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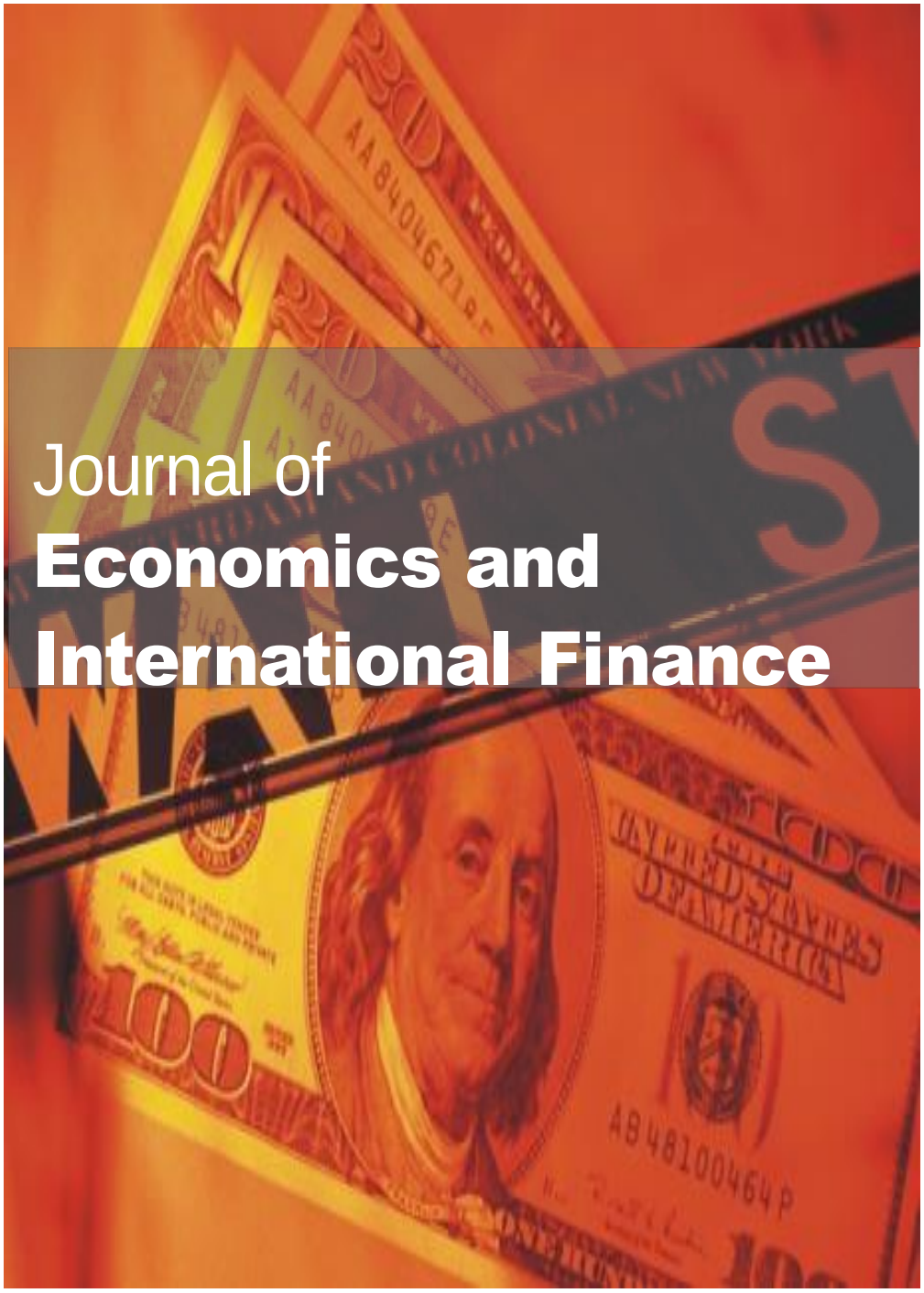

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Full Length Research

Estimating the Marshall-Lerner condition of China

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The US labeled China a Currency Manipulator in August 2019 because of the massive trade balance surplus of China. The correlation between RMB's exchange rate and China's trade balance has been discussed worldwide. The Traditional Marshal-Lerner Condition states if the sum of the absolute value of export and import price elasticity of demand is more than 1, the trade balance will be adjusted through the fluctuation of the exchange rate. However, Traditional Marshal-Lerner Condition requires trade balance is 0 at the beginning, while China benefits the huge surplus of the trade balance for decades. Therefore, the Traditional Marshal-Lerner Condition may not be appropriate to explain why RMB's exchange rate failed to shrink the surplus of China's trade balance. The author reconsiders the derivation of Marshall-Lerner condition and presents another Marshall-Lerner condition which illustrates the conditions the export and import price elasticity of demand need to meet when the trade balance is uneven at the beginning so that the fluctuation of exchange rate can play a role in regulating trade balance. Then the industry-level data from January 2008 to June 2018 were used to calculate the export and import price elasticities of demand by using ARDL model. The empirical results show the validity of Traditional Marshal-Lerner Condition in China was investigated, while the Generalized Marshal-Lerner Condition cannot be satisfied during the sample period. Taking the huge amount of surplus, and the movements of RMB's exchange rate recent years into consideration, the results of Generalized Marshal-Lerner Condition, that the variation of RMB's exchange rate will not succeed in adjusting the trade balance in the Chinese economy, maybe more persuasive than the traditional one.

Key words: China, Marshall-Lerner condition, trade balance, ARDL model.

INTRODUCTION

Since China joined the WTO in 2001, China's economic international standing has been rising rapidly due to the development of international trade. China's export share, which occupied 6% of the World's share in 2001, has expanded to around 16% in 2018 significantly, taking the top position in the world. Concerning China's import share, it has expanded steadily from 5% in 2001 to 13% in 2018, making it the third-largest in the world. That is to say while ensuring its status as a "World's Factory", China has also made itself to be a "Global Consumer Market".

Along with the expansion of China's trade balance, trade friction between China and other countries is becoming fiercer nowadays. The US implemented treat

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restrictions such as imposing tariffs on “Made in China” in September 2018. There is a growing debate on the situation of China; now is identical to Japan in the 1990s, the focus of the friction between the US and China is likely to shift from “Trade” to “Exchange Rate”. Since the friction between the US and China started, the tendency for the depreciation of the RMB to the USD rate is accelerated. The US hopes to force China to adjust the RMB’s exchange rate to reach its goal, which is to reverse the situation of the trade imbalance between these two countries. Revaluation of RMB’s exchange rate has been perceived as an effective way to settle the trade disputes between the US and China, and also the driving global imbalances. Since the RMB exchange rate reform in 21st July 2005, which People’s Bank of China (PBC) announced to implement a reform of the exchange rate regime-switching from the ‘Dollar-peg Regime’ to ‘A Managed Floating Regime with Reference to a Currency Basket and the Supply-demand Conditions’, the nominal exchange rate of RMB to USD appreciated to about 17.32%, and the Nominal Effective Exchange Rate (NEER) and Real Effective Exchange Rate (REER) rose by 42.28 and 32.78% respectively. Despite the variation of RMB, China’s trade balance is still having a huge surplus these years. Before the 2008 Financial Crisis, the surplus of China has reached 296.5 billion dollars, and after that, it reached its peak of 601.6 billion dollars in 2015. Therefore, the movements of RMB’s exchange rate failed to adjust the trade balance surplus of China.

The liaison between the exchange rate and trade balance is an imperative basis for the foreign policy of every country. For them, it is a major concern whether the domestic currency’s appreciation or depreciation will have corresponding effects on the trade balance or not. Traditionally, because the appreciation of domestic currency will make the price of export to increase, foreign consumers tend to choose other country’s goods instead. So many economists and politicians believe that the appreciation of domestic currency will decrease the international competitiveness of domestic goods when exporting them to market abroad. While the appreciation of domestic currency will increase domestic consumer’s purchasing power, they will buy more import goods when the domestic currency is appreciated. Hence, the appreciation of domestic currency will lessen export and add import at the same time; it will reduce the trade balance of a country. This opinion is considered as a policymaking instruction to exacerbate the surplus of the trade balance.

According to the traditional economic theory, the affiliation of the exchange rate and trade balance can to a great extent be explained by the Marshall-Lerner condition (ML Condition) and Pass-through theory. ML condition states that if the sum of price elasticity of demand for export (the extent to export flows) is responsive to relative prices change and price elasticity of demand for import (the extent to import flows is responsive to relative price change) is greater than 1, then the Balance of Trade will be adjusted through the variation of exchange rate. However, this ML Condition is based on many strict assumptions such as the trade balance is initially 0. On the one hand, if a country’s trade balance is even, there is no need to improve the trade balance by alternating the domestic currency’s exchange rate. When a country’s trade balance is uneven, it is necessary to take actions to adjust the imbalance of trade. On the other hand, in reality, most countries suffer from the deficit of trade balance or enjoy the surplus of the trade balance, especially China, which has the largest surplus of trade balance in the world. Therefore, it might not be appropriate to use the ML Condition to discuss whether the movement of RMB’s exchange rate can have an effect on China’s trade balance or not. There are numerous studies about whether China’s export and import price elasticity of demand meets the ML condition or not, but they did not take a full consideration about China’s trade balance is bigger than 0, which is against one assumption of the ML Condition. The present studies use the country-level data to calculate the export and import price elasticity of demand. While, some industries’ export and import price elasticity of demand may meet the ML condition, and others may not. So the results by using macro data will ignore each industry’s characteristics due to the ‘Aggregation Effect’. Therefore, this paper uses the industry-level data to calculate the China’s export and import price elasticity of demand.

LITERATURE

ML condition has been estimated many times during these years for the developing and developed countries. Most of the studies had reported evidence in favor of ML condition; therefore, these countries were able to improve their trade balance by depreciating home currency as their elasticity of import and export were greater than one. On the other side of the same mirror, some studies found no evidence in favor of ML condition. Reinhart (1995) points out if trade flows are very sensitive to relative prices in a significant manner, devaluation will reduce trade imbalances. Bahmani-Oskooee (1998) imply that the sum of import and export elasticities is greater than one is thus an underlying explanation for the J-curve. However, this study was based on the aggregate level of exports and imports. To come up with a more detail analysis of the ML condition, Bahmani-Oskooee and Niroomand (1999) use data for the US and her six trade partners. The study confirms the existence of ML condition for Japan, UK, France, and Italy, while there was no evidence of the existence of ML condition for the US trade with Canada and Germany. Brooks (1999) empirically estimates the ML condition for the bilateral trade balance between the US and G7 countries. The results of the study indicate that the US fulfills the ML

condition on bilateral trade with all G7 countries except Canada. Therefore, the depreciation of the dollar must improve the trade balance of the US. Hooper et al. (2000) find trade elasticity of G7 countries have shown less response to meet with ML condition in the short run but met in the long run. Ahearn (2002) empirically analyzes the impact of currency depreciation on the balance of trade of Southeast Asian countries. Philippines and Malaysia have improved their trade balance permanently, which means that only these 2 countries satisfy ML condition, while Korea and Singapore would never improve their trade balance even in the long run. Maura and Silva (2005) confirm the empirical estimation and both linear and nonlinear impulse response functions show that the ML condition holds. Fang et al. (2006) state real exchange rate depreciation pushes up exports for most Asian economies but its impact on export growth is smaller. Thochitskaya (2007) also examines that ML condition is fulfilled and depreciation can pick up the balance of trade in the long run.

Bahmani et al. (2013) examine the literature of author's owned studies on the confirmation of ML condition for 29 countries. The study used Auto Regression Distributed Lag (ARDL) approach to estimate the trade elasticity for ML condition. The findings of the study postulate the ML condition holds in some cases and fails in some cases. The study suggested that policymakers should form more effective policies to improve their trade activities. Panda and Reddy (2016) investigate the trade relations between China and India under the umbrella of ML condition and J-curve hypothesis. The study applied the ARDL model and ECM to estimate the short-run and long-run relationship between domestic income, foreign income, trade balance, and exchange rate by using the annual frequency data from 1987 to 2014. The results reveal the long-run relationship between the concerned variables, while the results of the ARDL and ECM model rejected the validity of the ML condition and J-curve phenomenon. Thus, the study concludes no improvement in the trade balance of India with China in response to Rupee depreciation.

There are also great quantity studies in China both theoretically and empirically. In theoretical studies, researchers mentioned the strict assumption of ML condition, such as the trade balance is measured by domestic or foreign currency, use of the domestic exchange rate or effective exchange rate while calculating the export and import price elasticity of demand may lead to different export and import price elasticities of demand. Fu (1997) mentioned that the ML condition is based on many strict assumptions, so it needs to make some revision before using it to discuss whether the fluctuation of the exchange rate can adjust the trade imbalance. Zhao (2005) mentioned whether the ML Condition can be fulfilled depending on whether the trade balance is measured in domestic currency or foreign currency. They also point out that the ML condition, in theory, is taken as 1 as the dividing line, but in reality, the ML condition is a dividing zone, not a dividing line. In empirical studies, the researcher uses the OLS, Co-integration model, and ARDL model to calculate the export and import price elasticity of demand. Lu and Li (2013) decompose RMB's REER and reexamine the ML Condition. They point out the USD's real effective exchange rate elasticity against the RMB/USD exchange rate and the RMB's weight in the USD Effective exchange index play an important role in revising the Marshall-Lerner Condition. They use the co-integration model to analyze the relationship between RMB and China's export and import. Their empirical results reveal that the revised Marshall-Lerner Condition exists, the devaluation of RMB's real exchange rate against USD can improve the trade balance, and the devaluation of USD may have negative effects. Liang et al. (2019) use the ARDL model to analyze the liaison of RMB and China's export. This paper concludes that why the devaluation of RMB fails to increase trade balance is that the continuous devaluation of RMB leads to the decline of the expected price of China's export products and thus brings about the deflation effect and the postponement of US importers to import China's products. But all of these studies ignored the assumption that China's trade balance is not initially even, and they use the country-level data to calculate the export and import price elasticity of demand.

METHODOLOGY

This section will analyze and test hypotheses if the fluctuation of exchange rate can adjust the trade balance of China. In other words, if the export and import price elasticities of demand can meet the ML Condition or not, by using variables such as exports volume, imports volume, nominal effective exchange rate, industry's production index of China and overseas, producer price index of China and overseas. The sample period for this study is from January 2008 to June 2018.

