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Role of Innovation in the Energy Sector for Enhancing Export Performance and Economic Growth

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Abstract: *Innovation in the energy sector plays an important role in enhancing the export performance and economic growth of the country. In this conceptual paper, we make a difference between innovation within the industry from innovation outside the industry, and their impact on the export performance and economic growth of the country. The most essential aspects of conceptualized relationships are that innovations in the energy sector i.e. electricity sector can significantly improve the economic growth of the country and the export performance of manufacturing organizations. The energy consumption theory and neo-classical theory involves in order to explain economic growth in the prospect of innovation. It is identified that by making innovation in the energy sector, it becomes possible for the government to overcome the tariff rates of electricity, which ultimately reduces the production cost of organizations, and enhances the export performance and economic growth of the country.*

Key Words: Economic Growth, Export Performance, Innovation

JEL Classification:

Introduction

In today's economy, innovation in the energy sector is the most important resource for a country's development and to gain a competitive advantage in a dynamic business environment (Ahmad & Ahmad, 2018; Lee, 2006). Without energy consumption (electricity consumption), it is difficult to improve the productivity of the agriculture and industry sector and to make improvements in the education system and healthcare services (Lee, 2006). Energy is the most important strategic commodity to gain economic growth and it is identified that there is a strong positive relationship between economic growth and energy consumption (Sahir & Qureshi, 2007). Previously, many studies have been done to identify the impact of energy consumption on economic growth in developed and developing countries. In the case of developed countries, there is a mixed result of the impact of energy consumption on economic growth (Altinay & Karagol, 2004; Lee, 2006; Soytas & Sari, 2003) while in the case of developing countries, it is identified that there is a significant relationship between economic growth and energy consumption

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(Masih & Masih, 1997). The difference in findings between developed and developing countries is due to the difference in economic structure and dependency on the energy sector (Sari, Ewing, & Soytas, 2008). It is very important for policymakers to identify the causality relationship between energy consumption and economic growth, as it enables them to make a decision according to the nature of the relationship. Policymakers have to focus on the energy-dependent policy if the consumption of energy enhances economic growth, while they have to focus on an energy protection policy if the consumption of energy become unable to enhance economic growth. Aligning the right policy plays a vital role to enhance economic growth (Apergis & Payne, 2009).

Economic growth is the percentage rate of change in the gross domestic product (GDP), which reflects the value of a country's productivity and the monetary value of goods, and services produced over a specific period of time in a country (Wolde-Rufael, 2005). The neo-Classical model which is also known as the Solow-Swan growth model, explains the economic growth of a country by taking the productivity growth of organizations as an important determinant rather than taking capital and level of savings(Yoo & Kwak, 2010). The neo-classical theory focuses on three factors: labour, capital and technology, more specifically technological advances as the most important determinant of industry output (Yoo & Kwak, 2010). The theory explains that an equilibrium state can be accomplished by varying the amounts of labour and capital in total factory production along with technological advancement that puts a major impact on economic growth, which was constant in classical growth theory by considering technological advancement happen by chance (Kirbach & Schmiedeberg, 2008). Researchers have to put more focus on the use of the neo-classical model as a cause of economic growth by estimating the effect of capital, labour and technological change (Kirbach & Schmiedeberg, 2008).

Traditionally, researchers consider labour, land and capital as important production factors (Cleveland & Stern, 2002), while in the current dynamic environment, energy is also been considered an important production factor for organizations around the world (Agency, 2009). Many studies have been done to identify the role of energy in economic growth, and it is identified that energy is the most important factor for economic growth due to production function, which is the complementary part of every organization (Altinay & Karagol, 2004; Lee, 2005; Shiu & Lam, 2004; Stern, 2000). Researchers try to explain the performance of economic growth between different countries by using the relationship between economic growth and export performance. Export performance as an important determinant of economic growth is not new and it relates to Adam Smith and David Ricardo's economic theories, which argue that trade export across the global market plays a significant role in the growth of a country's economy (Lee, 2006).

