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The relation between financial development, energy consumption and economic growth: empirical evidence for the United States.

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ABSTRACT

This paper examines the relation between financial development, energy consumption and economic growth in the United States (U.S) for the period 1966-2011. We use a vector error correction model (VECM) to investigate the effect of financial development and energy consumption on economic growth in the U.S. In addition to examining the relation in the long run of the aforementioned variables using Johansen co-integration analysis, we also examine the short-run and long-run causalities between them. In addition to economic growth, financial development and energy consumption variables, we also examine the impact of real interest rate, gross fixed capital formation and trade openness on economic growth. We find that there is at least one co-integrating relation among the variables. There is some evidence that in the long run financial development causes economic growth; however, there is no evidence that economic growth causes financial development. Neither do we find evidence that financial development positively affects energy consumption either in the short- or long-run. However, in the short run, we find some evidence of two-way causality between economic growth and financial development.

JEL Classification: O16, E22, E44

Key words: Financial development, economic growth, energy consumption, co-integration, Granger causality.

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1.0 INTRODUCTION

The relation between financial development and economic development is not new. The fact that finance and economic growth is strongly correlated with each other has been well documented in the literature of economic development. However, the results of previous research are mixed and conflicting. This is particularly so when it comes to causality of this nexus.

Levine (2005) provides an intensive review of the theory and evidence about relation between finance and growth. According to Levine (2005), Miller (1998, p.14) once argued that "the idea that financial markets contribute to economic growth is too obvious for serious discussion". In addition, Levine (2005) reports a famous statement made by Robison (1952, p.86) who states that "where enterprise leads finance follows". However, Levine (2005) points out that it was Schumpeter (1934) was the first to consider this relation. Schumpeter contended that financial development causes economic development. Levine (2005) also reports that Gurley and Shaw (1955), Goldsmith (1969), and McKinnon (1973) reject the idea that there is no correlation between finance and economic growth.[1]

Given the sophistication of financial markets in the developed countries as well as the interdependence of the development of the economies across the world and the integration of international financial markets in the past few decades we can cast doubt on the view that finance and growth has no relation. Furthermore, it is difficult to reject the mutual impact of finance and growth. Investment projects and hence economic growth require funding and the role of finance is to mobilising funds within the economy to fund these investment projects. The more efficient the financial markets, the faster the economy will grow because scarce resources will be allocated to the most productive investments.

Alternatively, as the economy grows, it induces the financial sector to develop financial innovations (e.g. derivative securities and modern payment systems) to satisfy the demand of the real economy. The integration of the world economy has led to further developments in financial markets. For example, the modern hedging instruments used by international traders to minimise the impact of risks whilst trading across countries. This demand-led development in financial markets (including stock markets) may be significant.

Caporale et al. (2004) advocate that the relation between banking sector and economic growth, as well as that between stock market development and economic growth, should be examined in a unified framework. Demirgc-Kunt and Levine (1996) note that countries with better-developed stock markets also have better-developed banks and non-bank financial intermediaries. Conversely, countries with weak stock markets tend to have weak financial intermediaries. Levine and Zervos (1998) contend that to understand the relation between the financial system and long-run growth, we need to incorporate both stock market and banks in the study of the finance-growth nexus.

[1] For further discussion, see Levine (2005: 867).

Recently a new line research has emerged focusing on the role of financial development in energy consumption. According to Sadorsky (2010 & 2011) the development of the financial system makes it easier and less costly to obtain funds for households and firms, which stimulate consumption of consumer durables for individuals, and expansion of existing businesses for firms. In both cases, financial development causes demand for energy to increases. Accordingly, we incorporate the impact of financial development on energy consumption and hence economic growth in our study. The latter inclusion has been a growing focus in recent literature on economic growth.

This study uses the latest dataset compiled by the World Bank and contributes to existing literature in two respects. First, we focus on the completeness of the interactions between the financial sector and the real-world economy by incorporating the wealth effect. Second, we incorporate the impact of energy consumption into the finance-growth relation.

Our paper is organised as follows. In section 2, we review existing literature in this area of research. Section 3 describes data and methodology and Section 4 presents empirical results of this study. Section 5 provides concluding remarks and future research direction.

2.0 LITERATUTRE REVIEW

Existing studies can conveniently be divided into: supply-side, demand side, mutual and no relation views of the finance development and economic growth nexus.