Marshall-Lerner condition

According to the international economics theory, a real depreciation of a country's currency improves its current account. However, the validity of this assumption depends on a condition called Marshall-Lerner Condition, which states, a real depreciation improves the current account if export and import volumes are sufficiently elastic concerning the real exchange rate. To start with, write the trade balance, measured in domestic output units, as the difference between exports and imports of goods and services similarly measured:

$$\mathrm{TB} = \mathrm{EX} - \mathrm{eIM} \tag{1}$$

Where TB, EX, IM stand for the trade balance (in domestic currency), export (in domestic currency), IM (in foreign currency), respectively; e represents the nominal exchange rate. The change in the trade balance can be written as the difference between the change in the exports and the change in the imports.

$$\Delta\mathrm{TB} = \Delta\mathrm{EX} - \Delta\mathrm{eIM} \tag{2}$$

$$\Delta \mathrm{TB} = \Delta \mathrm{EX} - \mathrm{IM}\Delta \mathrm{e} - \mathrm{e}\Delta \mathrm{IM} \tag{3}$$

Dividing through ∆e gives the trade balance response to a change in the exchange rate,

$$\frac{\Delta \mathrm{TB}}{\Delta \mathrm{e}} = \frac{\Delta \mathrm{EX}}{\Delta \mathrm{e}} - \mathrm{IM} - \frac{\mathrm{e}\Delta \mathrm{IM}}{\Delta \mathrm{e}} = IM(\frac{1}{IM}\frac{\Delta \mathrm{EX}}{\Delta \mathrm{e}} - \frac{e}{\Delta \mathrm{e}}\frac{\Delta \mathrm{IM}}{IM} - 1) \tag{4}$$

The change in demand in response to a variation in price is called price elasticity of demand. So the export price elasticity of demand and import price elasticity of demand can be defined as,

$$\eta_X = -\frac{p^*}{\Delta p^*}\frac{\Delta EX}{EX} \tag{5}$$

$$\eta_M = -\frac{p}{\Delta p}\frac{\Delta IM}{IM} \tag{6}$$

Where p and p^* stand for the trade price in domestic and foreign currency, respectively. the relationship between export price in domestic currency and export price in foreign currency is,

$$\mathrm{p} = \mathrm{e}p^* \tag{7}$$

For export, when the exchange rate changed, p^* will change, but p is being held constant, therefore $\Delta \mathrm{p} = 0$.

$$\Delta \mathrm{p} = \Delta \mathrm{e}p^* = \Delta e \times p^* + e \times \Delta p^* \tag{8}$$

$$0 = \Delta e \times p^* + e \times \Delta p^* \tag{9}$$

$$\frac{p^*}{\Delta p^*} = -\frac{\Delta e}{e} \tag{10}$$

Put Equation 10 into Equation 5, the export price elasticity of demand can be replaced as,

$$\eta_X = \frac{\Delta e}{e}\frac{\Delta EX}{EX} \tag{11}$$

For import, when the exchange rate changed, p^* is being held constant, p will change, therefore, $\Delta p^* = 0$.

$$\Delta p = \Delta e \times p^* = \Delta e \times (p/e) \tag{12}$$

$$\frac{\Delta p}{p} = \frac{\Delta e}{e} \tag{13}$$

Put the Equation 13 into Equation 6, the import price elasticity of demand can be replaced as:

$$\eta_M = -\frac{e}{\Delta e}\frac{\Delta IM}{IM} \tag{14}$$

The ML condition requires that the surplus or deficit of trade balance is initially 0, where EX=eIM. Then Equation 4 goes to,

$$\frac{\Delta \mathrm{TB}}{\Delta \mathrm{e}} = IM(\frac{e}{EX}\frac{\Delta \mathrm{EX}}{\Delta \mathrm{e}} - \frac{e}{\Delta \mathrm{e}}\frac{\Delta \mathrm{IM}}{IM} - 1) \tag{15}$$

Put Equation 11 and 14 into Equation 15,

$$\frac{\Delta \mathrm{TB}}{\Delta \mathrm{e}} = IM(\eta_X + \eta_M - 1) \tag{16}$$

Then only if

$$\eta_X + \eta_M > 1 \tag{17}$$

be satisfied, the variation of exchange rate can adjust the trade balance.

Equation 17 is the well-known Traditional ML condition (TML condition), which states that if the trade balance is initially 0, the depreciation of currency improves a current trade balance if the sum of the price elasticities of export and import demand exceeds 1. But what if the trade balance is not 0 initially, the TML condition may fail to answer the question of whether the movements of the exchange rate can adjust trade balance or not. In reality, most of the countries in the world suffer from the trade balance deficit or benefit from the trade balance surplus, few countries' international trade balance is 0, where EX≠eIM. Therefore, Equation 4 can be written as,

$$\frac{\Delta \mathrm{TB}}{\Delta \mathrm{e}} = IM(\frac{1}{IM}\frac{EX}{e}\frac{e}{EX}\frac{\Delta \mathrm{EX}}{\Delta \mathrm{e}} - \frac{e}{\Delta \mathrm{e}}\frac{\Delta \mathrm{IM}}{IM} - 1) \tag{18}$$

Let m denote the ratio of export and import as a function of $\mathrm{m} = EX/eIM$, which is also known as the terms of trade, Equation 16 turns out to be:

$$\frac{\Delta \mathrm{TB}}{\Delta \mathrm{e}} = IM(m\eta_X + \eta_M - 1) \tag{19}$$

$$m\eta_X + \eta_M > 1 \tag{20}$$

Equation 20 calls the Generalized ML Condition (GML condition) mentioned by Murata and Satoma (1991), states that if the trade balance in domestic currency is not initially zero, the depreciation of currency causes a current trade balance surplus if Equation 20 can be held. But Equation 20 only applies for the trade balance in domestic currency, which cannot be used in the situation that trade balance in foreign currency. To overcome this shortage, Okabe (2010) extended the GML condition as seen in Table 1.

Data

As we all know, the higher the foreign income, the more the demand for export. Therefore, export is a function of foreign income. Alternatively, the import is a function of domestic income,

Table 1. The Marshall-Lerner Condition and Generalized Version.

Variable	Trade balance (in domestic currency)	Trade balance (in foreign currency)
Trade balance is initially 0	$\eta_X + \eta_M > 1$	$\eta_X + \eta_M > 1$
Trade balance is not initially 0	$m\eta_X + \eta_M > 1$	$\eta_X + (1/m)\eta_M > 1$

m represents the term of trade, which is the ratio of export and import.

because the higher the domestic income, the demand for foreign goods will increase. Also, competitors' prices may indeed be correlated with exchange rate changes, because the lower the competitors' price, the demand for export and import will reduce. Hence, the variables of the export model include Export (EX), Nominal Effective Exchange Rate (NEERE, weighted in export volume), Foreign Industrial Production Index (IPIF), Foreign Producer Price Index (PPIF). The variables of import model include Import (IM), Nominal Effective Exchange Rate (NEERI, weighted in import volume), China's Industrial Production Index (IPIC), China's Producer Price Index (PPIC). The export and import model defined as:

$$\ln \mathrm{EX}_i = \alpha_0 + \alpha_1 lnNEERE_i + \alpha_2 lnIPIF_i + \alpha_3 lnPPIF_i + \varepsilon_i \quad (21)$$

$$\ln \mathrm{IM}_i = \beta_0 + \beta_1 lnNEERI_i + \beta_2 lnIPIC_i + \beta_3 lnPPIC_i + \epsilon_i \quad (22)$$

This paper's purpose is to verify whether the ML condition can be satisfied by using industrial data. It may not be appropriate to use the aggregate NEER published by BIS when calculating the industrial export and import price elasticities of demand, which may cause "Aggregation Bias". Hence, this paper constructed NEER in 8 sectors (FOOD, MINERAL, CHEMICAL, WOODS, TEXTURE, METAL, EMACHINE, and MACHINE), following the HS code classification; it selected 10 countries and areas (the US, EU, Australia, Canada, Hong Kong, Japan, Korea, Singapore, Thailand, and UK) based on two conditions: 1. They are the important trade partner of China; 2. Their currency is included in the Currency Basket which RMB's exchange rate refers to. All variables were transformed into nature logarithms. The detailed explanation of each variable is as follows:

(1) Export (EX) and Import (IM). The export data (Total and Sectors, foreign currency dominate), and import data (Total and Sectors, foreign currency dominate) are taken from Wind Database.
(2) Foreign producer price index (PPIF). This paper obtains each country's PPI above from the OECD database, and calculates the PPIF as follows:

$$\mathrm{PPIF}_{j,t,m} = PPI_{j,t,1} \times PPI_{j,t,2} \times \cdots \times PPI_{j,t,m} \times 100 \quad (23)$$

$$PPI_{j,t,m} = \prod_{c=1}^{n} \left(\frac{PPI_{c,t,m}}{PPI_{c,t-1,m}} \right)^{w_{c,t}^{j}} \quad (24)$$

Where $PPI_{j,t,m}$ indicates the PPI of sector j of t year m month, $PPI_{c,t,m}$ stands for trade partner c's PPI of t year m month, $w_{c,t}^{i}$ represents the trade weight of country c in sector i of year t. $\mathrm{PPIF}_{j,t,m}$ represents the foreign PPI weighted by trade partners' trade volume.

(3) Foreign industrial production index (IPIF). The calculation method is the same as PPIF mentioned above. The data of each trade partners' IPI came from the OECD database.
(4) China's industrial production index (IPIC) and producer price index (PPIC). China's industrial production index and producer price index were taken from Wind Database.
(5) Nominal effective exchange rate in sector (NEERE_i, NEERI_i). We use the method of Shioji and Uchino (2010) mentioned to construct the disaggregated NEER of RMB. $w_{c,t}^{i}$ represents the trade weight (which can be replaced by export volume or import volume depending on the dependent is export or import) of country c in sector i of year t (the entire target countries in sector i of year t is represented by $C_{t,i}$), defined as Equation (3).

$$w_{c,t}^{i} = \frac{tradevalue_{c,t}^{i}}{\sum_{c \in C_{t,i}} tradevalue_{c,t}^{i}}, \qquad 0 \le w_{c,t}^{i} \le 1 \quad (25)$$

$tradevalue_{c,t}^{i}$ is the trade volume of country c in sector i of year t. Assuming that $e_{c,t,m}$ is the nominal exchange rate of the country c's currency to the RMB in t year m month, we can calculate the change of the NEER in sector i year t by using the trade weight mentioned above, which is represented by $I_{i,t,m}^{t}$.

$$I_{i,t,m}^{t} = \prod_{c \in C_{t,i}} \left(\frac{e_{c,t,m}}{e_{c,t,1}} \right)^{w_{c,t}^{i}} \quad (26)$$

Here, assuming $I_{i,t+1,1}^{t}$ indicates the variation of exchange rate from January year t to January year t+1; we can calculate the sector i's NEER of t year m month as follows.

$$CI_{i,t,m}^{t} = \prod_{\tau=2008}^{t-1} I_{i,\tau+1,1}^{\tau} \times I_{i,t,m}^{t} \quad (27)$$

Table 2. ADF test result (Export Model).

Sector	EX		NEER(Export weight)		IPIF		PPIF	
	level	1st differenced	level	1st differenced	level	1st differenced	level	1st differenced
Total	(C,0,0) -2.24	(C,0,1) -4.62***	(C,T,4) -2.99	(C,T,4) -2.99	(C,T,2) -3.99**	(C,T,2) -3.97**	(C,0,12) -9.73***	(C,0,12) -10.73***
Food	(C,T,0) -2.72*	(C,0,3) -4.57***	(C,0,0) -2.63*	(C,0,0) -10.71***	(C,0,9) -4.57***	(C,0,9) -5.87***	(C,0,8) -3.97***	(C,0,7) -7.43***
Mineral	(C,0,0) -3.68***	(C,0,3) -3.323**	(C,0,0) -2.561	(C,0,0) -11.23***	(C,0,11) -7.64***	(C,0,11) -5.894***	(C,0,3) -5.46***	(C,0,11) -6.30***
Chemical	(C,0,0) -2.65*	(C,0,2) -4.08***	(C,0,0) -2.86*	(C,0,0) -11.03***	(C,0,5) -3.89***	(C,0,7) -5.59***	(C,0,11) -5.12***	(C,0,11) -5.08***
Woods	(C,0,3) -1.72	(C,0,2) -6.25***	(C,0,0) -2.84*	(C,0,0) -11.37***	(C,0,12) -8.62***	(C,0,7) -5.20***	(C,0,11) -4.89***	(C,0,11) -4.98***
Texture	(C,0,3) -1.63	(C,0,2) -6.71***	(C,0,0) -3.01**	(C,0,0) -11.73***	(C,0,9) -4.46***	(C,0,9) -6.30***	(C,0,11) -4.73***	(C,0,11) -4.87***
Metal	(C,0,0) -2.64*	(C,0,2) -4.47***	(C,0,0) -3.05**	(C,0,0) -11.50***	(C,0,11) -8.48***	(C,0,7) -5.59***	(C,0,11) -5.13***	(C,0,11) -5.24***
Emachine	(C,0,0) -2.31	(C,0,0) -4.46***	(C,0,0) -2.96**	(C,0,0) -12.17***	(C,0,9) -4.17***	(C,0,7) -5.35***	(C,0,11) -4.64***	(C,0,7) -7.17
Machine	(C,0,0) -2.44	(C,0,2) -4.27**	(C,0,0) -2.78*	(C,0,0) -11.58***	(C,0,9) -4.00***	(C,0,7) -5.53***	(C,0,3) -5.29***	(C,0,7) -6.69***

The intercept term, trend term (0 indicates no trend term), lag order is showed in the bracket. *, **, *** indicate the coefficient is significant in 10%, 5%, 1% level, respectively.

EMPIRICAL RESULTS

Pesaran and Shin (1999) provide the ARDL model, which can be applied to a small sample size such as the one used in this study. China's export and import demand function for the concerned period included 114 observations. While this method provides another advantage to the researchers over conventional co-integration testing, which is even if some variables are I(0), and the rest variables are I(1), a long term relationship between the series can be investigated.

Unit root test

Before estimating the export and import price elasticity of demand, it is necessary to examine the stationarity of all variables, because if the data are unstable, the estimated coefficient may be biased and unreliable. There are several Unit Root Tests to determine stationarity of series or not; and the most popular test is the Augmented Dickey-Fuller (ADF) test. The ADF test results of export model variables and import model variables are given in Tables 2 and 3, respectively.

According to the ADF results, all variables are stationary either in level or after 1st differenced, that is, all variables are either I(0) or I(1). Therefore, the ARDL method was chosen for this analysis.

ARDL bounds test approach

Based on the former literature review, ML condition is barely met in short-run, but almost can be held in the long-run. Hence, this section only provides the coefficients of $NEERE_i$ (δ_1) and $NEERI_i$ (θ_1) in the long-run. Before estimating the export and import price elasticity of demand, it is necessary to determine the existence of the long-term co-integration relationship. The calculated F-statistics were tabulated as described by Pesaran and Shin (1999). If the calculated F-test exceeds the upper critical value, the null hypothesis of no co-integration can be rejected. The results in Table 4 show that the calculated F-test statistics are higher than the upper critical value; a long-term co-integration relationship exists for each export model and import model both.

$$\Delta \ln EX_{i,t} = \alpha_0 + \sum_{k=0}^{n} \alpha_1 \Delta lnENEER_{i,t-k} + \sum_{k=0}^{n} \alpha_2 \Delta lnIPIF_{i,t-k} + \sum_{k=0}^{n} \alpha_3 \Delta lnPPIF_{i,t-k} + \sum_{k=1}^{n} \alpha_4 \Delta lnEX_{i,t-k} + \delta_1 lnENEER_{i,t-1} + \delta_2 lnIPIF_{i,t-1} + \delta_1 lnPPIF_{i,t-1} + \mu_t \quad (28)$$

Table 3. ADF test result (Import Model).

Sector	IM		NEER(Import weight)		IPI		PPI	
	Level	1st differenced	level	1st differenced	level	1st differenced	level	1st differenced
Total	(C,0,4) -1.59	(C,0,2) -4.25***	(C,0,1) -3.18**	(C,0,0) -10.03***	(C,0,12) -1.76	(C,0,12) -3.42**	(C,0,2) -2.89**	(C,0,12) -3.47**
Food	(C,0,4) -1.65	(C,0,3) -4.79***	(C,0,2) -3.88***	(C,0,1) -5.95***	(C,0,12) -2.56	(C,0,12) -5.18***	(C,0,12) -1.46	(C,0,12) -4.67***
Mineral	(C,0,0) -1.63	(C,0,0) -3.59***	(C,0,1) -3.62***	(C,0,0) -9.78***	(C,0,12) -1.75	(C,0,12) -3.76***	(C,0,12) -0.77	(C,0,12) -3.88***
Chemical	(C,0,4) -1.60	(C,0,3) -3.99***	(C,0,0) -3.15**	(C,0,12) -11.28***	(C,0,12) -1.87	(C,0,12) -3.77***	(C,0,12) -1.33	(C,0,12) -3.78***
Woods	(C,0,0) -2.89**	(C,0,1) -5.12**	(C,0,0) -2.68*	(C,0,0) -11.08***	(C,0,12) -1.87	(C,0,12) -5.19***	(C,0,12) -0.89	(C,0,12) -4.29***
Texture	(C,0,4) -0.95	(C,0,3) -5.17***	(C,0,0) -3.24**	(C,0,0) -10.75***	(C,0,4) -4.70***	(C,0,12) -3.26**	(C,0,2) -3.02**	(C,0,0) -4.75***
Metal	(C,0,0) -2.29	(C,0,0) -4.99**	(C,0,12) -2.51	(C,0,11) -5.53***	(C,0,12) -1.99	(C,0,12) -3.79***	(C,0,12) -1.16	(C,0,12) -4.29***
Emachine	(C,0,0) -2.73*	(C,0,3) -3.34**	(C,0,0) -3.41**	(C,0,0) -11.26***	(C,0,12) -1.83	(C,0,12) -3.41**	(C,0,12) -1.78	(C,0,12) -3.66***
Machine	(C,0,0) -1.57	(C,0,3) -2.82*	(C,0,0) -2.89*	(C,0,0) -10.52***	(C,0,6) -3.48**	(C,0,12) -2.84*	(C,0,4) -3.87***	(C,0,10) -6.26***

The intercept term, trend term (0 indicates no trend term), lag order is showed in the bracket.
*, **, *** indicate the coefficient is significant in 10%, 5%, 1% level, respectively.

