technology entrepreneur, as the focus of the investigation, we have taken into account what is meant by technology and entrepreneur to formulate an appropriate definition. Accordingly, technology is defined as "the application of scientific knowledge for practical purposes, especially in industry" [24]. Also, "technology refers to methods, systems, and devices which are the result of scientific knowledge being used for practical purposes" [25], and the "study of knowledge of the practical, especially industrial, use of scientific discoveries" [26]. Further to this, an entrepreneur is "someone who starts their own business, especially when this involves seeing a new opportunity" [26], and "is an individual who creates a new business, bearing most of the risks and enjoying the rewards. The entrepreneur is commonly seen as an innovator, a source of new ideas, goods, services, and business/or procedures" [27]. Taking into account these definitions we define a technology entrepreneur as a person who applies their business ideas using technology to make a profit and create wealth.

3. Research Methodology

The methodology for the study into the wealth of successful technology entrepreneurs in the United Kingdom was undertaken in three stages. By using a systematic process [28] each research stage used appropriate methods (Table 1) [29]. The most suitable method for analysis was used at each stage taking account of potential downfalls by not relating some hidden underlying trends. The research question investigated "what is the average net wealth of successful technology entrepreneurs in the United Kingdom?" In order to respond to the research question, initial sources (predominantly literature) and further sources (mainly business information) were investigated [30] in stage one to gain an understanding of the measurement of

DOI: https://doi.org/10.30564/jmser.v3i1.2607

the wealth of technology entrepreneurs. The study utilises text analysis involving secondary documents [31]. Analysis of the Rich List (2019) [1] and synthesis of information were undertaken in stage two to determine the average net worth of wealth for technology entrepreneurs in different areas of activity. In this research the Average Net Worth (ANW) is expressed as:

$$ANW = \frac{\sum_{i=1}^{n} CVA - L}{N}$$

where CVA is the Current Value of Assets of technology entrepreneurs;

L is the Liabilities of technology entrepreneurs;

N is the Number of technology entrepreneurs.

Table 1. Research Strategy

Focus of the study into the measurement of the wealth of successful technology entrepreneurs in the United Kingdom		
Research Stage	Research Focus	Research Methods
Stage 1	An understanding of the measurement of the wealth of technology entrepreneurs.	Existing research and secondary data sources. Secondary data sources have included literature in the area.
Stage 2	Analysis and synthesis of data on the wealth of technology entrepreneurs.	Analysis of data to determine the average net worth of wealth for technology entrepreneurs in different areas of activity.
Stage 3	The nature and importance of the measurement of the wealth of technology entrepreneurs.	To examine in detail the nature and importance of the measurement of the wealth of technology entrepreneurs to formulate conclusions.

A coding process was used to identify areas and enable the measurement of activity for comparison purposes (Table 2). This was based on an alphabetical listing and number system. Also, the ranked order of technology entrepreneurs was determined according to calculated wealth. Stage three considered in detail the importance and nature of the measurement of the wealth of technology entrepreneurs to articulate conclusions. Table 1 shows the research strategy adopted for the study.

The research stages described in Table 1 investigated the following aspects of the wealth of technology entrepreneurs in the United Kingdom:

Stage 1: An understanding of the measurement of the wealth of technology entrepreneurs

The research has set out to obtain an understanding of the measurement of the wealth of technology entrepreneurs in the UK. It has drawn initially on existing research and further data sources. Further data sources have included literature in the area.

Stage 2: Analysis and synthesis of data on the wealth of technology entrepreneurs

This part of the research has consisted of the analysis of data from the Rich List (2019) [1] to determine the average net worth of wealth for technology entrepreneurs in different areas of activity.

Sage 3: The nature and importance of the measurement of the wealth of technology entrepreneurs

The objective of this stage of the research has been to examine in detail the nature and importance of the measurement of the wealth of technology entrepreneurs to formulate conclusions. Indicators were determined from information, concepts and factors identified in the literature, data available, and findings.

The coding system [32,33] used to identify areas and enable the measurement of activity for comparison purposes in the second stage of the research is shown below in Table 2.