2.1 Supply-side view: Supply-side view asserts that financial development causes economic growth.

According to Gurley and Shaw (1955) the financial system is more sophisticated in developed countries. They argue that financial markets can extend a borrower's financial capacity and improve the efficiency of trade. With well-developed financial markets investors can be provided with the necessary funds for their projects. They conclude that financial markets contribute to economic development by enhancing physical capital accumulation. According to Tobin (1969), as share prices increase, firms find it easier to raise funds for their investment expenditure and hence resulting in higher economic output.

Dailami and Aktin (1990) argue that in the long-term, stock markets can play several key roles. First, they can help spread the risks of long-term investment projects and reduce the cost of equity capital and hence stimulating investment and growth. Second, stock markets can contribute to efficient investment by imposing a degree of control over the behaviour of borrowing companies through continuous monitoring of their share prices. Third, by attracting foreign capital portfolio stock markets can increase the supply of funds to domestic companies in emerging economies. Finally, they can contribute to the mobilisation of domestic savings by providing savers an enhancing the set of financial instruments to diversify their portfolios. In doing so, they provide an important source of investment capital with low cost.

Levine (1991) proposes an endogenous growth model in which liquidity and productivity risk elicit the creation of a stock market which in turn changes the incentives of investors in ways that alter steady state growth rates. Levine (1991) identifies innovation as the main channel of transmission between finance and growth. In particular, by separating ownership from management, ownership may be traded without disruption to firms, and permits investors to diversify their portfolios.

According to Pagano (1993) there are three channels that financial development can affect economic growth. First, financial intermediaries can increase the productivity of capital (i.e. investments) and thereby promoting growth by: (i) collecting information and evaluate alternative investment projects; and (ii) induce individuals to invest in riskier but more productive technologies through risk-sharing. Second, an efficient financial sector can reduce transaction costs and hence induces more savings to be channelled into productive investments. In addition, such a sector can improve liquidity of investments. Third, financial development can affect growth by altering the saving rate. However, Pagano (1993) also points out that financial development may also reduce saving and thereby growth.

King and Levine (1993) find that higher levels of financial development are positively associated with faster economic growth, physical accumulation, and economic efficiency. This association holds after controlling for numerous country and policy characteristics. King and Levine (1993) find that the predetermined component of financial development is a good predictor of long-run growth and that finance does not simply follow economic growth. Levine (1997) argues that that financial development promotes economic growth through two channels, namely, capital accumulation and technological innovation.

According to Obstfeld (1994), international risk-sharing through internationally integrated stock markets can improve the allocation of resources and accelerates the process of economic growth. Similarly, Demirgüc-Kunt and Levine (1996) argue that stock markets integrated internationally enhance economic growth by directing savings into superior investments. However, they also point out that greater risk sharing can reduce the need for precautionary saving, and thereby compromise growth. In addition, Demirgüc-Kunt and Levine (1996) argue that well-developed stock markets increase the efficiency of economic growth by aligning owner and manager interests.

Demetriades and Hussein (1996) find that finance is a leading factor in the process of economic growth. However, they also find evidence of bi-directionality and some evidence of reverse causation. Furthermore, they note that the causality patterns vary across countries.

Levine and Zervos (1996, 1998) consider the relation between stock markets, banks and economic growth for 47 countries over the 1976-1993 period. Levine and Zervos (1998: 546) find that "both the initial level of banking development[2] and that of stock market liquidity[3]

[2] Levine and Zervos (1998) use bank credit as an indicator for banking development. They define bank credit as "the value of loans made by commercial banks and other deposit-taking banks to the private sector divided by GDP".

have statistically significant relation with long-run future values of output growth, capital stock growth, and productivity growth even after controlling for many other factors associated with long-run economic performance".

Caporale et al. (2004) find a robust relation between stock market development measured by share value traded ratio and economic growth. They also argue that a well-developed stock market facilitates monetary policy, changes the demand for money pattern, creates liquidity, and encourages economic growth. Likewise, Christopoulos and Tsionas (2004) find that for all of the ten developing countries in their sample, financial depth causes economic growth. In addition, Kiran et al. (2009) find a long run relation between financial depth and economic growth, and also that financial development has a positive and significant effect on economic growth. Finally, Antonios and Athanasios (2013) find that stock market development causes economic growth for the U.S for the period 1970-2012.

There is a distinction between the role of stock market and that of bank on economic growth. Stiglitz (1985) and Boyd and Prescott (1986) argue that banking sector development can play an important role in promoting economic growth, as banks are better than stock markets when it comes to resource allocation. Likewise, Arestis et al. (2001) report that while both banks and stocks markets play an important role in the growth process, banks have a higher effect on economic growth.