Innovation in the energy sector can reduce energy (electricity) tariffs and can improve the export performance of manufacturing organizations by reducing production costs, but it is very complex to identify the amount of these economic benefits(Hartley & Medlock, 2005). Innovation in the energy sector (wind, solar, coal, biomass and nuclear power production) is helpful to overcome the unit production cost of the organization (Hartley & Medlock, 2005) and is very much needed because more than 70% of the total production of electricity in Pakistan is through fossils fuels(M. A. Khan & Ahmad, 2008). Fluctuations in oil prices across the globe increase the tariff rate of electricity and it becomes eventually impossible for organizations to keep the cost of the product under control (Hartley & Medlock, 2005). Innovation in the energy sector of Pakistan is very much needed because the world economy enters a regime, where efficiency in the production system and low unit production cost is very essential in order to compete at the domestic level as well as at the international level (Sahir & Qureshi, 2007). Innovation in product and services are increasing in many businesses due to the dynamic environment and fast-paced

economy, and it becomes more difficult for organizations to compete in the era of globalization and innovation (Khoshroo, Mulwa, Emrouznejad, & Arabi, 2013). Organizations can sustain their economic growth by making innovations in their product and services, and through innovation in other sectors i.e. energy sector (Higgins, 1996).

Research Objective

The objective of this research paper is to identify the role of innovation in the energy sector in enhancing economic growth and export performance.

Research Question

1. How innovation in the energy sector can improve the economic growth of Pakistan?
2. How innovation in the energy sector can improve the export performance of Pakistan?

Significance of the Study

The energy sector plays a significant role in order to achieve sustainable development in three dimensions: economic, social and environmental dimension (Kirbach & Schmiedeberg, 2008). The energy sector is not only the determinant for developed countries but it is also for developing countries in order to compete in the global economy (M. A. Khan & Ahmad, 2008). The energy sector is underdeveloped in Pakistan, due to which economic activities in the country are not flourishing as much (electricity shortages put an adverse impact of 2% per year on GDP). The energy crisis (electricity shortage) has an adverse impact on economic growth and this influence is not only on the manufacturing sector but also on the service and agriculture sectors of Pakistan (Hye & Riaz, 2008). The main reasons for the energy crisis in Pakistan are the increase of energy consumption by 8% per annum due to high population growth, extensive migration to urban areas, advancement of technology in the agriculture sector, giving access to un-served consumers (give access to 86% of the total population) and move more towards industrialization, while the investment in the energy sector is less than 2% per annum (Amjed, Shah, & Riaz, 2022; Filippini & Pachauri, 2004). In past, many studies have been done in order to identify the impact of energy consumption on economic growth and there has been limited research, which highlights the impact of energy crisis and innovation on economic growth and export performance. This research paper helps to identify how innovation in the energy sector is helpful to flourish the economic growth of Pakistan.

Literature Review

Innovation in Energy Sector

Innovation is the application of a new idea, new process and better solution by meeting the requirements of new markets as well requirements of existing markets. Innovation in the energy sector can significantly reduce energy tariffs and can improve export performance and economic growth by reducing production costs, but it is very complex to identify the amount of these economic benefits (Hartley & Medlock, 2005). Innovation in the energy sector (solar, wind, biomass, coal and nuclear power production) is helpful to overcome the unit production cost of organization and is very much needed because more than 70% of the total production of electricity is through fossils fuels (Hartley & Medlock, 2005). Fluctuation in oil prices increases the tariff rate of electricity and it becomes eventually impossible for the organizations to keep the cost under control (Mahmood & Siddiqui, 2000).

To produce innovative products at lower cost demands the availability of electricity at a low cost and in an efficient manner. Electricity shortage has an adverse impact on economic growth due to load-shedding in the service and industrial sectors (M. A. Khan & Ahmad, 2008). In Pakistan, the energy crisis starts two decades ago, when the energy policy in 1994 is adopted to rely more on fuel rather than hydropower, which results in the shape of high generation costs and tariffs rate. In the 1980s, Pakistan produce more than 60% of its electricity from hydropower, while in 1994

power policy encourage foreign investors to quickly install a fuel-based thermal plant and overcome the energy crisis. Privatization was also the part of 1994 policy to give autonomy to companies that are responsible for generation, distribution and transmission. This strategy enhances the production capacity by about 8 per cent annually between 1994 and 2005, while the production of electricity instead of this capacity is very low. Pakistan's economy is not flourishing as much as it has potential due to the high demand for electricity and less investment in the energy sector (Hinnant & O'Looney, 2007). To enhance economic growth and export performance, the Pakistani government have to invest more in the energy sector and have to make innovation in the energy sector in order to reduce the tariff cost of electricity and make competition possible for the domestic industry in the global economy.