Table 2. Coding Table

Coding used to measure the wealth of successful technology entrepreneurs in the United Kingdom		
	Technology Area	Code
1	Aviation	AVI
2	Biotechnology	BIO
3	Chemicals	CHE
4	Computers	COM
5	Electronics	ELE
6	Energy	ENE
7	Engineering	ENG
8	Industry	IND
9	Internet	INT
10	Mobile technology	MOB
11	Pharmaceuticals	PHA
12	Plastics	PLA
13	Software	SOF
14	Technology	TEC
15	Telecoms	TEL

The coding table uses an alphabetical (AVI-TEL) listing and number system (1-15). From this the ranked order of technology entrepreneurs was determined according to calculated wealth. The list of entrepreneurs generated for each technology area is based on estimates of the minimum wealth of the technology entrepreneurs. Actual size of fortunes may be larger than the figure recorded. The figures were calculated up to the end of March 2019. Identifiable wealth has been measured including land, property, art or significant shares in publicly quoted companies.

 DOI: https://doi.org/10.30564/jmser.v3i1.2607

Some technology entrepreneurs have generated their personal wealth from the sales of their enterprises. The value of the enterprises takes account of the tax paid on sale proceeds (18%). Here entrepreneurs' relief is applied at 10% lifetime limit. Private companies are valued at a multiple of their profits depending on the strength of balance sheets, track record and sector. Where an enterprise has strong net assets but low profits, the net asset figure is used as a benchmark for valuation.

The results of the research are presented in the following sections of the paper under the headings of Findings, Analysis, Discussion, and Conclusions.

4. Findings

The research findings of the study into the wealth of successful technology entrepreneurs in the United Kingdom are shown in Table 3. There are eight columns which show the number of areas (1-15), the name of the area, the code for each area (AVI-TEL), the number of entrepreneurs in each area, the 2019 Rich List Rank (highest and lowest), the 2019 total wealth for the area in the Rich List (bn, m), increase in wealth since 2018 for entrepreneurs in the area, and the number of entrepreneurs who have increased or decreased wealth, those with no change and new entries since 2018.

Table 3 shows that there are 170 technology entrepreneurs in the 15 technology areas investigated. The 2019 Rich List Ranking for the highest and lowest ranked entrepreneurs is shown. The total wealth for each area is shown with a total of £195.255bn. The increase in wealth since 2018 for each area is also shown and by calculating the total increase taking the total for those areas showing an increase and the decrease this equals £15.011bn - £4.985bn which gives £10.026bn. The last column in the table shows the increase/decrease in wealth for technology entrepreneurs since 2018 for each technology area and also if there was no change for each area and new entries since 2018. This shows that 92 entrepreneurs had an increase in wealth, 30 had a decrease, 39 showed no change and 9 were new entries.

5. Analysis

The analysis of the research findings for the study into the wealth of successful technology entrepreneurs in the United Kingdom is shown in Table 4. There are eight columns which show the number of areas (1-15), the name of the area, the code for each area (AVI-TEL), the number of entrepreneurs in each area, the 2019 Rich List average rank for the area, the 2019 total wealth for the area (bn, m), the average wealth for the area (bn, m), and the percentage in-

Table 3. General Findings for the study into the wealth of successful technology entrepreneurs in the United Kingdom

No	Area	Code	No of Entrepreneurs	2019 Rich List Rank Range		2019 Total Wealth for area (£)	Increase/ Decrease in Wealth for area since 2018 (£)	Wealth Increase (I), Decrease (D), No Change (NC), New Entry (NE)			
								I	D	NC	NE
1	Aviation	AVI	13	62	964	6.32bn	-26m	7	3	1	2
2	Biotechnology	BIO	2	405	585	523m	23m	2			
3	Chemicals	CHE	8	3	964	35.19bn	-4.586bn	2	4		2
4	Computers	COM	8	118	876	3.19bn	199m	3	1	4	
5	Electronics	ELE	5	452	978	705m	8m	4		1	
6	Energy	ENE	2	751	848	300m	10m	2			
7	Engineering	ENG	10	111	848	5.69bn	-51m	4	2	4	
8	Industry	IND	23	1	843	49.73bn	5.151bn	14	2	6	1
9	Internet	INT	38	2	978	37.85bn	5.637bn	22	4	10	2
10	Mobile technology	MOB	7	97	978	4.33bn	-158m	4	3		
11	Pharmaceuticals	PHA	32	15	978	25.69bn	559m	15	8	7	2
12	Plastics	PLA	1	26		5.40bn	243m	1			
13	Software	SOF	12	47	731	6.09bn	-164m	6	3	3	
14	Technology	TEC	5	5	768	13.44bn	3.14bn	4		1	
15	Telecoms	TEL	4	283	606	1.33bn	41m	2		2	
Total			170			195.255bn	10.026bn	92	30	39	9