Caporale et al. (2004) suggests that stock markets can fund riskier investments that are avoided by banks. The relation between stock markets and growth may also be influenced by the link between stock markets and financial intermediaries. Biswas (2008) argues that stock markets and banks are clearly substitute sources for corporate finance, and that a firm's borrowing needs decline when the firm issues new equity.

2.2 Demand side view: economic growth creates a demand for developed financial institutions and services.

Duca (2007) uses Granger causality test to examine the relation between stock market and GDP and finds that stock market prices and GDP in developed market economies tend to move together. The author finds that periods of economic sluggishness or depression are preceded by the periods of substantial decline in asset prices. He finds that for Japan, France, the US and the UK, causality appears to run only from stock prices to GDP, while for Germany no causality is observed. He attributes this relation to the decline in stock prices reflecting lower expected dividends associated with poorer economic conditions. Moreover, he cites the Permanent Income Hypothesis of Friedman (1957), which states that household expenditure is not only a function of income but also of asset values such as stock holdings. The latter is known as the wealth effect. In view of the contribution of domestic consumption

[3] Levine and Zervos (1998) use two liquidity indicators as stock market development indicators: Turnover and Value Traded. The former is defined as "the value of the trades of domestic shares on domestic exchanges divided by the value of listed domestic shares". The latter is defined as "the value of the trades of domestic shares on domestic exchanges divided by GDP".

to economic growth, the wealth effect could severely affect a country's economic growth when asset prices exhibit major corrections.

Vazakidis and Adamopoulos (2009) examine the causal relation between stock market development and economic growth for France for the period 1965-2007. They argue that a developed stock market enhances liquidity, permits investors to diversify unsystematic risk and increase the return on capital. They find that economic growth Granger causes stock market development in France. Moreover, Koller (2010) reports that since most of the decline in equity markets comes after a recession has already begun, it is changes in economic growth that causes changes in stock markets.

2.3 Mutual relation view: financial development and economic growth are complementary and there is bidirectional causality.

Garcia and Liu (1999) proposed a bi-directional relation between finance and growth. They suggest that economic growth makes the development of financial institutions profitable, while the establishment of an efficient financial system permits faster economic growth. Luintel and Khan (1999) also conclude bi-directionality of the causality between financial development and growth. They find that in the long-run financial depth is positively and significantly affected by the levels of per capita real income and the real interest rate, and that changes in real income have a greater effect on financial development than those in real interest rate. Further support for bi-directional causation between financial development and economic growth is provided by Adamopoulos (2010), Akinlo and Egbetunde (2010), Peetz and Genreith (2011), and Antonios and Athanasios (2013).

Hondroyannis et al. (2005) use error-correction models and find a bilateral causal relation between financial development and economic growth for Greece using time series analysis. Apergis et al. (2007) employed panel cointegration analysis for a sample of 65 countries. They find a positive association between financial depth and economic growth and their results support a bi-directional causality between financial deepening and growth.

Enisan and Olufisayo (2009) use a VAR procedure to examine the relation between stock market development and economic growth. They find mixed causality for different countries. On some occasions, they note that higher economic growth needs greater stock market development and greater stock market activity leads, in turn, to economic growth.

2.4 No relation view: no relation between financial development and economic growth

This view, represented by Lucas (1988) rejects any relation between financial development and economic growth. He claims that role of finance in economic growth is overemphasised by the economists and rejects the existence of a finance-growth relation. Similarly, Graff (2003) claims financial development and growth are not causally related. According to Graff (2003) while modern economic growth is governed by the real sector, the financial development is rooted in the history of financial institutions.

2.5 Energy consumption and economic growth

Financial development can contribute to economic growth through efficient usage of energy. Financial development facilitates better technology diffusion which helps reduce energy intensity, thereby increasing economic growth. Sadorsky (2010) identifies a direct link between financial development and energy consumption. According to Sadorsky development of financial system makes it easier and less costly to obtain funds for households and firms, which stimulate consumption of consumer durables for individuals and expansion of existing businesses for firms. In both cases financial development causes demand for energy to increases. Sadorsky (2010) examines this financial development and energy relation for 22 emerging economies[4] over 1990 – 2006 period. Using generalised methods of moments (GMM) technique he finds that there is statistically significant relation between energy consumption and financial development indicators as measured by stock market capitalization to GDP, stock market value traded to GDP and stock market turnover.