Factors contributing to the energy crisis are physical shortages (Supply not increasing with the demand of 8% per annum), financial shortfalls (power companies are unable to cover the cost of supply due to subsidies given by the government to consumers) and government crisis (unable to compel profitable discipline in government institutions and their performance is below the level than other countries), high population growth, extensive migration to urban areas, advancement of technology in the agriculture sector, giving access to un-served consumers (access to 86% of the total population while 60% of the population access to energy consumption) and moves more towards industrialization(Filippini & Pachauri, 2004).

The high cost of electricity production is the main reason for the electricity shortage in Pakistan and results in the shape of low industrial sector contribution to economic growth. Continuous electricity supply is an important factor of economic growth and according to the rule of thumb, a manufacturing organization utilizes 33% of the production cost of a product in terms of the price of energy (Masih & Masih, 1996). The production cost of organizations affects by increases in tariffs of electricity and organizations reduce the labour cost to minimize the cost of production in order to compete in the global market. From 2008 to 2010, the energy crisis reduces the productivity of industry very much and resulted in the shape of high poverty and unemployment among labourers (B. Khan, 2010).

Consequences of Energy Crisis

Energy crisis results in the shape of different consequences: economic (energy crisis influences all over the economy in the shape of low GDP growth, increase in prices of commodities and decrease in productivity of the industrial sector as well as the agricultural sector), the industrial sector (cost of production increases due to which firms are unable to compete in international market and results in the shape of shifting of production units to other countries or closing the production units in Pakistan), agricultural sector (productivity decreases due to not consistently running tube wells and machinery), unemployment (energy crisis increase the unemployment ratio due to closing of industrial unit production), poverty (40% of Pakistan population are living below the poverty line and it increases due to low GDP growth, unemployment, low industrial and agriculture growth) and social issues (energy crisis increases the frustration among the public).

The alternate energy development board of Pakistan makes a policy in 2006 to rely more on solar, wind, coal and nuclear electricity production plant as an alternative to fuel and gas electricity production plants (Haq, Nazli, & Meilke, 2008). Alternate electricity production plants can produce cheap electricity (6 rupees per unit as compared to 12 rupees per unit from fuel and gas plants) and are more efficient as compared to fuel and gas plants (Haq et al., 2008). Natural gas is the main source to produce electricity in Pakistan but due to the continuous reduction of this resource, electricity production companies start to depend more on crude oil which is relatively more expensive than natural gas in order to produce electricity (Hartley &

Medlock, 2005). To overcome the energy crisis, it is necessary to invest more in alternate and cheap sources that are accessible inside the country. This requirement can be fulfilled by solar, wind and biomass resources, which are available in enough amounts to overcome the energy crisis and tariff rate in order to support the industry sector as well as the agriculture sector in Pakistan.

Economic Growth

Economic growth is the percentage rate of change in the gross domestic product (GDP), which reflects the value of a country's productivity and the monetary value of goods, and services produced over a specific period of time in a country (Ahmad & Ahmad, 2018). The role of technological advancement in enhancing the growth of the country's economy is well documented and previous studies segregate the output growth into two mechanisms. One mechanism is recognized for the growth of primary input factors like labour and capital, while another mechanism is recognized for technological change or advancement (Yoo, 2005). The country's industry is the main pillar of economic growth and the production process of the industry is dependent on the continuous supply of energy (Yoo, 2005).

There are five types of theories related to economic growth: classical theory, neo-classical theory, modern-day theory, Schumpeterian theory and energy consumption theory (Yoo & Kwak, 2010). Classical economic theory is the combined work of David Ricardo, Thomas Robert Malthus and Adam Smith in the nineteenth century. The theory states that every economy has a steady state GDP and any deviation in that state is temporary and will eventually return. The theory is based on the concept that the growth in GDP is due to an increase in labour and capital (factor of production) and the main criticism of this theory is that it takes technological change as constant, which is the most important factor contributing to economic growth (Yoo & Kwak, 2010). The neo-Classical theory is the combined work of T.W. Swan and Robert Solow which makes an important contribution to economic growth theory in developing the Solow-Swan growth model. The neo-classical theory focuses on three factors: labour, capital and technology and more specifically technological advances as the most important determinant of output (Yoo & Kwak, 2010). The theory explains that an equilibrium state can be accomplished by varying the amounts of labour and capital in the total factory production with technological advancement or technological discontinuity that puts a major impact on economic growth (which was constant in classical growth theory) and this technological discontinuity will be happening by chance. This theory also states that when technological advancement or new technology is available to the country, then the capital and labour are needed to adjust in order to continue growth equilibrium, and economic growth will not keep on until the technological advancement continues. Modern-day theory argues that technological advancement or innovation cannot have happened by the chance and it depends on the worker how hard they are looking and in search of new innovation (Ahmad & Ahmad, 2018). Schumpeterian Growth theory argues that growth occurs as the outcome of innovation and creative destruction by making old products or technologies obsolete (Ahmad & Ahmad, 2018). Energy consumption growth theory argues that consumption of energy and efficiency in energy impacts the growth of the economy. Energy consumption theory, Schumpeterian theory and neo-classical theory are very helpful in order to understand innovation in the energy sector and its impact on economic growth (Yoo & Kwak, 2010).