Table 4. Co-integration bounds test.

Export Model	F-statistics	Import Model	F-statistics
Total	4.579	Total	4.800
Food	4.605	Food	3.861
Mineral	6.715	Mineral	4.790
Chemical	4.254	Chemical	4.065
Woods	3.478	Woods	6.334
Texture	4.34	Texture	3.521
Metal	5.71	Metal	4.461
Emachine	4.789	Emachine	4.566
Machine	4.636	Machine	4.599

The lower critical value and upper critical value of 5% level is 2.37 and 3.2 respectively.

$$\Delta \ln \mathrm{IM}_{i,t} = \beta_0 + \sum_{k=0}^{n} \beta_1 \Delta lnINEER_{i,t-k} + \sum_{k=0}^{n} \beta_2 \Delta lnIPIC_{i,t-k} + \sum_{k=0}^{n} \beta_3 \Delta lnPPIC_{i,t-k} + \sum_{k=1}^{n} \beta_4 \Delta lnIM_{i,t-k} + \theta_1 lnINEER_{i,t-1} + \theta_2 lnIPIC_{i,t-1} + \theta_1 lnPPIC_{i,t-1} + \varepsilon_t \quad (29)$$

The lower critical value and upper critical value of 5% level is 2.37 and 3.2 respectively. The next step is to find out long-term elasticity coefficients of export and import function. The calculated long-term export and import elasticities of each equation are given in Table 5.

According to the TML condition, whether the movements of exchange rate can adjust trade balance or not depends on the export and import price elasticity of demand. If export and import prices do not lead to a change in demand, no adjustment can be achieved. The empirical analysis tried to investigate whether the sum of China's export and import price elasticities of demand is bigger than 1 or not. The findings of this study can be interpreted as:

Table 5. Bounds test results.

Sector	η_X	η_M	$\eta_X+\eta_M$	1/m	$\eta_X+(1/m)\eta_M$
Total	-0.564** (0.388)	0.412*(0.258)	-0.152	0.833	-0.220
Food	-0.870*(0.523)	-0.546*(0.396)	-1.616	1.413	-1.924
Mineral	-0.800***(0.223)	0.342(0.282)	0.458	9.835	2.564
Chemical	1.063**(0.486)	0.369**(0.173)	**1.432**	1.166	**1.493**
Woods	0.825**(0.406)	0.322**(0.618)	**1.147**	0.796	**1.081**
Texture	0.664*(0.266)	1.458(0.807)	**2.122**	0.116	0.833
Metal	0.718*(0.134)	0.680**(0.322)	**1.398**	0.852	**1.297**
Emachine	0.568**(0.273)	0.507*(0.347)	**1.075**	0.652	0.899
Machine	0.559*(0.259)	0.539*(0.325)	**1.098**	0.638	0.903

The value of 1/m is the average value of sample period.
*, **, *** indicate the coefficient is significant in 10, 5 and 1% level, respectively.

(1) Except for the mineral import price elasticity of demand, the others are significant, which indicates the variation of the exchange rate can affect export or import volume except for mineral. The import of mineral reaches its minimum in 2015, but there is no connection between the drop of mineral import and the RMB's reform in August 2015. The drop in oil prices, from a peak of 115 dollars per barrel in June 2014 to under 35 dollars at the end of February 2016, is the most important explanation of why China's imports reduced sharply, also the surplus of trade balance of China reaches its peak in 2015. Hence, the results can barely find the relevance between RMB's exchange rate and import of Mineral.
(2) Since the export price elasticity of General, Food, and Mineral, and the import price elasticity of Food has a significant negative value, it can be said that both the TML Condition and GML Condition for these industries is not fulfilled. One of the reasons that these industries cannot meet ML Condition is, there is no substitute for these imported products; the price elasticity is extremely low, hence there is limit room for the exchange rate to adjust the prices of these industry's products.
(3) The export price elasticity of primary goods is bigger than end-products. China's primary goods only occupy 5% of the total export of China, and do not have competitiveness in the international market. Foreign importers will find other substitutes if the RMB is appreciated or buy more primary commodities from China if RMB is depreciated. But the situation of Chinese manufacturing goods is different. First of all, Chinese manufacturing goods have strong international competitiveness, the demand of "Made in China" would not turn around easily because of the fluctuation of exchange rate; second, exporters in related industries may take several actions to avoid the exchange rate risk, such as sacrifice their profit margin to maintain their overseas market share. These actions of micro-economies may shrink the export price elasticity of demand.
(4) The import price elasticity of primary commodities is smaller than the manufacturing goods. About the import of primary goods, China overwhelmingly relies on foreign commodities plus there are no substitutes in the domestic market, even if the exchange rate fluctuates rapidly, the domestic demand will not change. Therefore, the import volume will stay at the same level. On the other hand, China imports manufacturing goods from overseas, assembles them into end-products in domestic, and export finished goods to overseas. This feature of "Processing trade" let the connection between export and import demand inseparable. When RMB appreciates, the decrease of export demand will cut down the import demand; when RMB depreciates, the import price will increase, then enterprises will use the domestic substitutes instead of using foreign goods, the import demand will lessen.
(5) The results of Texture, Emachine, and Machine meet the TML condition but fail to satisfy the GML condition. The value under GML condition is 0.833, 0.899, 0.903 respectively, which is less than 1 and fails to fulfill the condition to adjust the trade balance. The results not only depict that bigger surplus of trade balance will reduce the value of 1/m; the movement of exchange rate can be hardly used to adjust the trade balance. It also indicates that the TML condition may be ineffective to interpret the correlation between exchange rate and trade balance if a country's trade balance is surplus at the start.

Conclusion

So far, the study uses the ARDL model to calculate export and import price elasticity of demand for the Chinese economy from January 2008 to June 2018. Going by the empirical results, some industries' results cannot meet the TML Condition and GML Condition. Rest of the results show the sum of export and import price elasticity of demand that met the TML condition, which

assumes that the trade balance is initially 0; but fails to satisfy the GML condition, which assumes the trade balance is not initially 0. If the trade balance is 0 at the very first beginning, there is no need to let the exchange rate fluctuate to adjust the trade balance. The surplus amount of China's trade balance recorded in recent years has reignited the debate on the effect of exchange rate changes trade flows and global imbalances. Therefore, the results of the GML condition are more appropriate to explain whether the fluctuating exchange rate can influence trade balance.

Overall, the chemical, woods, metal results suggest that GML condition holds in the long-run. This means even though these industries' trade balance is greater than 0, the variation of exchange rate can adjust the trade balance in these sectors. While the GML condition is not satisfied in Texture Emachine, machine for the sample period data, it indicates that the movement of the exchange rate cannot adjust the trade balance in these 3 sectors. Texture, Emachine, Machine are the backbone of the Chinese economy as they fuel growth, productivity, and employment and strengthen other sectors of the economy. The surplus of these 3 sectors of trade balance occupies 90% of China's total surplus trade balance in 2018. The empirical results indicate that these 3 sectors' surplus can hardly be influenced by the fluctuation of the exchange rate, plus the anchor standing of these 3 sectors in the Chinese economy. We may say the appreciation will not succeed in adjusting the trade balance surplus in the Chinese economy.

The movement of the exchange rate was expected to achieve its goal to adjust the trade balance but failed in reality. There are various constraints in which an economy faces macroeconomic factors such as the transition of economic structure, the development of the global value chain, the lessen restriction on trade, and microeconomic factors like the expansion of overseas investment, multiple strategies to avoid the exchange rate risk. As a result, both government and enterprise will take corresponding actions to avoid the exchange rate risk, and ensure the development of international trade. It is much more complicated to convert the trade balance through the change of exchange rate. Therefore, it is not appropriate to expect the trade balance will be transferred to rely on the alteration of the exchange rate.

CONFLICT OF INTERESTS

The author has not declared any conflict of interests.

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Unconditional convergence of Chinese provinces (1952-2017): Some statistical analysis results

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This research tests the economic convergence hypothesis of 31 inland Chinese provinces over the period from 1952 to 2017. Regression and descriptive analysis methods are adopted to study the economic convergence among these Chinese provinces in terms of GDP growth and per-capita GDP growth. The research results show that GDP growth does not exhibit a tendency of convergence, rejecting the absolute convergence hypothesis among the Chinese provinces. But per-capita GDP growth does suggest convergence, especially after China's economic reform from 1978 to 2017, supporting the relative convergence hypothesis among the Chinese provinces. Practical and policy implications are provided based on the research results.

Key words: Economic convergence, regression, descriptive analysis, GDP, per-capita GDP, China.

INTRODUCTION AND RESEARCH BACKGROUND

The idea of economic convergence

As directly implied by the assumption of diminishing returns, the classical Solow growth model states that regions or countries that are the same or similar in all of the controlling parameters, such as population growth rates, savings rates, and technical progress rates, should ultimately converge to similar levels of per capita income (Mankiw et al., 1992; Solow, 1956;Sala-i-Martin, 1996). As capital per (efficient) unit of labor must reach to a steady level common to all regions or countries, the general economic convergence will happen irrespective of the initial level of each region, as measured by their starting values of per capita income.

The above economic convergence hypothesis sounds trivial on one hand. Since we assume similar long-run parameters for all regions, naturally expect long-run growth convergence among all regions will be expected. On the other hand, actually the hypothesis is also far from being obvious, since we only assume the same exogenous parameters of economic growth across regions, their initial levels of per capita income (or equivalently, per capita capital stock) are not controlled for. The key point of the economic convergence claim is that, given or assuming similar parameters governing the evolution of the economy for different regions, their different historical conditions or initial states do not matter for where they will arrive in the long-run.

The basic idea of economic convergence can be well explained graphically as shown in Figure 1, which plots the logarithm of per capita income against time, so that a constant growth rate (in the long-run steady state) will appear as a straight line S_0S_1, where income per (efficient) unit of labor stays precisely at the steady level generated by the steady level of per capita capital, as implied by the Solow growth model. The time path L_0L_1represents a region or country that starts below the line corresponding to the steady-state per capita level. According to the Solow growth model, this region would

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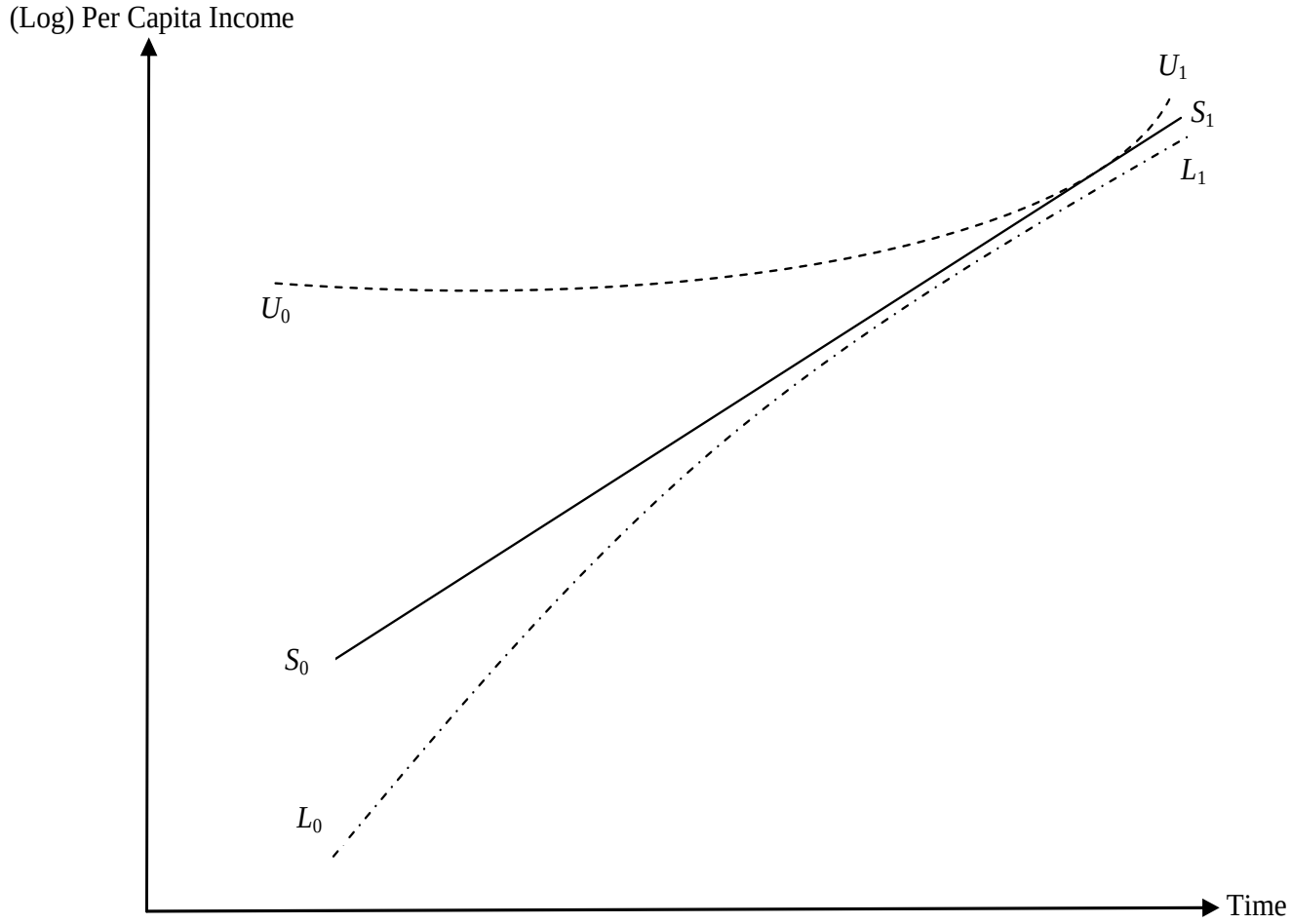

Figure 1. Economic convergence among regions over time.

Initially grow at a rate higher than that corresponding to the steady-state level. Over time, its growth rate will gradually decelerate to the (lower) steady-state level, or its time path of (log) per capita income will move up asymptotically to the steady S_0S_1 line as shown. Similarly, a region or country that starts above the line corresponding to the steady state per capita level will follow a growth pattern like U_0U_1, it would initially experience a lower growth rate but eventually its time path of (log) per capita income will flatten out to the steadyS_0S_1 line from above. That is, no matter where a region or country started, in the long-run its per capita income will converge to the same steady-state level.

From the above explanations, it is quite clear that economic convergence can be indicated by a (strong) negative relationship between the initial level of per capita income and the subsequent growth rates of per capita income. Largely based on this easily-implementable idea, many studies have been conducted using various statistical analysis methods and data from different regions or countries to validate or reject the classical growth convergence over time.

The economic convergence assertion is important and interesting in both economic theory and practice, which has attracted a great amount of researches to show whether or not there is economic convergence across regions or countries using real data and various statistical methods, especially for developed economies such as the US and European Union (EU) countries where higher quality data are more available over a longer time period. In this regard, it is worth to mention the special contribution made by the ongoing Maddison Project (Maddison 1982, 1991, 2007, see also http://http://www.ggdc.net/maddison/) that compiles data on a larger group of countries over a much longer time period back to the mid-19th century and even earlier.

China's economic convergence

Just as for other regions or countries in other parts of the world, it is of theoretical and practical interests to investigate the economic convergence among (inland) Chinese provinces regarding certain macroeconomic indicators. Since China started to reform its socialist planned economy to a market-oriented one in late 1978, China has achieved widely-known economic success in the past 40 years, with an average annual growth rate about 8-9%, much higher than the growth rates in developed economies and many other countries. But it has also been noticed in the literature that the income

inequality in the Chinese provinces has been increased with possible growth divergence across provinces since 1978 (Cheong and Wu, 2013, 2014; Ho and Li, 2010; Knight, 2014; Lau, 2010; Lyhagen and Rickne, 2014). For example, Ho and Li (2010) investigate the stochastic properties of output per capita across the Chinese provinces for the after-reform period from 1984 to 2003, and observe clear evidence of output divergence across the provinces. Similar evidence is also obtained by Lyhagen and Rickne (2014) for half of Chinese cities using nonlinear trend functions in the vector error correction model (VECM) over a much longer period between 1952 and 2007.