Using a dynamic panel data model Sadorsky (2011) finds that between 1996 and 2006, financial development variables, such as, deposit money bank assets to GDP, financial system deposit to GDP, liquid liabilities to GDP, stock market turnover, have a positive and statistically significant impact on energy consumption in nine Central and Eastern European frontier economies.[5]

Shahbaz and Lean (2012) use a bound test approach and find a long-run equilibrium between energy consumption and financial development. Çoban and Topcu (2013) examine the impact of financial development on energy consumption in 27 European Union countries over 1990 – 2011. Using a system-GMM procedure they find that for the more developed original member countries, financial development, both banking sector development and stock market development, have significant impact on energy consumption; however, in new member countries only banking sector development is found to have significant impact on energy consumption.[6] Shahbaz et al. (2013) find similar results for China. They examine causal link among energy consumption, financial development, international trade and economic growth over 1971 – 2011 periods. Using an ARDL bound testing approach, they find a significant relation among the variables, and particularly, a bi-directional causality between energy consumption and financial development and between energy consumption and international trade.

[4] Argentina, Brazil, Chile, China, Colombia, Czech Republic, Egypt, Hungary, India, Indonesia, Israel, South Korea, Malaysia, Mexico, Morocco, Peru, Philippines, Poland, Russia, South Africa, Thailand and Turkey.

[5] Bulgaria, Croatia, Estonia, Kazakhstan, Lithuania, Romania, Serbia, Slovenia and the Ukraine.

[6] Old member countries: Luxembourg, United Kingdom, Netherlands, Spain, Portugal, Germany, Austria, Belgium, Ireland, Denmark, France, Italy, Finland, Greece, and Sweden. New member countries: Cyprus, Malta, Czech Republic, Slovak Republic, Estonia, Hungary, Bulgaria, Slovenia, Poland, Latvia, Lithuania and Romania.

Despite the extensive research on the finance-growth nexus and the recent focus on finance-energy consumption link, no study has examined the triangular relation among finance, energy consumption and economic growth. We opt to investigate this relation in the context of the USA.

The next section presents data and methodology used in this study.

3.0 DATA AND METHODOLOGY

3.1 Data

We examine the relation between financial development, energy consumption and economic growth for the US for the period 1966 to 2011 using data from the World Development Indicator from the World Bank's database. Supplementary data are sourced from the International Monetary Fund's International Financial Statistics Data CD and Thomson Reuters Datastream.

3.2 Methodology

This study uses the VECM to examine the relation between financial development (which includes stock market development and banking development) and economic growth. We extend this relation by incorporating energy consumption as an additional variable that has an impact on economic growth via its relation with financial development.

We proceed by firstly carrying out unit root tests for all variables data in their levels and first differences. Augmented Dickey-Fuller (ADF) and Kwiatkowski-Phillips-Schmidt-Shin (KPSS) tests are used to test the data series are stationary. For the ADF test, the null hypothesis is that time series contains a unit root and this hypothesis is accepted unless there is evidence against it. In the case of the KPSS test the null hypothesis is that the series has no unit root. Where there is a conflict of test results, we will choose KPSS test as it is known to be more powerful than the ADF test.

Secondly, once the presence of unit roots have been confirmed for all data series, we will determine whether there exists a long-run equilibrium relation among variables. Johansen co-integration analysis is applied to examine whether the variables are co-integrated for the same order taking into account the maximum eigenvalues and trace statistics tests. Finally, Granger causality tests will be applied to find the direction of causality.

If there exists a long-run relation between the variables under consideration, we would expect deviations from this long-run equilibrium to feed back to the changes in the dependent variables (either financial development or economic growth) and force their movements towards the long-run equilibrium. In our model, the effect of interest rate and openness on economic growth and financial development will also be explored. Intuitively, we expect the interest rate to have a negative impact on economic growth and financial development.

3.2.1. Discussion of variables used.

Economic Growth

According to Caporale et al. (2004) existing theory found that development of financial markets was significantly correlated with the level of per capita income (Goldsmith (1969), Shaw (1973) and McKinnon (1973).

Levine and Zervos (1998) use the real per capita GDP growth rate as a proxy for economic growth. The real per capita variable is used because, as Arestis and Demetriades (1996, cited in Biswas 2008, p.236) note, the same errors that affect GDP are also responsible for distortions in population statistics, and therefore are offsetting.