Export Performance

Export performance is the comparative achievement and failure of firms' or nations' efforts to sell the domestic product and services in other countries and to gain an advantage by using its resources in a global world at a specific time period (Theodosiou & Leonidou, 2003). Previously, many studies have been done in order to identify the determinants of export performance and some

determinants of export performance are firm-specific (internal factors) while others are environmental factors (Moini, 1995). Studies that examine the internal factor are grounded in a resource-based view approach and presume that the organization's export performance is under the control of management, firm characteristics, firm competence (technology and quality control) and export strategy (Theodosiou & Leonidou, 2003). Resource-based view argues that immobile resources controlled or owned by a firm are the source to get superior performance (Theodosiou & Leonidou, 2003). Studies that examine external factors (market-specific and industry-specific) are grounded in contingency theory and presume that organizations will survive when they adapt or align with the external environment, which will lead the organization to superior performance (Robertson & Chetty, 2000). Export performance is a significant and important tool for organizations to increase their growth in a competitive environment and to sustain their competitive edge (Leonidou, 2004).

Historically since the 1980s, the manufacturing sector of Pakistan having a good economic growth record this growth slowed down after 1995 due to the energy crisis, total factor productivity growth, political instability, agriculture production variation due to weather conditions and not adopting the trade liberalization regime (M. A. Khan & Ahmad, 2008). Pakistan's major exports are cement, textile, chemical, engineering, sugar, rice, wheat, vegetables and sports goods sector. The textile industry of Pakistan is the biggest sector whose contribution is more than 60% to total export and also has the largest contribution of more than 46% in the manufacturing sector. The textile sector of Pakistan contributes 8.5% to the GDP and provides 38% of the labour force in the country. From 2007 to 2009, the Textile industry growth decreases and the cost of production increased (fixed cost remains the same but production of the textile industry decreases) due to the severe energy crisis and export of Pakistan's textile industry badly affected by the international markets (Kamran, 2018). The textile industry mostly orders transfer to other countries like Srilanka and Bangladesh due to a decrease in production capacity and energy crisis. The textile and cement sector is the major part of the export sector and the decline in performance put a diverse effect on 2% GDP per annum due to the energy crisis (Kamran, 2018). The reason for bearing huge losses in the textile, cement and engineering sector is that these sectors are totally electricity-intensive equipment and due to the severe energy crisis, their production and output decreases to 6% per year (Ghaus-Pasha, Pasha, & Zubair, 2010). The sugar, chemical and sports goods industries did not bear such huge losses because the sugar sector is a seasonal production sector and has its own electricity production plant, while the chemical and sports goods sector is not fully dependent on electricity consumption as other sectors are dependent (Kamran, 2018).

Relationship between Innovation, Export Performance and Economic Growth

Production cost is the main factor that influences the export performance of an industry (Skumatz & Dickerson, 1999). Production cost relates to what actually the manufacturing cost of a product is in the organization and this production cost can be reduced by focusing on main production integral parts like labour, factory overhead, material, and energy supplies (Zsidisin, Ellram, & Ogden, 2003). Cost of production or operating cost increases due to the unavailability of electricity and high tariff rates that result in the shape of reducing organization competitiveness within the region (Zsidisin et al., 2003). Firms lose the opportunity to increase production and to improve their competitiveness in the global market due to the unavailability of electricity supply and poor power quality which results in the shape of damage to equipment (Zsidisin et al., 2003). Continuous electricity supply and availability of electricity at lower tariff rates are very necessary for organizations in order to achieve efficiency in their production system (Mohamed & Bodger, 2003).