However, there are also many papers in the literature to obtain the evidence of convergence of per capita income (output) across the Chinese provinces (Herrerias and Monfort, 2015; Herrerias and Ordóñez, 2012; Herrerias et al., 2011; Sakamoto and Islam, 2008). For instance, Herrerias et al. (2011) find the evidence of convergence for the per capita GDP across 28 Chinese provinces for the period from 1952 to 2005. Using the panel unit-root method of Phillips and Sul (2007), Herrerias and Ordóñez (2012) investigate the stochastic properties of club convergence in terms of per capita income, labor productivity, and capital intensity for the period from 1952 to 2008. They find a statistically significant club convergence in the Chinese regions over the period under concern. Herrerias and Monfort (2015) also investigate the stochastic properties of convergence across 28 Chinese provinces for the period 1952 from 2008 using the test technique of Phillips and Sul (2007). They observe a significant degree of convergence in capital intensity, labor productivity and total factor productivity (TFP) in the Chinese provinces.

Research objective

Studies are needed to provide more evidence supporting or against economic convergence hypothesis among Chinese provinces. This paper is just to empirically test the economic convergence prediction of the classical Solow growth model in the context of 31 Chinese provinces using more recent data covering a longer period from 1952 to 2017. Having increasingly more international influence, China is very big in terms of land area, population, and economic scale, with 31 inland provinces. Hong Kong, Macao, and Taiwan are the other three special regions of China, which are quite different from the 31 inland provinces historically, economically, and politically, and hence will not be included as in many similar studies. Each of the 31 Chinese provinces is still quite big in land area and population compared to, for example, many EU countries. Thus it is theoretically and methodologically meaningful to study the economic convergence among these Chinese provinces regarding some popular and important economic indicators, which is useful for different provinces to consider different development strategies for future growth. This kind of study is also of a special methodological advantage with no sample selection bias since all inland Chinese provinces are included.

LITERATURE REVIEW

Economic convergence within a group of regions or countries can be generally defined as a decline in the degree of income disparity within the group over time (Simionescu, 2015). Bernard and Durlauf (1995) and Durlauf (1996) distinguish between the two definitions of convergence as output convergence; two regions or countries converge if the logarithm of output per capita for both is the same in the long run, and catching-up convergence; two regions or countries converge between two time points if the difference in the logarithm of output per capita at the earlier time point diminishes in value at the later time point. It is clear that output convergence implies catching-up convergence, but not necessarily vice versa, and that the two definitions can both be generalized to the multivariate cases.

In the economics literature, there is also another pair of widely used concepts: beta-convergence, implying that the poor regions or countries tend to grow faster than rich economies, and sigma-convergence, implying a decrease in income variation between poor and rich economies. It is easy to see that beta-convergence corresponds to output convergence while sigma-convergence matches with catching-up convergence. In both cases, there is a further division between absolute convergence, which implies the same steady-state income or output, and relative convergence, implying that the economies increase at the same rate in steady state.

The empirical methods for examining economic convergence are oriented on a number of different directions, such as the simple correlation and regression methods (Barro, 1991; Baumol, 1986, De Long, 1988; Parente and Prescott, 1993), cross-section augmented Solow regression models (Barro and Sala-i-Martin 1992; Mankiw et al., 1992), the chronological series tests of unit root and co-integration (Evans,1996, 1998; Evans and Karras, 1996a, 1996b; Kutan and Yigit, 2005; Guetat and Serranito, 2007; Siklos, 2010; Lopez and Papell, 2012), and the non-linear time-varying latent factor framework of club convergence (Borsi and Metiu, 2015; Phillips and Sul, 2007; von Lyncker and Thoennessen, 2017).

In terms of practical or empirical applications, there are a great amount of studies in economic convergence, covering different regions or countries in the world over different periods of time. Especially, there have been many studies for regional economic convergence in Europe, largely due to the availability and quality of economic data across European Union (UE) countries over time. For example, Borsi and Metiu (2015) investigate per capita real income convergence between 1970 and 2010 in EU within a non-linear latent factor framework. Quah (1996) shows that in income repartition dynamics, one should take spatial locations and spill overs into account. Sala-i-Martin (1996)

Table 1a. Test of absolute convergence from 1952 to 2017.

ln(GDP2017/GDP1952) = *a* + *bln(GDP1952)**				
Parameter	**Estimate**	**Standard error**	***t*-value**	***p*-value**
Intercept (*a*)	7.4489	0.2534	29.3958	0.0000
Slope (*b*)	-0.0969	0.0882	-1.0986	**0.2813**
R-Square	0.0414			

assesses beta and sigma-convergence in terms of real GDP per capita in 90 regions of eight countries from Europe. Crespo et al. (2008) measure the beta-convergence in GDP per capita for EU-15 during the period from 1960 to 1998, showing a faster convergence especially for the relatively poorer economies. Cunado and Perez de Garcia (2006) test the real convergence in five countries from East and Central Europe, rejecting the hypothesis of convergence over the period from 1950 to 2003. Cavenaile and Dubois (2011) find conditional beta-convergence for real GDP per capita for the EU-27 countries over the period from 1990 to 2007, with the convergence rates of new members being quite different from the EU-15 countries. Kutan and Yigit (2005) find significant real convergence for the new members of EU over the period from 1993 to 2003. After studying the real GDP and monetary aggregate convergence in CEEC, Brada et al. (2005) conclude that there are limited advantages offered by EMU accession. Kutan and Yigit (2007) show that the economic integration is useful for new member countries only on the long run, while for the founding countries the benefits are immediate. Diaz del Hoyo et al. (2017) show that certain EU countries began to face a “non-convergence trap” long before the euro years by taking a “long view” and reviewing the evidence since the 1960s.

There are also many studies about economic convergence among cities, states or provinces within a big economy like the US (Gerolimetto and Magrini, 2017; Ó’hUallacháin, 2008; Phillips and Sul, 2007; Wang, 2008) and China. A brief literature review about economic convergence among Chinese provinces has already been intentionally conducted in the Introduction with a number of relevant references provided, and hence will not be repeated here again.

METHODOLOGY

When testing the economic convergence hypothesis, the issue of time horizons must be considered. It would be ideal if we could go back one or two centuries in history, but the systematic collection of data for many countries, especially for developing economies, over a so long time period is difficult. In reality, generally we have two choices, the first one is to cover a large number of regions or countries but just over a relatively short period of time, which now is not a problem with the availability of economic data across many regions and countries during the past few decades, as provided by global and regional organizations like the United Nations, World Bank, IMF, OECD, and APEC. The second choice is to cover a relatively small number of countries, largely the more advanced economies like the US and EU countries, but over a long period of time. In this regard, the Maddison Project led by Prof. Angus Maddison has made an important contribution, which has compiled data on a number of countries back to the mid-19th century and even earlier (Maddison 1982, 1991, 2007; Maddison Project webpage athttp://www.ggdc.net/maddison/).It should be noticed that, although the Maddison Project can provide data over the past few decades for many regions and countries, there are only a small number of countries with data stretching back into the nineteenth century.

For example, when William Baumol published one of the earliest studies of long-run economic convergence in 1986, there were only16 countries in Maddison’s database for which per-capita income data were available back to as early as 1870. These countries were, in ascending order of 1870 per capita income, Japan, Finland, Sweden, Norway, Germany, Italy, Austria, France, Canada, Denmark, the United States, the Netherlands, Switzerland, Belgium, the United Kingdom, and Australia, all among the richest countries in the world today. Baumol (1986) plots the 1870 per capita income for these 16 countries on the horizontal axis and their growth rates of per capita income from 1870 to 1979 as measured by the difference in the logs of per capita income over the period on the vertical axis. A strong negative correlation between the 1870 per capita income and the growth rate of that income over the period was observed, which was formally implied by a simple regression (of growth rate on the log of the starting income level) estimated for the 16 countries as follows (Baumol, 1986):

Growth Rate (1870-1979) = 5.25 – 0.75ln(*GDPper Work-Hour*in 1870), $R^2 = 0.88$ (1)

Hence, the convergence of these 16 countries to one another, starting from very different levels of per capita income in 1870, is undoubtedly verified. It seems that Baumol’s finding quite strongly supports the unconditional convergence hypothesis, but unfortunately it is subject to possible statistical bias in the sense that the 16 countries studied are not selected randomly but just because they are the first group to have historical records in Maddison’s database. Actually, when De Long (1988) adds seven other countries, all with initial per capita income similar to some countries cover in Baumol’ (1986) study, the slope coefficient of the regression of Equation 1is still negative, but the goodness-of-fit is very bad as indicated by the very large residual disturbance terms.

RESULTS AND DISCUSSION

Absolute convergence test

In our study, the same model (1) was used but for all 31 mainland provinces in China, hence the possible sample selection bias issue is eliminated. It was first examines whether GDP (or total income) has any convergence tendency for the 31 Chinese provinces from 1952 to 2017, with data from China Data Online (https://www.china-data-online.com/). Table 1a shows the modelling results, where for each province in the

Table 1b. Test of absolute convergence from 1978 to 2017.

ln(GDP2017/GDP1978) = *a* + *bln(GDP1978)**				
Parameter	**Estimate**	**Standard error**	***t*-value**	***p*-value**
Intercept (*a*)	5.5939	0.3669	15.2446	0.0000
Slope (*b*)	-0.0351	0.0813	-0.4315	**0.6693**
R-Square	0.0064			

Table 2a. Test of relative convergence from 1952 to 2017.

ln[(GDP per capita 2017)/(GDP per capita 1952)] = *a* + *bln(GDP per capita 1952)**				
Parameter	**Estimate**	**Standard Error**	***t*-value**	***p*-value**
Intercept (*a*)	8.8860	0.6715	13.2339	0.0000
Slope (*b*)	-0.5693	0.1402	-4.0598	**0.0004**
R-Square	**0.3705**			

Table 2b. Test of relative convergence from 1978 to 2017.

ln[(GDP per capita 2017)/(GDP per capita 1978)] = *a* + *bln(GDP per capita 1978)**				
Parameter	**Estimate**	**Standard error**	***t*-value**	***p*-value**
Intercept (*a*)	**8.1393**	**0.6030**	**13.4973**	**0.0000**
Slope (*b*)	**-0.5283**	**0.1014**	**-5.2122**	**0.0000**
R-Square	**0.4837**			

regression, the dependent variable of average GDP growth rate from 1952 to 2017 is formally taken as the difference between the logs of GDP in 2017 and 1952, and the dependent variable of starting GDP level is also taken as the log of GDP in 1952 to be comparable. As can be expected, such kind of absolute convergence among Chinese provinces cannot be supported as the regression has a poor goodness-of-fit (R^2 = 0.0414 and *p*-value = 0.2813 for the slope's significance test).

It was also checked whether after the 1978 reform, absolute convergence among Chinese provinces can be observed. Table 1b shows the modelling results. The regression output again rejects the convergence hypothesis since the regression has an even poorer goodness-of-fit (R^2 = 0.0064 and *p*-value = 0.6693 for the slope's significance test).

Relative convergence test

Then the relative convergence hypothesis was tested using GDP per capita data for the 31 Chinese provinces from 1952 to 2017. Table 2a shows the modelling results. The regression outcome confirms the hypothesis with a satisfactory goodness-of-fit (R^2 = 0.3705) and a highly significant slope estimate (*p*-value = 0.0004).

If the relative convergence hypothesis starting from China's economic reform in 1978 is tested, the conclusion is stronger as the regression has more satisfactory goodness-of-fit (R^2 = 0.4837) with a very significant slope estimate (*p*-value = 0.0000) as reported in Table 2b. This seems to imply that after 1978, there is a stronger tendency than before for Chinese provinces to converge in terms of per capita income.

Another approach

Economic convergence can also be examined without using a modelling approach, but just using appropriate descriptive analysis. For example, Parente and Prescott (1993) study 102 countries from 1960 to 1985. In this study, each country's per capita real GDP is expressed as a fraction of U.S. per capita GDP for the same year. Then the standard deviation of these values is calculated separately for each year. If the convergence hypothesis holds, these countries should move closer to each other in per capita income levels, and we expect the standard deviation of their relative incomes to fall over time. In Parente and Prescott(1993) study, however, it actually increased by 18.5% over the 26-year period, and the increase was fairly uniform from year to year. Hence the convergence hypothesis could be rejected.

Similar idea in China's context was used. We first check the absolute convergence issue using the GDP data for China's 31 provinces from 1952 to 2017. It is observed that the average GDP level among the 31 Chinese provinces increased substantially over the period, the average variation or standard deviation of the 31 provinces' GDP also increased substantially over the period, but the relative variation in GDP, as

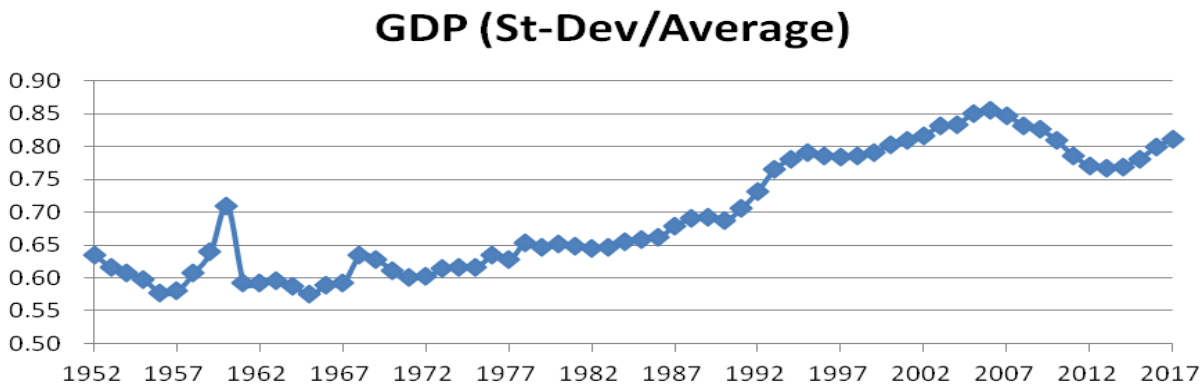

Figure 2. Relative variation of 31 Chinese provinces' GDP.

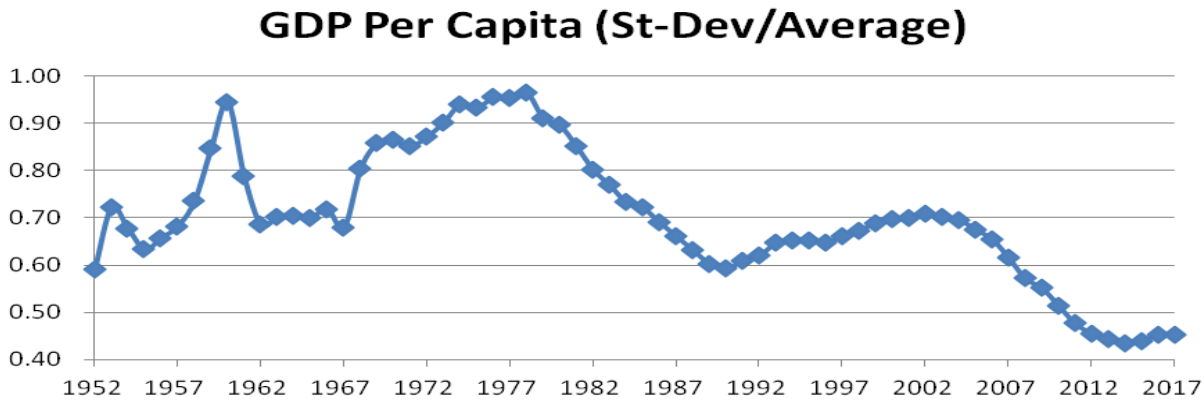

Figure 3. Relative variation of 31 Chinese provinces' per capita GDP.

measured by the ratio of standard deviation over average, only exhibited a slowly increasing trend, as shown in Figure 2. This implies some kind of stability or convergence among the 31 provinces' total income (GDP) levels.