Financial Development

We use three variables to proxy financial development in our study: (1) The liquid liabilities of the financial system defined as the currency plus demand and interest bearing liabilities of bank and non-bank financial intermediaries divided by GDP (i.e. the M3 To GDP ratio) (See Kiran et al., 2009). According to Estrada et al. (2010), the ratio of M3 to GDP measures the relative size of the overall financial depth, consisting of currency plus demand and interest-bearing liabilities of banks and nonbank financial intermediaries. This is the broadest measure of the financial intermediation activity since it covers all banks, central banks, or nonfinancial intermediary activities. (2) Instead of using bank credit (BC) from IMF's International Financial Statistics database, we use bank lending to private sector provided by Datastream which is more consistent in its categorisation than measures provided by the IMF. (3) We use the AMEX index as a proxy for stock market development in our study (Vazakidis and Adamopoulos, 2009). Other researchers (e.g. Estrada et al., 2010; Caporale et al., 2004; and Enisan and Olufisayo, 2009) use stock market capitalization relative to GDP, which gauges the relative size of equity market in an economy. However, Levine and Zervos (1998) indicate that market capitalisation is not a good predictor of economic growth.

Policy interest rate

Interest rate is the price of the use of money and it is expected to have a negative effect on economic growth (Vazakidis and Adamopoulos, 2009). Enisan and Olufisayo (2009) argue that as the discount rate increases, the level of market liquidity is expected to reduce with adverse effects on economic growth and vice-versa.

Energy consumption

Sadorsky's (2010 & 2011) show that there is a positive relation between financial development and energy consumption. Çoban and Topcu (2013) conclude that both banking sector and stock market have significant impact on energy consumption.

Trade Openness

In addition to interest rates, we will also use the trade ratio to proxy for the degree of openness of an economy. We argue that openness is an important variable that links the development of stock markets and national economies during all phases of business cycle (see, for example, Allen (2009) and Baltagi, Demetriades and Law (2009), Mishkin (2009) and Enisan and Olufisayo (2009). It has been shown that openness (proxied by trade ratio) can boost economic activities (economic growth) and influences changes in interest rates in national economies through the balance of payments (see Baltagi, Demetriades, Law (2009) for example).

Enisan and Olufisayo (2009) argue that the omission of other variables could have a great impact on economic growth and could bias the direction of causality between stock market development and economic growth. Accordingly, they included two control variables (discount rate and openness ratio) to avoid simultaneous bias in their regressions.

Investment

Adenuga (2010) uses the ratio of gross fixed capital formation to nominal GDP to proxy the investment ratio. King and Levine (1993) explore the channels through which financial development is linked to growth by examining two sources of growth. One of which is the rate of capital accumulation measured as both as an estimate of the per capita growth rate of physical accumulation and the ratio of investment to GDP.

Rousseau and Wachtel (2000) find that stock market liquidity and the intensity of activity in traditional financial intermediaries stimulate growth on per capita output. Beck and Levine (2004) find that both stock market liquidity and banking development are important for economic growth. Enisan and Olufisayo (2009) measures economic growth by per capita nominal GDP and stock market development by the size and liquidity level of stock market. For the size of stock market they use the market capitalisation ratio (the ratio of the value of listed shares to GDP) and for liquidity they use the value traded ratio (which equals the total value of shares traded on the stock exchange divided by GDP).

Adamopulos (2010) measured economic growth by the rate of change of real GDP and the credit market development is expressed by the domestic bank credits to private sector (BC) as a percentage of GDP. Adamopoulos (2010) reasons that BC more accurately represents the role of financial intermediaries in channelling funds to private sector than other monetary aggregates. Adamopoulos (2010) also uses the general stock market index as a proxy for stock market development, and employs industrial production index (IND) to measure the growth of industrial sector and its effect on economic growth.

[Insert Table 1]

4.0 EMPIRICAL ANALYSIS

Unit root tests

The ADF test results reported in Table 2 strongly support the non-stationary nature of the data, which is supplemented by KPSS test results. In the ADF test, the null of unit root at level is not rejected, whereas, at first difference the null is rejected at a very high significance level. This finding is supported by KPSS test results, where null of stationary is rejected at level and not rejected at first difference. These results indicate that we cannot run the simple OLS regression. Simple OLS with non-stationary variable might produce spurious results. We, therefore, next proceed to examine the long-run relation among the variables through co-integration analysis.