Technological innovation in the energy sector is the one way to reduce the tariff rates

of electricity and helpful for organizations to exploit more market opportunities, which ultimately results in the shape of increasing energy consumption. Continuous electricity supply is an important factor of economic growth and export performance and according to the rule of thumb, manufacturing organization utilizes 33% of the production cost of product in terms of prices of energy (Masih & Masih, 1996). The production cost of organizations affects by increases in tariffs of electricity and organizations reduce the labour cost to minimize the cost of production in order to compete in the global market (Masih & Masih, 1996). China is one country where the labour cost is twice as compared to other Asian developing countries but still they have the huge export growth during the last five years due to a decrease in electricity tariffs. China now focuses more on alternate energy resources in order to catch up with increasing electricity demand and to reduce the electricity tariffs in order to support industrial growth. In past, some studies have been done in developed countries and identified that reduction of electricity prices can significantly improve the export performance of organizations (Abraham & Sasikumar, 2011; Larudee & Koechlin, 1999; Skumatz, Dickerson, & Coates, 2000).

Hence the propositions of the research study are,

Proposition 1: Innovation in the energy sector (electricity sector) can reduce the tariff rate of electricity, which results in the shape of low production costs for organizations.

Proposition 2: Low production costs of manufacturing organizations can improve export performance.

Energy consumption is a significant element of the export performance of manufacturing organizations and many studies have been done in order to identify the impact of energy consumption on export performance (Crone & Roper, 2001; Gorg & Ruane, 2000). Previous research study states that there are two main academic viewpoints exist on the relationship between export performance and innovation: neo-endowment and technology base models (Harrington, Vernon, & Viscusi, 1996). In the neo-endowment model, specialization is based on capital, labour and material, while in the technology-based model, specialization is based on the life cycle and technology gap theory of trade (Harrington et al., 1996). Many organizations adopt technology-based models and studies regarding this concluded that these firm are more innovative (low-price and high-income elastics) and goes towards major exports rather than imports. Previously no research study has been done to identify the impact of innovation in the energy sector (electricity sector) on export performance (Becchetti & Rossi, 2000; Bernard & Jensen, 1999).

Innovation within the organization (product and process innovation) and outside the organization is the main strategic component to increase the market share and exploit more market opportunities (Kirbach & Schmiedeberg, 2008). Product innovation within the organization is the best factor to increase export performance than process innovation (Costantini & Melitz, 2007; Nocke & Yeaple, 2006). Innovation is the essential element for firms to sustain long-term growth and performance in international markets one way to sustain this growth is to encourage innovative activities within the organization (product and process innovation) and the second way is to get the benefit of innovation in other sectors like energy consumption sector (Kirbach & Schmiedeberg, 2008).

Hence the proposition of the research study is,

Proposition 3: Innovation in the energy sector (electricity sector) can significantly improve the export performance of manufacturing organizations.

Energy is the central point of a country's development and without energy consumption, it is impossible to improve the productivity of an organization and more part to build an economic base for the country to participate in the global economy (Sahir & Qureshi, 2007). Energy is the most important strategic commodity to gain growth in the economy and there is a strong relationship between energy consumption and economic

growth (Sahir & Qureshi, 2007). Many studies have been done in order to identify the impact of energy consumption on economic growth and all studies concluded that there is a strong bidirectional relationship between energy consumption and economic growth (Asafu-Adjaye, 2000; Lariviere & Lafrance, 1999; Masih & Masih, 1996; Narayan & Singh, 2007; Yoo & Kwak, 2010). The relationship between electricity consumption and economic growth is vice versa i.e. economic growth can increase electricity consumption and innovation in the electricity sector can increase economic growth (M. A. Khan & Ahmad, 2008). Different researchers use different factors (urbanization, population growth, usage of electricity in agriculture) that contribute to increased energy consumption in order to identify its impact on economic growth but not highlight the innovation perspective in the energy sector and its impact on economic growth.

The energy crisis (electricity shortage) has a significant impact on economic growth and this influence is not only on the manufacturing sector but also on the service and agriculture sector of Pakistan (M. A. Khan & Ahmad, 2008). The role of technological change in the energy sector is well documented in previous research but no research study has been done to identify the impact of innovation in the energy sector (Yoo & Kwak, 2010). The dependence of countries on energy increases day by day and now energy has also been considered an important part of the production function of an organization and an important determinant of economic growth (Yoo & Kwak, 2010). In other words, energy becomes the main concern of many developing countries in order to sustain economic growth and innovation in the energy sector reduces the production cost and able firms to take a competitive advantage in the global market (Taylor, Tam, & Gielen, 2006).