DOI: https://doi.org/10.30564/jmser.v3i1.2607

Table 4. Analysis of the Findings for the study into the wealth of successful technology entrepreneurs in the United Kingdom

No	Area	Code	No of Entrepreneurs	2019 Rich List Av. Rank for area	2019 Total Wealth for area (£)	Average Wealth for area (£)	Wealth Increase (I), Decrease (D), No Change (NC), New Entry (NE) (%)			
							I	D	NC	NE
1	Aviation	AVI	13	456	6.32bn	486m	53.8	23.1	7.7	15.4
2	Biotechnology	BIO	2	495	523m	261.5m	100			
3	Chemicals	CHE	8	300	35.19bn	4.40bn	25	50		25
4	Computers	COM	8	489	3.19bn	399m	37.5	12.5	50	
5	Electronics	ELE	5	748	705m	141m	80		20	
6	Energy	ENE	2	800	300m	150m	100			
7	Engineering	ENG	10	425	5.69bn	569m	40	20	40	
8	Industry	IND	23	282	49.73bn	2.16bn	60.9	8.7	26.1	4.3
9	Internet	INT	38	441	37.85bn	996m	57.9	10.5	26.3	5.3
10	Mobile technology	MOB	7	440	4.33bn	619m	57.1	42.9		
11	Pharmaceuticals	PHA	32	486	25.69bn	803m	46.9	25	21.9	6.2
12	Plastics	PLA	1	26	5.40bn	5.40bn	100			
13	Software	SOF	12	420	6.09bn	507m	50	25	25	
14	Technology	TEC	5	421	13.44bn	2.69bn	80		20	
15	Telecoms	TEL	4	434	1.33bn	333m	50		50	
Total			170	6,663	195.255bn					
Av.			11	444	13bn		62.6	14.5	17.4	3.7

crease, decrease in wealth for the area together with those entrepreneurs showing no change and new entries (since 2018).

In Table 4 it is shown that for the 170 technology entrepreneurs in the 15 technology areas the average number of entrepreneurs in each area is 11 with an average Rich List rank in 2019 for areas of 444. The 2019 total wealth for technology areas in the Rich List was £195.255bn giving an average of £13bn. The average wealth of technology entrepreneurs in the Rich List for 2019 was £1.15bn (average net worth). In terms of the increase or decrease in wealth for technology entrepreneurs for all areas investigated some 62.6% of technology entrepreneurs had an increase in wealth, 14.5% had a decrease in wealth, there was no change for 17.4% and 3.7% were new entries.

6. Discussion

The discussion has been undertaken according to discussion point comparisons for technology areas as shown in Table 5. There are eight points (1-8) and comparisons have been undertaken for each one. These include areas with the highest number of technology entrepreneurs and lowest; areas with the highest average rank and lowest; the highest total wealth and lowest total wealth areas; the highest average wealth and lowest average wealth areas; areas with the highest increase and highest decrease in wealth; the highest and lowest number of technology entrepreneurs showing wealth increase/decrease for areas; the number of male/female technology entrepreneurs in areas; and the number of billionaires/millionaires in areas.

Table 5. Discussion Points

Discussion Point Comparisons for Technology Areas	
Point	Comparison
1	Areas with highest number of technology entrepreneurs and lowest
2	Areas with highest average rank and lowest
3	Highest total wealth and lowest total wealth areas
4	Highest average wealth and lowest average wealth areas
5	Areas with highest increase and highest decrease in wealth
6	Highest and lowest no/% of technology entrepreneurs showing wealth increase/decrease for areas
7	Male/Female technology entrepreneurs in areas
8	Billionaires/Millionaires in areas

With regard to the number of technology entrepreneurs those areas with the highest number are the Internet (38), pharmaceuticals (32), industry (23), aviation (13), software (12) and engineering with 10, chemicals and computers with 8 each, and mobile technology with 7. Those areas with the lowest number of entrepreneurs are electronics and technology with 5 each, telecoms with 4, biotechnology and energy with 2 each, and plastics with 1. This shows that both new technology areas as well as more established areas had high and low numbers of entrepreneurs.