[Insert Table 2]

Co-integration Test Using Johansen-Juselius Technique

Next, we use the Johansen-Juselius technique to test the co-integration of our data series. First, we determine the optimal lag length that would give normally distributed errors. In addition, autocorrelation and heteroskedasticity was quarantined from our analysis. The rule of thumb for selecting the optimal lag length is based on the majority of selected lag length by the following criteria: Akaike Information criterion (AIC), Schwarz information criterion (SIC), Hannan-Quinn information criterion (HQ), Final Prediction Error (FPE) and sequential modified LR test statistic. The LR and HQ criteria select two lags, the SIC chooses one lag and the AIC and the FPE criteria indicate four lags. We decided to choose two lags because the model is only stable with the two-lag length.

Johansen (1988) and Johansen and Juselius (1990) proposed two test statistics for testing the number of cointegrating equations: the trace (λ_{trace}) and the maximum eigenvalue (λ_{max}).

$$\lambda_{\text{trace}}(r) = -T \sum_{i=r+1}^{p} \ln\left(1 - \widehat{\lambda}_i\right)$$

where $\hat{\lambda}_i$ is the largest estimated value of ith characteristic root (i.e. eigenvalue) obtained from the estimated matrix, r =0,1,2,....., p-1, and T is the number of usable observations. The λ_{trace} statistic tests the null hypothesis that the number of distinct characteristic roots is less than or equal to r (0,1,2...p-1) against the general alternative.

$$\lambda_{\text{max}}(r, r+1) = -T \ln\left(1 - \widehat{\lambda}_{r+1}\right)$$

The λ_{max} statistic tests the null hypothesis that the number of cointegrated vectors is r against the alternative of (r+1) cointegrated vectors.

[Insert Table 3]

Johansen co-integration test results in Table 3 report two test statistics – trace and maximum eigenvalue. According to the trace statistic the null of at least two co-integrating equations is rejected at 5% significance level, which indicates that there are three co-integrating relations among the variables. However, according the maximum eigenvalue statistic there is only one

co-integrating relation among the variables under consideration. Since the maximum eigenvalue is considered to be more powerful than the trace statistic, we use the results from the former test statistic.

Next, we build a vector error-correction model (VECM) for our data series. In this model, in the short run, deviations from the assumed long-run equilibrium will feed back to the changes in the dependent variables to force their movements returning towards the long-run equilibrium state. More specifically, the equilibrium relation among our endogenous variables will prevail over the long run. We focus on what causes changes in economic growth. Our VECM can be specified as follows:

$$\begin{aligned}\Delta \text{rpcgdp}_t = \beta_0 &+ \sum_{i=1}^{k-1}\beta_i \Delta \text{rpcgdp}_{t-1} + \sum_{i=1}^{k-1}\alpha_i \Delta \text{amex}_{t-i} + \sum_{i=1}^{k-1}\delta_i \Delta \text{trdgdp}_{t-i} + \sum_{i=1}^{k-1}\varphi_i \Delta \text{gfcgdp}_{t-i} \\ &+ \sum_{i=1}^{k-1}\varphi_i \Delta \text{rirate}_{t-i} + \sum_{i=1}^{k-1}\gamma_i \Delta \text{blgdp}_{t-i} + \sum_{i=1}^{k-1}\eta_i \Delta \text{m3gdp}_{t-i} + \sum_{i=1}^{k-1}\lambda_i \Delta \text{enercons}_{t-i} \\ &+ \pi \text{ECM}_{t-1} + \varepsilon_t \qquad (1)\end{aligned}$$

where *rpcgdp* = real per capita GDP, *amex* = American exchange index, *trdgdp* = the ratio of trade (i.e. export + import) to GDP, *gfcgdp* = the ratio of Gross Fixed Capital (GFC) to GDP, *rirate* = real interest rate, *blgdp* = ratio of bank lending to private sector to GDP, *m3gdp* = ratio of M3 to GDP, *enercons* = energy consumption (measured by energy use in kg of oil equivalent per capita), *ECM* = Error correction term and Δ indicates the first difference of a series. In equation (1) above we have *rpcgdp* on the left-hand side. Similar equations can be specified for the remaining seven variables putting them on the left-hand side one by one.

In the equations above, the coefficient of the ECM variable contains information whether the past values of variables affect the current values of the variables in equation. The size and statistical significance of the ECM coefficient measures the tendency for each variable to the equilibrium. In terms of causality, a significant and negative ECM term indicates that causality runs from the independent variables to the dependent variable in the long run. In addition, the short run dynamics are captured through the individual coefficients of the difference terms (See Akinlo and Egbetunde (2010: 21)). Significant short-run coefficients indicate short-run causality running from the independent variables to the dependent variable. The results of VECM are reported in Table 4. From the results we find evidence on long-run causality in *rirate, amex,* and *m3gdp* equations only. Out of three, two financial development indicators (*amex, & m3gdp)* are influenced in the long run by the independent variables. Short run causality results indicate that only *amex* is caused by per capita GDP and the effect is positive; however, *blgdp* is negatively influenced by per capita GDP. This might be the case that as income increases and stock market develops; firms find it convenient to raise funds from by issuing shares rather than going to bank. However, we do not find any evidence on short or long run causality running towards *rpcgdp*. Our finding, therefore, supports the demand side view of the finance-growth nexus. A summary of the short-run relations is provided in Table 5.