When we do the same using the per capita GDP data for China's 31 provinces from 1952 to 2017, another picture was find (Figure 3) showing the relative convergence. It is observed that, as in the above GDP case, the average per capita income (GDP) level among the 31 Chinese provinces increased substantially over the period, and the average variation or standard deviation of the 31 provinces' per capita GDP also increased substantially over the period, but the relative variation in per capita GDP, as measured by the ratio of standard deviation over average, exhibited a somewhat clear decreasing trend, especially after 1978 when China started its economic reform. This implies again a kind of stability or convergence among the 31 provinces' per capita income (GDP) levels.

For each year from 1952 to 2017, when we consider the ratio of each province's GDP over the GDP of Beijing, and the ratio of each province's per capita GDP over the per capita GDP of Beijing (Figures 4 and 5), we find quite similar results as above, which further confirms certain kind of economic convergence among China's 31 provinces in the past several decades.

Conclusion

This research empirically tests the economic convergence prediction of the classical Solow growth model in the context of 31 Chinese provinces. Simple regression and descriptive analysis methods are adopted to study the economic convergence among these Chinese provinces in terms of GDP growth and per-capita GDP growth. Our regression results show that, GDP growth does not exhibit a strong tendency of convergence, rejecting the absolute convergence hypothesis among the Chinese provinces, for the whole time period from 1952 to 2017 and the reform period from 1978 to 2017 as well. However, per-capita GDP growth does suggest convergence, especially after China's economic reform from 1978 to 2017, supporting the relative convergence hypothesis among the Chinese provinces.

Descriptive analysis further confirms the results. In terms of standard deviations over average and also relative to Beijing's, GDP growth does not exhibit convergence, while per-capita GDP growth does

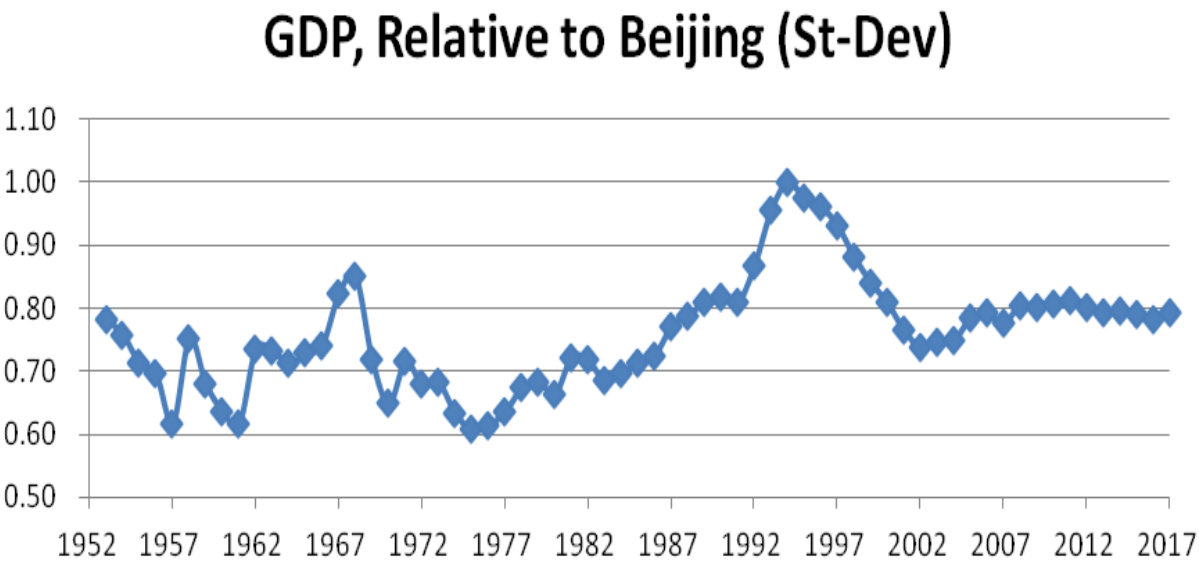

Figure 4. Variation of 31 Chinese provinces' GDP over Beijing's.

Figure 5. Variation of 31 Chinese provinces' per capita GDP over Beijing's.

suggest convergence, especially after China's economic reform, again rejecting the absolute convergence hypothesis and supporting the relative convergence hypothesis among the Chinese provinces.

Our research results have meaningful implications. Rejection of the absolute convergence hypothesis shows that, due to differences in, e.g., resources, technologies and initial conditions, GDP growth in different Chinese provinces still quite differs. Less developed provinces should work harder to catch up with the more developed provinces, which may help achieve regional economic balance in the long run. Supporting of the relative convergence hypothesis suggests that, although differs a lot in GDP growth or economic scale, different Chinese provinces tend to converge in per-capita GDP growth or average income, especially after China's economic reform since 1978. This is an encouraging trend, which shows the great economic success in China, not only in GDP growth or efficiency, but more importantly in average income growth of equality.

It may be argued that our research results are not robust and may change by taking different approaches, which however should be the case. From the brief review in this paper's Introduction part, different studies do get different results about economic convergence among Chinese provinces. If much more studies can provide similar results, then the results will reasonably become more reliable. Our study is just to provide further evidence in this regard, hopefully contributing to the accumulation of the relevant knowledge. In the future, more studies about economic convergence among Chinese provinces should be conducted using different methods and economic indicators (including, for example, consumer price index, total capital investment, and consumption-income ratio) over different and possibly longer time periods, so as to get more comprehensive and possibly more consistent and

reliable results.

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CONFLICT OF INTERESTS

The author has not declared any conflict of interests.

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Impact of foreign direct investment and inflation on economic growth of five randomly selected Countries in Africa

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Foreign Direct Investment (FDI) has been viewed as a major source of finance for developing countries and it has gained significant momentum since the sweep of globalization in the early 1990. This is because most of the developing countries see FDI as important in their strategy for growth. In this study, the impact of FDI and inflation on economic growth was examined. Five countries in Africa were selected randomly for the study. The variables used for this study are inflation rate, GDP per capita (economic growth), and FDI inflows. The study relied on IMF Data Mapper and UNCTAD stat for a period of 23-year time series 1996 to 2018 as the source of data for the study. Lastly unit root test and regression analysis were employed to estimate the objective of the study and output showed that FDI has a positive impact on economic growth in all the five countries under review. Except Egypt, Inflation has a negative impact on economic growth in four out of the five countries reviewed. This study recommended that Government should endeavor to create conducive environment that will enable FDI to thrive and also look into policies that will regulate money supply to encourage low and stable inflation rate, in order to absorb the maximum benefits of FDI inflows.

Key words: Economic growth, FDI, inflation, 5 randomly selected countries in Africa.

INTRODUCTION

The contribution of foreign direct investment (FDI) to economic growth in host countries has long been the subject of intense debate.

The contribution of foreign direct investment (FDI) to economic growth in host countries cannot be overemphasized. Most countries highly sought after FDI because it has been viewed as a major stimulus to economic growth in developing countries. According to Owusu-Antwi et al. (2013), FDI's ability to deal with two major obstacles; namely, shortages of financial resources and technology and skills, has made it the center of attention for policymakers in low-income countries in particular'. Most of the emerging countries in Africa, experience shortage in capital supply hence, the need for

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FDI. Foreign Direct Investment (FDI)can also be seen as cross-border financial investments between firms belonging to the same multinational group (Jannick et al., 2019).

FDI stimulates growth, create job and boost productivity through transfers of capital, skills, and technology (Jannick et al., 2019). It increases national savings, enhances access to internationally available technologies and management know-how, raises efficiency and expand output so that the inward spiral turns to a trajectory of economic growth and prosperity (Chaudhuri and Mukhopadhyay, 2014). The level of economic growth in a country can be increased if the host country implements policies that provides conducive environment for FDI inflows to thrive.

FDI can be said to be different from other major types of external private capital flows in that it is motivated largely by the investors' long-term prospects for making profits in production activities that are being directly controlled by them (Parma and Karl, 1999). Despite the essential contribution of FDI to economic growth, there are areas in which the impact of FDI are negative, especially in cases where competition is stifled, restrictive business practices are used or transfer prices are manipulated (UNCTAD, 1999).

On the other hand, Inflation is generally used to describe a situation of high and sustained increase in the general price level of an economy. Where there is inflation, the currency loses purchasing power.

Why does inflation matter? A widely accepted concept in macroeconomics is that low inflation is essential for economic growth. Although the debate about the exact relationship between inflation and economic growth remains open, there are questions about the existence and nature of this link (Munir et al., 2009). High and sustained economic growth in combination with low inflation is the most important objective of macroeconomic policy. But can the two co-exist? Different schools of thought offer diverse evidence on the linkage between inflation and economic growth. For instance, ‘structuralists believe that inflation is essential for economic growth, whereas the monetarists see inflation as detrimental to economic progress’ (Girijasankar and Chowdhury, 2001). In view of the above, there is need to examine the impact of FDI and inflation on economic growth.

Statement of the problem

The impact of FDI on Economic growth has been a major debate in many African countries. ‘Since the beginning of the 1990s foreign direct investment (FDI) has become the most important source of foreign capital for emerging market economies’ (EMEs) (Hussain and Haque, 2016, p.1). ‘However, not all FDI brings capital in service of productivity gains’ (Jannick et al., 2019 p. 12).It appears that the achievements of the objective of FDI has been limited in Africa. In fact, in the recent times,‘ FDI flows to Africa have continued to slide, reaching $42 billion, down 21% from 2016’ (UNCTAD, 2018 p. viii).

According to Fischer (1993), high inflation reduces growth by reducing investment and productivity growth. That is, high inflation rate hurts economic growth. However, some studies did not find this negative impact of Inflation on economic growth (Aminu and Anono, 2012, p.183; Idalu, 2015). In view of these, the researcher has decided to investigate on the impact of FDI and Inflation on Economic growth.

Research question

This study would be guided by the following research questions:

1) To what extent does FDI impact economic growth?
2) To what extent does inflation impact economic growth?

Objectives of the study

The main objective of this paper is to assess the impact of FDI and Inflation on economic growth in emerging market countries in Africa for the period of 1996-2018 using time series data. Other specific objectives are:

1) To assess the impact of FDI on economic growth.
2) To assess the impact of inflation on economic growth.

Research hypotheses

The hypothesis to be tested in the study is stated below:

H_{0a}: There is no significant relationship between FDI and economic growth in emerging market countries in Africa.
H_{1a}: There is a significant relationship between FDI and economic growth in emerging market countries in Africa
H_{0b}: There is no significant relationship between inflation and economic growth in emerging market countries in Africa.
H_{1b}: There is a significant relationship between inflation and economic growth in emerging market countries in Africa.

Conceptual reviews and theoretical reviews

Economic growth, FDI and Inflation are key concepts in this study. A review of these concepts helps to understand the possible interrelationship among them.

FDI and economic growth

The neoclassical growth model (NGM) developed in the 1950s by Solow and Swan is the starting point for almost all analyses of growth. Neoclassical growth theory emphases on capital accumulation and its connection to savings decisions (Hernández, 2003). The theory states that, long-run growth in income and physical capital per worker is entirely driven by productivity growth (more precisely, by the rate of labor-saving technological progress). However, neoclassical growth models treat this growth rate as exogenous (Grossmann and Steger, 2007). It argues that technology changes have a major influence on an economy, and the economic growth cannot continue without technological advances. While the focus of NGM was primarily on the growth of productive inputs; savings, capital accumulation (associated with depreciation) in determining economic growth, the 'Endogenous growth theory (EGM) builds upon postulates of NGM and focuses on how innovations and technology can lead to economic growth in the long run' (Onyimadu, 2015, p.500).

Endogenous growth theory holds that economic growth is primarily the result of endogenous and not external forces also, that investment in human capital, innovation, and knowledge are significant contributors to economic growth.

Inflation and economic growth

The Keynesians' view on the theory of inflation is that increase in production costs as the reason for inflation especially when the extra costs of the goods and services are incorporated into the prices. Keynesian theorists believe wages and salaries of workers who are part of the production process affect the prices of the products. Where there is an increase in the salaries and wages of these workers the cost of production albeit increases hence inflation. The purchasing power of money reduces as inflation increases significantly, also savings decrease in value as the rate consumer price index increases over the preceding year. 'The Keynesian school of thought insists that the value of money during inflation can be further enhanced where investments are made' (John and Obioma, 2017). According to Jahan et al. (2014), an economy's output of goods and services is the sum of consumption, investment, government purchases, and net exports. Any increase in demand has to come from one of these four components.

Empirical literature review

FDI is often seen as an important catalyst for economic growth in the developing countries. 'It is primarily Motivated with long-term realization ofreturns from anenterprise in a foreign country'. (Chaudhuri and Mukhopadhyay, 2014) and affects the economic growth by stimulating domestic investment, increasing human capital formation and by facilitating the technology transfer in the host countries (Nuzhat, 2009). It can also influence growth by raising total factor productivity (OECD, 2002). Investments in firms in which a foreign investor acquires a controlling stake are classified as Foreign Direct Investments (Alfaro and Chauvin, 2017) and this can be seen as animportant driver for genuine international economic integration, and for boosting productivity through transfers of capital, skills, and technology (Jannick et al., 2019). Anochie et al.(2015 p. 84) asserts that FDI has emerged as the most important source of external resource flows to developing countries over the years.FDI also contributes to host country economic growth not only through capital, but also via spillover, competition, and productivity effects (Alfaro and Chauvin, 2017)

On the other hand, the economic growth of an economy is affected by the level of its inflation. High inflation rate has negative impact on the economic growth. High rate of inflation makes firms and households channel their resources from productive activities to nonproductive activities (Idalu, 2015).For instance, investors may decide to invest in free-risk areas (Treasury bill and Bond) rather than real sector that can generate more employment opportunity. Akinsola and Odhiambo (2017) claimed that the impact of inflation on economic growth varies from county to country and over time and that there is anegative relationship between inflation and growth, especially in developed economies. However, Aminu and Anono (2012) argued that inflation possessed a positive impact on economic growth through encouraging productivity and output level. There are three major types of inflation according to neo-Keynesians. The first is the demand-pull inflation, which occurs when aggregate demand is in excess of available supply (capacity), cost-push inflation occurs in the event of a sudden decrease in aggregate supply, owing to an increase in the price/cost of the commodity/production where there are no suitable alternatives and structural inflation, is built-in inflation, usually induced by changes in monetary policy in Aminu and Anono (2012: 185).

Economic growth is an increase in the productive capacity of an economy with a resultant effect of which the economy can produce additional quantities of goods and services. Economic growth therefore is synonymous with an increase in the general standard of living as standard of living is measured by the quantity of goods and services available to us (Benis and Olayiwola, 2018, p.23). One of the most complex and empirically unsettled subject in economics is the importance for the welfare of most people around

the world and there some controversies in growth analysis which is the relative role of capital accumulation and productivity growth in driving output´ (Shimelis, 2014, p.1).New evidence is showing that growth is a volatile phenomenon for most countries except probably high per capita income economies (Gutierrez and Solimano, 2007 as cited in Shimelis, 2014, p.1). FDI and inflation are important determinant of economic growth. This study will examine the impact of FDI and inflation on Economic growth.

There is a widespread realization and belief among researchers, practitioners and policy makers that FDI has the ability to boost economic growth (Khamis et al., 2015).Koojaroenprasit (2012) analyzed the relationship between FDI and economic growth in South Korea, he used a sample period of 29 years for the period 1980-2009 with annual time series. His research anchored on endogenous growth theory and his finding shows that FDI has a positive and significant impact on economic growth. Khun (2018) while investigating the Impact of foreign direct investment (FDI) on economic growth in Cambodia he asserted that in general, positive influence of FDI is explained by 'technological diffusion' originating from firms accepting foreign capital and spreading to related companies in a form of technical support. The analysis covered the period between 1998 and 2010 revealed that there is a positive relationship between economic growth (GDP) and FDI.Other studies such as Alfaro et al. (2004) and Anyanwu and Andrew (2004) claim, in their findings, that FDI promotes economic growth in economies with sufficiently developed financial markets.