Those areas with a higher average rank (shown with a lower number) were plastics, industry and chemicals,

 DOI: https://doi.org/10.30564/jmser.v3i1.2607

and low average rank (shown with a higher number) were electronics and energy. These were more established technology areas with newer technology areas in between.

For those areas showing the highest total wealth industry was the highest with £49.73bn followed by the Internet £37.85bn, chemicals £35.19bn, pharmaceuticals £25.69bn, and technology £13.44bn. The areas of aviation, software, engineering, plastics, mobile technology, computers and telecoms follow with between £6.32bn to £1.33bn total wealth. Areas with the lowest total wealth were electronics £705m, biotechnology £523m and energy £300m. Again this shows that more established technology areas had higher and lower wealth with newer technology areas between.

In relation to the average wealth for technology areas those with the highest figures were plastics (£5.40bn), chemicals (£4.40bn), technology (£2.69bn), industry (£2.16bn), Internet (£996m) and pharmaceuticals (£803m). Other areas had average wealth from electronics (£141m) to mobile technology (£619m) with energy, biotechnology, telecoms, computers, aviation, software, engineering in between.

For the increase in wealth for the area for 2019 since 2018 areas with the highest were the Internet (£5.6bn), industry (£5.2bn) and technology (£3.1bn). Other areas showing an increase in wealth for 2019 since 2018 were pharmaceuticals (£559m), plastics (£243m), computers (£199m), telecoms (£41m), biotechnology (£23m), energy (£10m), and electronics (£8m). Areas showing a decrease in wealth for 2019 since 2018 were aviation (-£26m), engineering (-£51m), mobile technology (-£158m), and software (-£164m). The area with the largest decrease in wealth was chemicals (-£4.6bn).

The areas showing the greatest number of entrepreneurs with wealth increase were the Internet with 22 (57.9%), pharmaceuticals 15 (46.9%), and industry 14 (60.9%). Areas showing a reasonable number of entrepreneurs with wealth increase were aviation 7 (53.8%), software 6 (50%), electronics, engineering, mobile technology, technology all 4, and computers 3. Those areas showing a low number of entrepreneurs with an increase in wealth were biotechnology, chemicals, energy and telecoms, all with 2, and plastics with 1.

There were 5 areas with female technology entrepreneurs and these included pharmaceuticals with 8, Internet 4, industry, 3, aviation 2, and software 1. In these areas there were 24 male entrepreneurs in pharmaceuticals, 34 in Internet, 20 in industry, 11 in aviation, and 11 in software. This shows that pharmaceuticals had 75% male and 25% female entrepreneurs, Internet 90% male and 10% female, industry 87% male and 13% female, aviation 85% male and 15% female, and software 92% male and 8% female.

Areas which had the most billionaires were pharmaceuticals with 11, industry 10, Internet 9, chemicals 5, engineering 3, and aviation 2. Further to this areas with the most millionaires were the Internet with 29, pharmaceuticals 21, industry 13, and aviation and software with 11 each.

These comparisons illustrate how successful technology entrepreneurs can accumulate considerable net wealth through innovative work in important technology areas.

7. Conclusions

The paper has investigated the wealth of successful technology entrepreneurs in the United Kingdom. Here the dimensions of wealth in terms of its measurement have been studied. The methodology involved three stages including stage one to obtain an understanding of the measurement of the wealth of technology entrepreneurs. Analysis and synthesis of data were undertaken in stage two to determine the net value of wealth. In stage three the nature and importance of the measurement of the wealth of successful technology entrepreneurs were examined to formulate conclusions. The contribution to knowledge of the research is that it provides a detailed comparison of wealth in different technology areas. In response to the research question the average wealth of technology entrepreneurs in the Rich List for 2019 was £1.15bn (average net worth). It was also found that the extent of wealth of individuals in different technology areas was dependent on the amount of activity and development of the area and also the accumulation of wealth by individuals. The limitations of the study are that it only considers comparisons between different technology areas. Recommendations for future research are to undertake studies to compare the technology areas investigated in the research with other areas of activity. This will provide important policy implications for academics, professionals and government experts.

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 DOI: https://doi.org/10.30564/jmser.v3i1.2607

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