[Insert Table 4]

In contrast to the arguments, and finding of Sadorsky (2010 & 2011), we do not find any evidence that financial development causes energy consumption. However, this difference is understandable. Sadorsky (2010 & 2011) study frontier and emerging economies. These economies are obviously at different levels of economic development compared to the USA. Accordingly sensitivity of consumer durables to the level of financial development in the USA is different from those of frontier and emerging economies. In the USA, consumer durables (such as, automobiles, refrigerators, air conditioners, washing machines and other white goods) are essentials and hence less sensitive to the level of financial development, whereas, in growing economies these items are considered as luxury items and highly sensitive to the availability of fund to purchase them.

[Insert Table 5]

5.0 CONCLUSION

This paper examines the relation between financial development, energy consumption and economic growth for the United States over the period 1966-2011. In addition to economic growth, financial development and energy consumption variables, we also examine the impact of real interest rate, gross fixed capital formation and trade openness on economic growth. Using standard unit root test we find that all the variables are non-stationary at level and stationary at their first differences, which led us to check co-integration among the variables. We use Johansen procedure and find that there is one (three) co-integrating relation among the variables according to max-eigenvalue (trace) statistic. Next we use a Vector Error Correction Model (VECM) to study the causality between these variables both in short and long run.

According to the long-run causality results, we find evidence to support the supply-side hypothesis in two out of three financial development equations. The error correction terms in the stock market development (*amex)* and liquidity (*m3dgp)* equations are found to be highly significant with expected negative signs. However, we do not find any evidence of demand-side hypothesis, that is, error correction term is the per capita GDP (*rpcgdp*) equation is found to be insignificant with the incorrect sign.

According to short-run causality results, we find some evidence supporting both demand and supply side hypotheses. The results show that there is bi-directional causality between stock market development (*amex*) and economic growth (*rpcgdp*) and uni-directional causality from liquidity (*m3gdp*) to economic growth (*rpcgdp*). We also find uni-directional causality from economic growth (*rpcgdp*) to bank lending to private sector (*blgdp*); however, the short-run coefficient is significantly negative. This negative sign may be due to the competition between the stock market and the banking sector as alternative sources of finance for firms. Accordingly we argue that as the stock market develops and the economy grows, firms find it convenient to raise funds by issuing shares, rather than borrowing from banks to fund investments.

We do not find any evidence of long-run or short-run causality running to the energy consumption (*enercons*) variable. This is inconsistent with what Sadorsky (2010 & 2011) find. However, this difference may be attributed to the difference in the level of economic development of the sample countries in Sadorsky (2010 & 2011) and the present study. In addition, we find that there is negative causal relation running from energy consumption to bank lending (*blgdp*), which is puzzling and provides an avenue for further research.

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Table 1. Definition of Variables	
Variable	Variable Definition
AMEX	American Stock Exchange
BLGDP	Ratio of bank lending to private sector to GDP
ENERCONS	Energy consumption measured by energy use in kg of oil per capita.
GFCGDP	Gross fixed capital formation to GDP
M3GDP	Liquidity measure using M3 money supply to GDP
RIRATE	Real interest rate
RPCGDP	Real per capita GDP
TRDGDP	Ratio of trade = (export + import)/GDP

Table 2: ADF and KPSS Unit Root Test Results						
Variable	ADF			KPSS		
	Level	1st Difference	Remarks	Level	1st Difference	Remarks
Rpcgdp	I(1)	I(0)***		I(1)***	I(0)	
Energy	I(1)	I(0)**		I(1)***	I(0)	
Gfcgdp	I(1)	I(0)***		I(1)***	I(0)	
M3gdp	I(1)	I(0)***		I(1)***	I(0)	
AMEX	I(1)	I(0)***		I(1)***	I(0)	
Blgdp	I(1)	I(0)***		I(1)***	I(0)	
Trdgdp	I(1)	I(0)***		I(1)***	I(0)	
Rirate	I(1)	I(0)***		I(1)***	I(0)	