Khamis et al. (2015) use the ARDL (auto regressive distributed lag) model to examine the relationships between the Inflation, FDI and economic growth between the period 1980 – 2013 and concluded that inflation rate did not have a significant impact on FDI while GDP per capita had a significant positive relationship with FDI. The researchers further stated that FDI increases capital stock and also the employment, it stimulates technology changes through technological diffusion and it also generate technology spillovers for local firms within the country

On the other hand, despite the fact that FDI is one of the most dynamic resources flowing into developing countries which can be an important component for economic growth, in terms of domestic savings, capital accumulation, employment generation, and growth. Worku (2017) contended that some researchers had come out with findings that suggest minimal impact of FDI on economic growth. Muhia (2019) reviewed the impact of FDI on economic growth on major sector of Kenya's economy. In his article, he examines the influence of foreign direct investment on Kenya's economic growth using Quantitative data. The researchers collected level two data from the World Bank and the Kenya National Bureau of Statistics KNBS from 2000 to 2017. The result of their findings revealed that foreign direct investment in the infrastructure sector has a significant impact on economic growth while FDI invested in manufacturing and Agricultural sector has no significant impact on economic growth.

Okeke et al. (2014) examined the impact of FDI on economic growth in Nigeria between 1977 and 2011. After testing for the unit root in the set of data used for the study, econometric result shows that Foreign Direct Investment has no significant effect on Nigeria economy. This suggests that FDI inflows into Nigeria may not have been an economically viable investment or properly channeled to productive economic activities. Olawunmi and Olufemi (2016), in their study, investigated the effect of FDI on economic growth in some randomly selected African economies from 1980 to 2013, using a modified growth model. The ordinary least squares regression (OLS) and the generalized method of moments (GMM) were the two-estimation technique used. They observed that except for Central African Republic, the estimate of FDI was positive and significant for both OLS and GMM in all the selected countries. However, despite the significant and positive coefficients of FDI, yet the most important feature of the coefficients is the extremely small magnitude which implied a minimal or negligible impact of FDI on economic growth. In the same vein, Adedeji and Rolle (2016), in their findings, suggested that though FDI has the tendency to stimulate growth in Africa, but it is not a critical factor in Africa's growth process. The researcher stated that SSA's receipt of global FDI has been quite unimpressive reflecting a case of global financial marginalization.

It is of no doubt that the level of economic growth in a country can be increased if the host country implements policies that provides conducive environment for FDI inflows to thrive (OECD, 2002). However, the level of inflation in an economy might determine the extent of such growth. The question on whether or not inflation is harmful to economic growth has recently been a subject of intense debate to policy makers and macroeconomists. Several studies have estimated a negative relationship between inflation and economic growth. Specifically, the bone of contention is that whether inflation is necessary for economic growth or it is detrimental to growth (Shailender and Amar, 2015).

Anidiobu et al. (2018) conducted a research on the Analysis of Inflation and Its Effect on Economic Growth in Nigeria using secondary source of data for the period 1986 – 2015. In their study, they asserted that inflation is known to diminish the purchasing power of currency as a result of a rise in prices across an economy and that one of the primary objectives of macroeconomic factors is to gauge the health condition of a domestic economy as a whole with regard to how a specific factor affects overall performance of such economy. For this reason, they considered it sufficiently beneficial to dis-aggregate

the factors with the ultimate goal of exploring how inflation has influenced the RGDP. This study found that Inflation had a positive but non-significant influence on RGDP. Girijasankar and Chowdhury (2001) examined the relationship between inflation and GDP growth for four South Asian countries. The authors used cointegration and error correction models to empirically examine long-run and short-run dynamics of the inflation-economic growth relationship for four South Asian countries using annual data collected from the IMF International Financial Statistics and they find evidence of a long-run positive relationship between GDP growth rate and inflation for all four countries. In their findings, it was revealed that moderate inflation is helpful to growth, but faster economic growth feeds back into inflation.

The findings of the study done by Mark et al. (2004) suggest a negative inflation-growth effect, and one that is stronger at lower levels of inflation. The empirical evaluation of their model is based on a large panel of OECD and APEC member countries over the years 1961-1997 and a hypothesized negative inflation effect is found comprehensively for the OECD countries to be significant. Muhammad and Saleem (2018) examined the effects of inflation on rate of economic growth of the Five Asian countries for the period 1973 to 2016. They employed the Least Squares and traditional panel estimation techniques and the result revealed that inflation has negative and statistically significant impact on economic growth in all sampled countries. They further stated that inflation is not helpful but harmful to the rate of economic growth. Their findings suggest that an effective macroeconomic policy mix needs to be devised to control inflation and encourage the process of economic growth and development.

Today it is more important to review the level of inflation that can affect economic growth and not just the simple impact of inflation on economic growth. Masiyandima et al. (2018) attempt to estimate a threshold level of inflation above which inflation is inimical to growth using Zimbabwe as a case study. The authors estimated threshold inflation for Zimbabwe during the stable period when Zimbabwe had its own currency that is from 1980 to 1997.The results suggest the threshold level of inflation of 8.7% for the period 1980 to 1997.In the same vein, Khairul and Sazib (2017) forecasted a threshold level of inflation and examined empirically the relationship between inflation and economic growth in Bangladesh using annual data set from 1986 to 2016. 8% was forecasted as a threshold level of inflation and any rate beyond this, will not significantly influence the growth rate also, the authors confirm that there is statistically significant positive relationship between inflation and economic growth.

METHODOLOGY

The empirical study focused on the 5 randomly selected counties in Africa. They include South Africa, Tanzania, Nigeria, Kenya and Egypt. In this study, the IMF Data Mapper, UNCTADstat for a period of 23 years starting from 1996 to 2018, constitute the source of data for the already variables identified. In order to achieve the objective of this study, the OLS technique will be used to measure the impact of FDI and Inflation on economic growth after testing for stationary using Unit Root Test. Hence the model for the study is presented below:

$$Y = f(X_1, X_2) \quad (1)$$

The model employed in the study includes the following:

$$Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \mu \quad (2)$$

Where, Y=Sum of Gross Domestic Product; X_1=Sum of Foreign Direct Investment; X_2=Sum of Inflation; U=Stochastic error term; β_i=Slope of the regression equation andβ_0=Intercept or constant.

Method of data collection and estimation techniques

Data used mainly are secondary time series data sourced from the International Monetary Fund Data Mapper and *UNCATDstat*.The data collected was tested and analyzed adopting the regression technique of ordinary least square method (OLS).

Techniques of estimation

This study employed appropriate Econometric techniques to estimate its stated objectives. They include ordinary least square technique and the unit root test.

Ordinary least square

It is being used to assess the effect of FDI and Inflation on Economic growth. It further identifies statistical tools that judge the statistical significance of each independent variable. The choice of OLS is that it closely 'fit' a function with the data by minimizing the sum of squared errors from the data. It also has some other advantages such as consistency, minimum variance, unbiasedment. It is generally known for property of BLUE (Best, Linear, Unbias, Estimate)

Unit root test

It is a tool used to test whether time series data forthe variables are stationary because the stationarity of a series can strongly influence its behaviour.

RESULTS AND DISCUSSION

The purpose of applying the unit root test is empirically examining whether a timeseries contains a unit root. If the series has a unit root, it is said to be non-stationary; otherwise, the series is considered as stationary (Dogan, 2013). To investigate the stationary and determine the integration level of the selected variables, this study employed ADF test. The testing results obtained in Table 1 suggest that all the variables were found to be

Table 1. Unit root test result.

Country	Parameter		
Tanzania			
Variables	**GDP**	**FDI**	**Inflation**
t- Statisitcs	-5.924772	-7.655244	-7.562233
1% Citical value	-3.808546	-3.78803	-3.831511
5% Citical value	-3.020686	-3.012363	-3.02997
10% Citical value	-2.650413	-2.646119	-2.655194
Prob	0.0001	0.000	0.000
Remark	At 2nd Diff	At 1st Diff	At 2nd Diff
South Africa			
Variables	**GDP**	**FDI**	**Inflation**
t- Statisitcs	-5.025548	-4.457227	-4.527785
1% Citical value	-3.831511	-3.769597	-3.78803
5% Citical value	-3.02997	-3.004861	-3.012363
10% Citical value	-2.655194	-3.004861	-2.646119
Prob	0.0008	0.0022	0.002
Remark	At 2nd Diff	At Level	At Level
Nigeria			
Variables	**GDP**	**FDI**	**Inflation**
t- Statisitcs	-4.45151	-6.858467	-5.685287
1% Citical value	-3.78803	-3.831511	-3.769597
5% Citical value	-3.012363	-3.02997	-3.004861
10% Citical value	-2.646119	-2.655194	-2.642242
Prob	0.0023	0.000	0.0001
Remark	At 1st Diff	At 2nd Diff	At Level
Egypt			
Variables	**GDP**	**FDI**	**Inflation**
t- Statisitcs	-5.201076	-4.190573	-5.659556
1% Citical value	-3.808546	-3.857386	-3.78803
5% Citical value	-3.020686	-3.040391	-3.012363
10% Citical value	-2.650413	-2.660551	-2.646119
Prob	0.0005	0.0051	0.0002
Remark	At 2nd Diff	At 1st Diff	At 1st Diff
Kenya			
Variables	**GDP**	**FDI**	**Inflation**
t- Statisitcs	-7.358786	-6.935763	-4.416663
1% Citical value	-3.808546	-3.78803	-3.769597
5% Citical value	-3.020686	-3.012363	-3.004861
10% Citical value	-2.650413	-2.646119	-2.642242
Prob	0.000	0.000	0.0024
Remark	At 2nd Diff	At 1st Diff	At Level

significant at either level, first difference or at second difference, respectively.

Furthermore, the study used the tool of regression to indicate the impact of FDI and inflation on economic growth for each country (Egypt, South Africa, Nigeria, Tanzania and Kenya). From the regression result, it shows that FDI has a positive impact on economic growth in all the five (5) countries, that is, a unit increase in FDI for these five countries will stimulate economic growth by25.8, 23.7, 73.2, 65.4 and 29.2%, respectively. In other

Table 2. Regression result.

Variable	Egypt	South Africa	Nigeria	Tanzania	Kenya
C	1.190294	1.790401	-0.175091	-0.444914	0.902028
FDI	0.258563	0.237848	0.732016	0.654279	0.292022
INF	0.009822	-0.036996	-0.003657	-0.004413	-0.011788
Rsquared	0.533337	0.351622	0.514527	0.763392	0.770295
Adj.Rsquared	0.484215	0.286784	0.465980	0.739731	0.747324
F-stat	10.857300	5.423105	10.598480	32.263960	33.534040
P-value	0.000717	0.013131	0.000727	0.000001	0.000000

Source: Computed by the author.

words, inflow of FDI is favourable to all the five countries but more favourable to Nigeria and Tanzania. This contradicts the findings of some exiting studies reported in our literature (Okeke et al., 2014; Olawunmi and Olufemi, 2016; Adedeji and Rolle, 2016). The reason for this contradiction might be as a result of a more favourable macroeconomic environment, for instance, as observed in this study the inflation rate experienced in most African countries has been relatively low and stable in the recent times.

There are several studies on the impact of inflation on economic growth. Evidence revealed that there has been mixed up so far, while a strong support can be found for the negative impact of inflation on the economy (Fischer, 1993; Akinsola and Odhiambo, 2017). Other studies revealed positive impact (Marjan and Najeeb, 2013; Anidiobu et al., 2018).However, the result of our study shows that inflation has a negative impact on economic growth in 4 of the selected 5 countries. For instance, a unit increase in the inflation of these 4 countries results into 3.6, 0.3, 0.4 and 1.1% reduction in economic growth except for Egypt, where there exists a positive relationship between Inflation and economic growth; a unit increase in inflation will lead to a 0.9% increase in economic growth.

The R squared shows that FDI and Inflation accounts 53.3% of the variation in the economic growth of Egypt; 35.1% variation in the economic growth of South Africa; 51.4% of the variation in the economic growth of Nigeria; 76.3% of the variation in the economic growth of Tanzania and lastly, 77.0% of the variation in the financial performance of Kenya. In other words, these two variables impact oneconomic growth of Tanzania and Kenya much more than that of other three countries. Statistically, the outcomes of this study show both positive and negative impact and they are all significant as indicated by the F-stat in the Table 2.

CONCLUSION AND RECOMMENDATION

In this study, an attempt was made to examine the impact of FDI and Inflation on economic growth in 5 randomly selected countries in Africa. Regression analysis result showed that FDI has strong and positive impact on economic growth in all the 5 countries, while inflation has an inverse but significant relationship with economic growth in 4 of the selected countries except for Egypt. This suggests that FDI has the tendency to stimulate growth while high inflation has the tendency of hindering growth in Africa.FDI is an important factor for economic growth especially for emerging and developing economies. It is also important for developing countries to know that, contrary to expectations, FDI may not automatically lead to economic growth, as is insinuated by many policy makers in the region (Akinlo, 2004 as cited in Awolusi and Adeyeye, 2016) as it depends on characteristics of the investment resulting from FDI, such as type, sector, scope, duration, proportion of domestic businesses in the sector, and so on.

African countries should endeavor to create conducive environment that will enable FDI to thrive by establishing favourable economic and political policies (Okonkwo et al., 2015);encouraging political stability, putting in place policies to improve the quality of human resources and labor skills (Trang et al., 2019). Since FDI cause major technology transfer to from develop countries to developing countries, there is need for highly skilled labour in order to effectively and efficiently utilize the new technology for economic growth. In addition, governments should look into policies that will regulate money supply to encourage low and stable inflation rate, in order to absorb the maximum FDI benefits.

CONFLICT OF INTERESTS

The author has not declared any conflict of interests.

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The determinants of credit demand among farmers in Hurungwe District of Mashonal and West Province in Zimbabwe

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Bank credit availability in the agricultural sector empowers farmers to adopt modern technologies and inputs that are vital for breaking poverty in developing economies like Zimbabwe. This study sought to establish the determinants of credit demand among farmers in Hurungwe District of Mashonaland West Province in Zimbabwe. A questionnaire survey was conducted on a sample of 354 farmers selected by stratified random sampling. The Direct Elicitation Approach was applied to comprehend the credit demand constraints faced by farmers using frequency statistics. Logistic Regression Analysis and Thematic Analysis were also used for analysing data. Farmers in Hurungwe District face price (95%), risk (79%) and transaction cost (58%) constraints. Interest rates, collateral and fear of debt have a negative and significant ($p<0.05$) effect on credit demand. Loan processing time emerged as another key determinant of credit demand among farmers. Policy should curb hyperinflation to ensure the affordability of loans and production inputs by farmers. Interest rate ceilings must also be restored, and financial markets literacy campaigns intensified to shield farmers from predatory lenders. Banks are challenged to improve communication with farmers, swiftly address their needs and relax collateral demands to enhance credit demand among farmers. Investments in irrigation and other weather resilience technologies should be prioritized to enhance agricultural sector performance and reduce credit uptake fears among farmers.

Key words: Collateral, constraints, credit demand, direct elicitation, investments, thematic analysis.

INTRODUCTION

Agriculture supports majority of the population and industries in Zimbabwe (Ministry of Agriculture Zimbabwe, 2017). However, financial investments in the sector are not being prioritized as evidenced by low agricultural loan books in most commercial banks (Vitoria et al., 2012). Despite being an agro-based economy,

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agricultural credit comprised only 16.36% of the loans advanced by commercial banks in Zimbabwe in 2015 (Reserve Bank of Zimbabwe (RBZ), 2016). Regardless of improving tremendously to 31.69% by December 2019, the banks' average agricultural loan portfolios are yet to surpass the pre-land reform maximum of 91.3% achieved in the year 1999 (RBZ, 2019). Consequently, the demand for bank credit in the agricultural sector remains unmet in Zimbabwe (Vitoria et al., 2012). This limited access to finance by farmers in Zimbabwe is cited as a major bottleneck to agricultural performance (RBZ, 2016). Besides, some studies have generally observed that a limited number of farmers, especially in the smallholder farming sector use credit, a financial resource whose deficiency constrains the farmers' capacity to invest in inputs and technologies that are essential for enhancing production, income and livelihoods (Chitungo and Munongo, 2015; International Finance Corporation, 2014). Various studies have proposed that the credit constraints faced by households or individuals can be understood better if focus is not only placed on why they fail to access loans from banking institutions, but also on why they are not seeking or demanding any bank credit in the first place (Ali et al., 2014; Zeller, 1994). Chitungo and Munongo (2015) also highlighted that conventional methods of estimating demand for credit have only utilized information sourced from farmers who have accessed credit before, thereby neglecting crucial information from farmers who have not borrowed. This also makes it impossible to account for the farmers' initial decision on whether or not to borrow.