[Insert Table 3]

Table 3: Johansen and Juselius Co-integration Tests				
Testing hypothesis	λ_{trace}	Critical value at 5%	λ_{max}	Critical value at 5%
$r = 0$	213.475***	159.529	75.835***	52.362
$r \leq 1$	137.640***	125.615	41.490	46.231
$r \leq 2$	96.148**	95.753	33.850	40.077
$r \leq 3$	62.299	69.818	24.036	33.876
$r \leq 4$	38.262	47.856	21.605	27.584
$r \leq 5$	16.657	29.797	11.143	21.131
$r \leq 6$	5.513	15.494	5.508	14.264
$r \leq 7$	0.0048	3.841	0.0048	3.841

Table 4: Temporal Causality									
	Short-run causality								Long-run causality
	ΔRPCGDP	ΔRIRATE	ΔENERCONS	ΔBLGDP	ΔAMEX	ΔTRDGDP	ΔGFCGDP	ΔM3GDP	ECM_{t-1}
ΔRPCGDP	0.445899***	0.002607	-9.748150	-2.03E-05	0.028268**	-1.22E-05	2.94E-05***	0.000101*	0.003544
	[4.29350]	[1.57370]	[-1.09867]	[-1.55148]	[1.99051]	[-0.62647]	[3.88261]	[1.67021]	[1.45415]
ΔRIRATE	5.252617	0.179607**	-74.65741	0.001476**	-0.226996	-6.72E-06	-0.000131	0.002337	-7.45E-05*
	[0.95090]	[2.03850]	[-0.15820]	[2.11538]	[-0.30052]	[-0.00648]	[-0.32515]	[0.72789]	[-1.91564]
ΔENERCONS	0.001505	-6.67E-06	0.682738***	1.87E-07	-7.22E-05	3.14E-07	2.13E-08	2.90E-07	0.230518
	[1.32364]	[-0.36766]	[7.03044]	[1.30470]	[-0.46446]	[1.47208]	[0.25718]	[0.43905]	[1.10719]
ΔBLGDP	-1361.760***	8.400536	-144240.4***	0.301872***	181.4101**	0.119188	-0.027919	0.311235	2.23E-06***
	[-2.33007]	[0.90116]	[-2.88884]	[4.09003]	[2.27000]	[1.08650]	[-0.65541]	[0.91611]	[7.25841]
ΔAMEX	2.337778***	0.018199*	83.78052	-0.000295***	0.540851***	0.000774***	7.37E-05	0.001153***	-0.001144***
	[3.61635]	[1.76499]	[1.51698]	[-3.61644]	[6.11845]	[6.37564]	[1.56375]	[3.06901]	[-3.43360]
ΔTRDGDP	-1084.628***	-7.582608	-46650.83	0.079760	-107.4114**	-0.071093	-0.031317	-0.236682	-4.07E-07
	[-2.77903]	[-1.21803]	[-1.39907]	[1.61820]	[-2.01261]	[-0.97044]	[-1.10089]	[-1.04320]	[-0.88951]
ΔGFCGDP	1809.891	66.83261***	143254.3	-0.391102***	-24.33164	0.184294	0.106846	1.633735**	1.02E-07
	[1.58984]	[3.68058]	[1.47291]	[-2.72036]	[-0.15630]	[0.86247]	[1.28768]	[2.46872]	[0.57488]
ΔM3GDP	11.75697	0.719286	-3930.468	0.043562**	-5.470095	0.092229***	7.32E-05	0.207292**	-5.64E-06***
	[0.07192]	[0.27587]	[-0.28144]	[2.11015]	[-0.24472]	[3.00587]	[0.00614]	[2.18145]	[-3.98218]

Table 5: Short-run causality.		
Variable	Cauality sign	variable
RPCGDP	+ ⟷	AMEX
RPCGDP	- →	BLGDP
RPCGDP	- →	TRDGDP
GFCGDP	+ →	RPCGDP
GFCGDP	← +	RIRATE
M3GDP	+ →	RPCGDP
M3GDP	→ +	AMEX
M3GDP	→ +	GFCGDP
BLGDP	+ →	RIRATE
BLGDP	→ -	GFCGDP
BLGDP	+ →	M3GDP
AMEX	+ →	BLGDP
AMEX	- ←	BLGDP
ENERCONS	- →	BLGDP
TRDGDP	+ →	AMEX
TRDGDP	← -	AMEX
TRDGDP	+ →	M3GDP