According to the Iowa State University (2019), demand is a price and quantity relationship, which expresses the quantity of a product demanded at various price levels. In this study, credit demand is perceived as the farmers' willingness to apply for bank credit from formal financial institutions at a given price, which is the interest rate. This study focused more on the taste/willingness/desire aspect of credit demand. Given the poor nature of most farmers in Zimbabwe, a focus on effective demand or the ability by farmers to afford the interest rates charged by banks would have segregated against farmers who had the desire to apply for bank credit, but could not afford the interest rates charged. According to Diagne et al. (2000), participation in credit programs is something that households or individuals choose to do, and was conceptualized by Zeller (1994) as a Sequential Decision Process (SDP). In the first stage of this SDP, the household or its member makes a decision to either apply or not apply for bank credit. In the second stage, the banker decides to supply or withhold the requested credit to the farmer who made credit application. The Direct Elicitation Approach (DEA) also embraces the SDP model's quest to understand household/individual credit constraints from both the demand and supply side. Rooted in works by Boucher and Guirkinger (2005) in Peruvian agriculture, the DEA proposes that directly asking households on the reasons why they do not participate in credit markets can give a clearer picture of the constraints that they face. Therefore, according to the DEA, farmers can be unconstrained (no need for credit because they have adequate resources); price constrain (interest rates too high or lack collateral); transaction cost constrain (do not know where to apply, no bank account, lack of supplier etc.); or risk constrain (fear of losing collateral, fear of being rejected, do not like to be indebted). The approach mostly focuses on lender attributes as determinants of credit demand within households.

One of the variables recognized as a determinant of credit demand is the interest rate. Interest rate is defined by Faure (2014) as the reward paid by a borrower/ debtor to a lender/creditor for the use of money for a specified period. It is also widely referred to as the price of money. Collateral is another DEA variable, which is defined as the asset or assets pledged to secure a loan (Baiden, 2012). Another variable in the DEA is distance, which is simply the distance between the lender and the borrower. Awareness is the extent to which the borrower knows about the credit products offered by the lender, whilst fear of debt captures the farmer's attitude towards borrowing, which may be partly attributed to the lender's behaviour (for example, loan processing time and service quality), lending conditions (like collateral requirements) and characteristics (like location) . This study is mostly interested in understanding these local supply side attributes of banks that act as deterrents to credit demand among farmers, which justifies the adoption of the DEA. A few studies in Zimbabwe have undergone the determinants of credit demand among farmers in Zimbabwe. Chitungo and Munongo (2015) investigated the effect of various farmer and farm characteristics (age, marital status, education, household size, income, remittances, and crop type) on the farmers' decision to apply for credit from informal lenders in the rural districts of Zaka, Chiredzi and Masvingo. Dube et al. (2015) only focused on the determinants of credit access in the formal sector among smallholder tobacco farmers in Makoni District. Therefore, no study to the researcher's knowledge has applied the DEA to comprehend how lender/ supply side attributes affect Zimbabwean farmers' credit demand for bank credit. Moreover, most of the available studies focused on credit demand determinants in the smallholder farming sector, somewhat neglecting the larger commercial farming sector. Most of the studies that investigated credit demand determinants also applied statistical techniques. Hence, there is a dearth of studies that have attempted to apply qualitative methodologies to comprehend credit demand constraints among farmers in general. These are the gaps that this study aims to fill, focusing on Model A1 smallholder and Model A2 commercial farmers in the Hurungwe District of Mashonaland West Province in Zimbabwe. Therefore, this study sought to establish the credit demand

Table 1. Definition of independent variables.

Variable	Type	Description	Expected sign
Interest Rates (IR)	Continuous	Price of bank loan in dollars ($)	-
Collateral Requirements (CR)	Continuous	Loan collateral value required in dollars ($)	-
Lender Borrower Distance (LBD)	Continuous	Distance of bank's location from the farmer in kilometers (Km)	-
Bank Credit Awareness (BCA)	Categorical	Farmer's awareness of loan products offered by banks: 1= Aware; 0= Unaware	+
Fear of Debt (FOD)	Categorical	Farmer's reluctance to borrow due to fear of being in debt:1= Fear Debt;0= No Fear of Debt.	-

Source: Author.

constraints faced by farmers in Hurungwe District, and the factors that influence their decision to seek formal bank credit.

MATERIALS AND METHODS

The study adopted the pragmatism research philosophy, which embraces both quantitative and qualitative techniques (Madondo, 2015). Having adopted the pragmatism research philosophy as highlighted above, the study took up the embedded mixed methods research strategy in which qualitative techniques were used to support the main quantitative methods (Terrell, 2012). Quantitative and qualitative primary data were collected simultaneously and were subsequently mixed during the analysis phase, where the latter was used to explain and support the former in order to gain a broader perspective than could be gained from using the quantitative data in isolation (Almalki, 2016). Also known as triangulation (Dawson, 2002), this amalgamation of quantitative and qualitative methods in this study provided a broader and more complete vision of the low credit uptake problem in the Zimbabwean context (Almeida, 2018). The study was conducted in Hurungwe District, which is situated in the North-Western part of Zimbabwe in Mashonal and West Province (Hurungwe Rural District Council (HRDC), 2019). A cross-sectional questionnaire survey was carried out on a sample of 354 farmers, which was determined by the Raosoft sample size calculator. The questionnaire was structured and contained both closed and open-ended questions. Open ended questions allowed the study to collect some qualitative data which was used to complement the qualitative findings. Stratified random sampling was used to select farmers across the Model A1 and Model A2 farming sectors. The sample was thus made up of 281 Model A1 farmers and 73 Model A2 farmers.

Quantitative data analysis

This study mainly used quantitative techniques. Firstly, Ali et al. (2014) Direct Elicitation Approach (DEA) was adopted to define the credit demand constraints status of farmers in Hurungwe District, using frequency statistics from the Statistical Package for Social Sciences (SPSS). The study adopted Zeller (1994) Sequential Decision Process (SDP) model. The SDP model was adopted in various empirical studies. For example, Zapata (2017) study on credit decision and rationing rules in the informal credit markets of the Philippines adopted both stages of the model using the Probit (in Stage 1) and Ordinary Least Square (OLS) (in Stage 2) methods. In Zimbabwe, Chitungo and Munongo (2015) also applied Stage 1 of the SDP model in their study on the determinants of farmers' decision to access credit in Masvingo, Zaka and Chiredzi rural districts, which were tested using the Probit method.

Therefore, this study adopted Stage 1 of the SDP model to comprehend the determinants of credit demand among farmers in Hurungwe District. It tested the statistical significance of some of Ali et al. (2014) DEA credit demand constraint factors (interest rates (IR), collateral (C), lender borrower distance (LBD), bank credit awareness (BCA) and fear of debt (FOD)) in influencing credit demand among farmers in Hurungwe District. Several studies adopted the DEA to comprehend households' credit constrains, for example Ali et al. (2014); Boucher and Guirkinger (2005) and Mukasa et al. (2017) in Rwanda, Peru and Ethiopia respectively. The testing of DEA's effect on farmers' credit demand was done through Binary Logistic Regression Analysis in SPSS. Binary Logistic Regression Analysis was adopted because the dependent variable of credit demand is binary, taking zero or one values (credit demanded=1; no credit demand=0). Isaga (2018) also applied logistic regression to determine factors that affected smallholder farmers' access to bank services in Tanzania. Its flexibility and ease of use also justified its adoption in this study (Isaga, 2018). The credit demand equation tested by Binary Logistic Regression Analysis in the study was modelled as follows:

$C_D = f$ (IR; CR; LBD; BCA; FOD)

Where:
C_D= Credit Demand, the dependent variable. It is a dummy variable defined further as follows:
C_D= 1 if credit is demanded;
C_D= 0 if credit is not demanded.

The study's independent variables were also defined as follows (Table 1). Findings from the quantitative data analysis were subsequently presented using tables and figures.

Qualitative data analysis

A few open-ended questions in the questionnaire allowed the researcher to access some qualitative data for the study to complement and support the main quantitative findings. NVivo was used to analyze the qualitative data through thematic analysis. Word Frequency Analysis was used to identify major themes from the farmers' responses. Findings from the qualitative data analysis were presented through a word cloud in this study.

RESULTS AND DISCUSSION

The findings from the study are presented in this section. The section initially presents and discusses the

Table 2. Credit application status of farmers in Hurungwe District within the Last 12 Months.

Total farmers		Non-applicants by sector		Non-applicants by sex	
n=332		n=312		n=312	
Applicants	**Non-Applicants**	**Model A1 Farmers**	**Model A2 Farmers**	**Males**	**Females**
20	312	278	34	204	108

Source: Primary Data (2019).

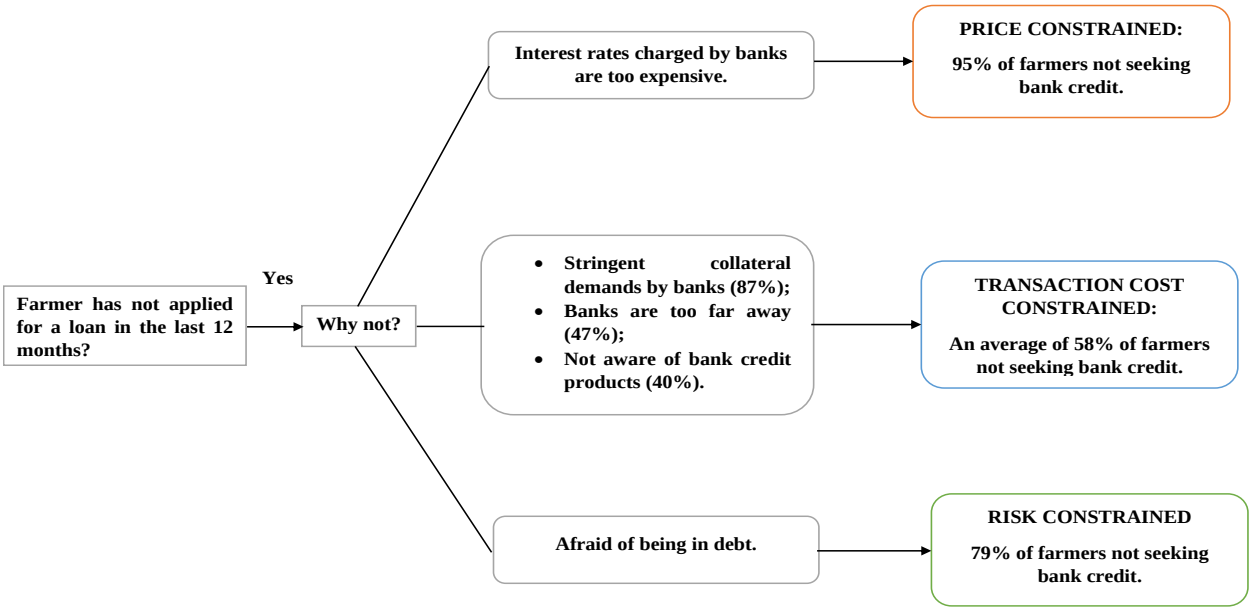

Figure 1. Direct elicitation of credit constraints faced by farmers in Hurungwe District.
Source: Primary Data (2019).

quantitative results before proceeding to present and discuss the qualitative findings.

Credit demand constraints status of farmers in Hurungwe District

Table 2 shows the Hurungwe District farmers' credit application status, which captures their demand for credit. Only 6% of the farmers under study applied for bank credit within the last 12 months (Table 2). Therefore, the majority of the farmers (94%) never applied for any bank loans within the same period. Out of the 312 farmers who never sought bank credit within the last 12 months, the majority (89%) were in the smallholder Model A1 farming sector, whilst a few (11%) were in the commercial Model A2 sector. Among the 20 farmers who applied for bank credit, only one farmer belonged to the Model A1 farming sector. The majority of non-applicants were also males (65%), whilst women comprised a minority 35%. Among the 20 farmers who applied for bank credit, only 5 were women. The minimal participation by Model A1 smallholder farmers in formal credit markets may be attributed to the preference for highly collateralized and bigger Model A2 commercial farmers by most banks in Zimbabwe as confirmed by various studies (FACASI, 2015; Vitoria et al., 2012). Chitungo and Munongo (2015) and Tetteh (2011) also established that men demanded more credit than women because they owned larger plots and possessed egos that compelled them to fight for surplus production, which require increased financial investments, thereby increasing their demand for credit.

The majority (95%) of the farmers in Hurungwe District who never sought bank credit in the last twelve months were price constrained as they lamented that the interest rates charged by local banks were expensive and beyond their reach (Figure 1). The United Nations (2014) and Vitoria et al. (2012) confirmed that interest rates charged on loans in Zimbabwe are high, uncompetitive, prohibitive and only affordable to high income earners, a scenario that was attributed to the liquidity challenges faced by the

Table 3. Model summary.

-2 Log likelihood	Cox and Snell R square	Nagelkerke R square
50.201[a]	0.262	0.717

Estimation terminated at iteration number 8 because parameter estimates changed by less than 0.001.
Source: Primary Data (2019).

entire financial sector. Some 87% of the farmers who never sought bank credit within the past year bemoaned that they lacked the immovable, titled collateral demanded by banks in Zimbabwe. A few (47%) farmers cited distance to the nearest bank as their barrier to seeking bank credit, whilst 40% claimed that they did not know where to apply for bank loans. Therefore, an average of 58% of farmers who never sought bank credit in Hurungwe District was transaction cost constrained (Figure 1). The dominance of collateral as a repellent of participation in credit markets by farmers in Zimbabwe was also observed by various studies, which ascribed it to the change in land tenure from freehold to usufruct rights after the Fast Track Land Reform Program (FTLRP) (Masiyandima et al., 2011; Ministry of Agriculture, 2013; Nyamutowa and Masunda, 2013; Richardson, 2005).

About 79% of the farmers who never sought bank credit in Hurungwe District were also risk constrained as they were afraid of being in debt (Figure 1). Most of the farmers highlighted that they were better-off using the little resources at their own disposal because they feared losing personal possessions if they defaulted, a situation which they felt was likely to happen because of the recurring droughts spells in the country and their high dependence on rain fed agriculture, due to lack of irrigation infrastructure. Several studies confirmed that extreme weather events like prolonged droughts are negatively affecting agricultural production in Zimbabwe and Africa at large, thereby affecting the farmers' ability to forecast with certainty their expected yields unlike other entrepreneurs (Chakoma and Chummun, 2019; Maurer, 2014; Nyamutowa and Masunda, 2013; United Nations, 2014).

Determinants of credit demand among farmers in Hurungwe District

The determinants of credit demand among the farmers in Hurungwe District were analysed using the Binary Logistic Regression model which was employed to predict the likelihood of farmers' credit demand based on a set of explanatory variables.

Binary logistic regression analysis results

The estimated logistic regression model was as follows:

$C_D = 6.675 - 0.675IR - 0.771CR - 0.425LBD - 0.402BCA - 1.075FOD$

Where:
C_D = Credit Demand. The dummy dependent variable
$C_D = 1$ if credit demanded; $C_D = 0$ if credit not demanded.
IR = Interest Rate Price of Bank Loan in dollars ($)
CR = Collateral Requirements Loan collateral value required in dollars ($)
LBD = Lender Borrower Distance of bank's location from the farmer in km
BCA = Bank Credit Awareness that is. Farmer's awareness of loan products offered by banks:
1= Aware; 0= Unaware
FOD = Fear of Debt that is. Farmer's reluctance to borrow due to fear of being in debt:
1= Fear Debt;0= No Fear of Debt.

Overall significance of the model

The Omnibus Test of Model Coefficients results (Chi-square=100.417, df=5, p=0.000) showed that the estimated model was highly statistically significant when compared to a model with the intercept only. This Likelihood Ratio test implies that the addition of explanatory variables to the null model contributed significantly to the model fitness thus enhancing its usefulness for prediction of credit demand status of farmers in Hurungwe District.

Table 3 shows the model summary results. The pseudo R^2 values that is. the Cox and Snell R Square (0.262) and the Nagelkerke R Square (0.717) values derived from the Model Summary results (Table 4) show the amount of variation in the dependent variable, Credit Demand, that is explained by the model. The Coxand Snell R^2 cannot achieve a value of 1 and the Nagelkerke R^2 is a modification that deals with this shortfall. Therefore, based on the Nagelkerke R^2 value, almost 72% of the variation in credit demand by farmers in Hurungwe District could also be explained by the estimated model. Table 4 shows the model's category prediction results which were used to assess the effectiveness of the model's predicted classification against the actual classification of farmers' credit demand.

The overall Percentage Correct Prediction (PCP) was 97.6%. This means that the model, with all the explanatory variables included, correctly predicted almost

Table 4. Classification table showing observed and predicted farmer credit demand classification.

Observed classification		Predicted classification		
		Credit demand		% Famers correctly predicted
		No	Yes	
Credit Demand	No	310	2	99.4
	Yes	6	14	70.0
Overall % Farmers Correctly Predicted				97.6

The cut value is 0.500
Source: Primary Data (2019).

Table 5. Determinants of credit demand among farmers in Hurungwe District.

Explanatory variable	B	S.E.	Wald	p-value	Odds ratio Exp(B)	Inverted odds ratio 1/Exp(B)
Interest rates	-0.675	0.286	5.567	0.018	0.509	2.0
Collateral requirements	-0.771	0304	6.438	0.011	0.462	2.2
Lender borrower distance	-0.425	0.470	0.818	0.366	0.654	1.5
Bank credit awareness	-0.402	0.458	0.772	0.380	0.669	1.5
Fear of debt	-1.075	0.376	8.174	0.004	0.341	2.9
Constant	6.675	1.580	17.843	0.000	792.633	

Source: Primary Data (2019).

98% of the farmers in Hurungwe District in terms of their credit demand status. The sensitivity, which is the percentage of farmers that demanded credit and were correctly predicted by the model (that is, true positives) was 70%. The specificity, which is the percentage of farmers that did not demand credit and were correctly predicted by the model (that is, true negatives) was 99.4%.

Partial significance of individual variable coefficients

The Wald statistic was used to test for the statistical significance of the individual predictor variables. Table 5 shows the logistic regression coefficient B, standard error of B, Wald statistic, p-value and the odds ratio (as implied by the Exp(B)) for each of the predictor variables. Benchmarking with a significance level of 0.05, it was observed that the credit demand partial effects of Interest Rate (p=0.018), Collateral (p=0.011) and Fear of Debt (p=0.004) were statistically significant. However, Lender Borrower Distance (p=0.366) and Bank Credit Awareness (p=0.380) had statistically insignificant effects on the credit demand of Hurungwe District farmers. The following is a discussion of the effects of the individual determinant variables on credit demand.

Interest rates (IR)

Interest rate loan price had a statistically significant but negative effect (B=-0.675, p=0.018) on farmers' credit demand (Table 5). The inverted odds ratio (1/Exp(B)=2) indicates that a marginal unit increase in the loan interest price will double the odds of a farmer not demanding credit, holding all the other variables constant. This coincided with the Law of Demand (Marshall, 1890) and the study's *apriori* expectation that as interest rates increased, less farmers would apply for bank credit. These findings were consistent with various studies that also established an inverse relationship between credit demand and interest rates, for example, Ololade and Olagunju (2013); Ijioma amd Osondu (2015) and Enimu et al. (2018) that were all done in Nigeria. Studies in Zimbabwe also confirmed that interest rates charged by banks in Zimbabwe are high and segregated against poor individuals (United Nations, 2014; Vitoria et al., 2012). However, on the contrary, Sebatta et al. (2014) (Zambia) and Mukasa et al. (2017) (Ethiopia) established a positive association between interest rates and credit demand due to illiteracy challenges among farmers. Farmers in their studies were unable to read and understand market signals, and were also desperate to finance agricultural production inputs even if it meant facing exorbitant interest rates.

Collateral required (CR)

Collateral requirements by banks were a statistically significant (B=-0.771, p=0.011) negative determinant of the farmers' demand for bank credit in Hurungwe District (Table 5). The inverted odds ratio (Exp(B)=0.462) reveals

that the odds of a farmer not demanding credit will more than double by a factor of 2.2 if the collateral requirements are increased by a marginal one unit. This conforms to the study's apriori expectation that as the collateral value demanded by banks increased, the demand for bank credit by farmers would decline. Therefore, this study infers that farmers with low or no collateral endowments have low demand for bank credit in Zimbabwe. The lack of collateral among farmers in Zimbabwe was confirmed by various studies (Masiyandima et al. (2011); Ministry of Agriculture (2013); Richardson (2005)), which ascribed it to the lack of property rights among land reform beneficiaries. Other studies in Zimbabwe also established that local banks demanded upfront immovable collateral before lending to farmers, which created a huge barrier to credit access by the farmers (FACASI, 2015; Masiyandima et al., 2011; Nyamutowa and Masunda, 2013; Vitoria et al., 2012).

Similar to this study's findings, Kedir (2003); Akram et al. (2008) and Ijioma and Osondu (2015) studies identified lack of collateral as the major constraint limiting farmers from seeking agricultural credit in studies in Ethiopia, Pakistan and Nigeria respectively. Some studies in Ghana (Tetteh et al., 2015) and India (Samuel et al., 2015) also established higher demand for bank credit among farmers with higher collateral endowments for augmenting and replacing their capital stock and meeting the demands of all-year round production, especially where there was irrigation infrastructure. However, on the contrary, some scholars established low credit demand among farmers with higher collateral endowments. For example, Korir (2015) (Trans-Nzoia County of Kenya) and Adams (2015) (Ghana) expounded that as the collateral/ asset value in the farm increased, its owners would demand less credit because of their improved wealth and income base that made more money available in the household.

Fear of debt (FOD)

The Wald test showed an extremely statistically significant and inverse effect of Fear of debt (B=-1.075, p=0.004) on credit demand among the farmers in Hurungwe District (Table 5). Inverting the odds ratio (Exp (B)=0.341) showed that when a farmer is in fear of debt, the odds of not demanding credit increased by a multiplicative factor of 2.9. The findings were also aligned with the study's prior expectation that as the fear of debt increased among farmers, their demand for bank credit would decline. Most farmers highlighted that they feared losing their personal possessions if they failed to pay back loans. The farmers foresaw a high likelihood of failure of their agricultural projects because of frequent drought spells that continue to occur in Zimbabwe. This was worsened by their dependence on rainfed agriculture and lack of irrigation facilities especially in Model A1 farming as supported by various studies (Chakoma and Chummun; 2019; United Nations, 2014). Similar findings were obtained in Ghana, where the fear of loan default was the most important reason that prevented farmers from participating in agricultural credit programs (Asante-Addo et al., 2017). In Zimbabwe, Dube et al. (2015) also established that the majority (63%) of farmers not accessing formal credit feared taking the risk that came with borrowing.

Lender-borrower distance (LBD)

Although Lender-Borrower Distance had a negative effect (B=-0.425) on credit demand, it was not statistically significant (p=0.366) among the farmers in Hurungwe District (Table 5). A marginal unit increase in the Lender-Borrower Distance, had the effect of increasing the odds (Exp (B)=0.654) of a farmer not demanding credit by as much as 1.5 times, based on the inverted odds ratio. The results agreed with the study's expectation that as the distance to the bank increased the farmers' demand for bank credit would decline. However, the statistical insignificance of distance on credit demand showed that it was not a barrier to credit demand among farmers in Hurungwe District.

Bank credit awareness (BCA)

Bank credit awareness (B=-1.075, p=0.380) did not seem to increase the likelihood of credit demand in Hurungwe District (Table 5). Contrary to expectations, the inverted odds ratio reveals that farmers, who lacked bank credit awareness, were surprisingly associated with a higher likelihood of credit demand by a factor of 1.5. This anomaly may have been the confounding effect caused by the fact that most of the farmers receive credit passively, not from the banks but indirectly, through integrated value chain financing arrangements. The study had expected a positive relationship between bank credit awareness and the farmers' demand for bank credit. As evidenced by the statistically insignificant result, awareness of bank credit products by farmers does not influence their demand for bank credit in Hurungwe District, all other factors held constant.

Summary of logistic regression results

The Binary Logistic Regression model was employed to test and predict the likelihood of farmers' credit demand based on selected predictor variables among the farmers in Hurungwe District. The estimated model was as follows:

Credit demand = 6.675 - 0.675 Interest rate price - 0.771

collateral requirements -0.425 lender-borrower distance -0.402 bank credit awareness -1.075 fear of debt + error term

The estimated model was statistically significant (Model Chi-square=100.417, df=5, p=0.000) implying that the addition of explanatory variables to the null model contributed significantly to its usefulness in predicting the credit demand status of farmers. Based on the Nagelkerke pseudo R^2 value, the model explained almost 72% of the credit demand variation among the farmers in Hurungwe District. The overall Percentage Correct Prediction (PCP) indicated that the model correctly predicted almost 98% of the farmers in Hurungwe District in terms of their credit demand status.

The Wald statistic was used to test for the statistical significance of the individual predictor variables. Benchmarking with a significance level of 0.05, it was observed that the credit demand partial effects of Interest Rate (p=0.018), Collateral requirements (p=0.011) and Fear of Debt (p=0.004) were statistically significant. However, Lender Borrower Distance (p=0.366) and Bank Credit Awareness (p=0.380) had statistically insignificant effects on the credit demand of Hurungwe District farmers. Interest Rate loan price had a statistically significant but negative effect (B=-0.675, p=0.018) on farmers' credit demand. A marginal unit increase in the loan interest price would double the odds of a farmer not demanding credit, holding all the other variables constant. Collateral requirements by banks were a statistically significant (B=-0.771, p=0.011) negative determinant of the farmers' demand for bank credit. The inverted odds ratio revealed that the odds of a farmer not demanding credit would more than double by a factor of 2.2 if the collateral requirements were increased by a marginal one unit. The Wald test showed an extremely statistically significant and inverse effect of Fear of debt (B=-1.075, p=0.004) on credit demand among the farmers. When a farmer is in fear of debt, the odds of not demanding credit increase by a multiplicative factor of 2.9; although Lender-Borrower Distance had a negative effect (B=-0.425) on credit demand, it was not statistically significant (p=0.366). A marginal unit increase in the Lender-Borrower Distance had the effect of increasing the odds of a farmer not demanding credit by as much as 1.5 times. Bank credit awareness (B=-1.075, p=0.380) did not seem to increase the likelihood of credit demand. Contrary to expectations, farmers who lacked bank credit awareness were surprisingly associated with a higher likelihood of credit demand by a factor of 1.5.

Thematic analysis

Loan processing time emerged as the major theme from the verbatim responses of farmers (Figure 2). Loan processing time was mentioned by all the 33 farmers who provided verbatim responses to open-ended questions 40 times. Farmers bemoaned long loan applications processing time, indicating lack of feedback on the progress or outcome of their applications. These findings were consistent with Ijioma and Osondu (2015), Abdul-Jalil (2015), Enimu et al. (2018) and Filli et al. (2015), whose studies argued that most of the formalities involved in securing loans delayed the release of credit funds to farmers. This resulted in the farmers' failure to meet their primary needs of bank credit like purchasing inputs, managing stock, harvesting and marketing. However, contrary to these findings, loan processing time was found to be insignificant in influencing agricultural credit demand in Rwanda (Musabanganji et al., 2015).

Converging with this study's prior findings, other themes that emerged as barriers of credit demand included the farmers' fear of debt, stringent collateral requirements by banks and the hyperinflationary environment that makes loans more expensive and out of reach of most farmers (Figure 2). These qualitative data analysis findings are supported by the frequency statistics (Figure 1), which showed that 95% of the farmers in Hurungwe District are price constrained due to high interest rates; 79% are risk constrained due to fear of losing their personal possessions in case of loan default; whilst 87% are no longer seeking bank credit due to stringent collateral requirements by banks. Logistic Regression Analysis results also converge with these findings as they established a negative relationship between interest rates, fear of debt, collateral requirements and credit demand (Table 5).

Conclusion

The majority of the farmers in the district were price constrain due to high interest rates. The farmers face high transaction cost constraints due to stringent collateral requirements by banks, as well as risk constraints due to fear of loss of personal possessions in the event of loan default. Interest rates charged by banks, collateral requirements by banks and fear of debt among farmers were the main determinants of credit demand in the Hurungwe District. High interest rates and stringent collateral requirements by banks deterred farmers from seeking bank credit. Due to the stringent collateral requirements by banks, farmers feared losing their personal assets in the event of loan default. Hence, they elected not to participate in credit markets. The long-time taken by banks to process loan applications also made farmers less willing to apply for bank credit.

Recommendations

Policy must make the necessary economic reforms to arrest hyperinflation in the country in order to make bank

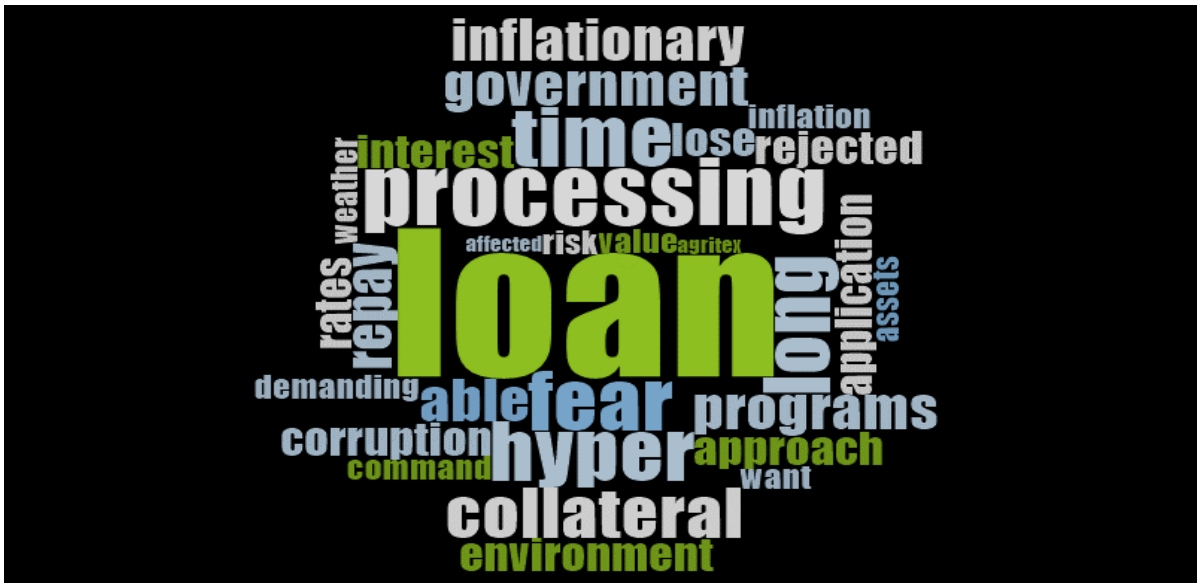

Figure 2. Word cloud output of verbatim responses by farmers on other factors that influenced their demand for bank credit.
Source: Primary Data (2019).

credit and agricultural production inputs affordable to local farmers. Interest rate ceilings must also be restored, whilst educational campaigns to improve financial markets literacy among farmers must be enhanced to protect the farmers from predatory lenders. The prioritization of investments in drought resilience infrastructure like irrigation may also help farmers to enhance and maintain good performance during low or no rainfall periods and lessen their fears of loan default due to poor performance, thereby improving their uptake of the indispensable bank credit. Banking institutions are challenged to relax their demands for collateral to improve the farmers' uptake of bank credit in order to improve production, livelihoods and overall economic performance. Moreover, banks are encouraged to attend to farmers' loan applications with urgency and provide feedback on unsuccessful loan applications to ensure that they address their deficiencies in good time and enhance their chances of credit access in future.

CONFLICT OF INTERESTS

The authors have not declared any conflict of interests.

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