Hence the proposition of the research study is,

Proposition 5: Low production costs of manufacturing organizations can improve the economic growth of a country.

Proposition 4: Innovation in the energy sector (electricity sector) can improve the economic growth of a country.

Economist theorists try to explain the growth pattern between countries through the export and economic growth relationship (Diks & Panchenko, 2005). The role of export as an important determinant of economic growth is not new and relates to Adam Smith and David Ricardo's classical economic theories (Diks & Panchenko, 2005). Previous studies concluded that export growth increases technological innovation and leads to greater utilization of resources and economic growth. The researcher used the Granger causality test in order to identify the impact and nature of the relationship between export growth and economic performance (Diks & Panchenko, 2005). Previous studies also concluded that it is not necessary that all exports contribute equally to economic growth.

Developing countries mostly focus on the export of primary products and this focus has a negligible impact on economic growth (Schnable et al., 2009). Many studies have been done in order to identify the impact of export performance on economic growth and all studies concluded that there is a significant and positive impact of export performance of manufacturing organizations on economic growth (Abou-Stait, 2005; Awokuse, 2003; Crespo Cuaresma & Wörz, 2005; Kalaitzi, 2013; Liu, Burridge, & Sinclair, 2002). Innovation in the energy sector can significantly reduce tariff rates which results in the shape of reducing production costs and making organizations capable to exploit more market opportunities. The flourishing of market opportunities by organizations can significantly improve the economic growth of the country (Kalaitzi, 2013).

Hence the proposition of the research study is,

Proposition 6: The export performance of manufacturing organizations can significantly improve the economic growth of the country.

Discussion

Energy is the most important strategic commodity to gain growth in the economy due to production function, which is the complementary part of every organization (Altinay & Karagol, 2004; Lee, 2005; Shiu & Lam, 2004; Stern, 2000). Innovation in the energy sector is the best solution in order to enhance economic growth and to make it possible for organizations to compete in the global economy and it is evident that better export performance is when government policies are integrated and aligned with an increase of innovation activities in the sectors like the energy sector, which is an integral part of whole economy. The impact of energy consumption on economic growth is very significant in developing countries (Masih & Masih, 1996) and if energy consumption enhances economic growth (energy-dependent policy), then the energy protection policy in order to overcome the consumption of energy may have a significant negative impact on economic growth (Apergis & Payne, 2009). Traditionally researchers consider labour, land and capital as important production factors, while in the current scenario of modern life, energy is also considered an important production factor around the world (Cleveland & Stern, 2002).

The energy sector is underdeveloped in Pakistan and due to this, economic activities in the country are not flourishing as much (electricity shortages put an adverse impact of 4% per year on GDP). The energy crisis (electricity shortage) has a significant impact on economic growth and this influence is not only on the manufacturing sector but also on the service and agriculture sector of Pakistan (M. A. Khan & Ahmad, 2008). The main reasons for the energy crisis in Pakistan are the increase of energy consumption by 8% per annum due to high population growth, extensive migration to urban areas, advancement of technology in the agriculture sector, giving access to un-served consumers (giving access to 86% of the total population) and move more towards industrialization, while the investment in the energy sector is less than 2% per annum (Filippini & Pachauri, 2004). The energy crisis starts two decades ago when the energy policy in 1994 is adopted to rely more on fuel rather than hydropower, which results in the shape of high generation costs and high tariffs rate. In the 1980s, Pakistan produce more than 60% of its electricity from hydropower, while in 1994 power policy encourage foreign investors to quickly installation of fuel-based thermal plants to overcome the energy crisis quickly. Privatization was also the part of 1994 policy to give autonomy to companies that are responsible for generation, distribution and transmission. This strategy enhances the production capacity by about 8 per cent annually between 1994 and 2005, while the production of electricity instead of this capacity is very low (M. A. Khan & Ahmad, 2008).

Organizations become able to produce innovative products at a lower price when energy is available at a low cost and in an efficient manner and according to the rule of thumb, manufacturing organization utilizes 33% of the production cost of a product in terms of price of energy (Farooq & Shakoor, 2013). The production cost of organizations affects by an increase in the tariff rate of electricity and organizations reduce the labour cost to minimize the cost of production in order to compete in the global market. China is the one case where labour cost becomes twice and still, their export performance is very good during the last five years because they make a policy to invest more in alternate energy sources to overcome the tariffs rate of electricity in order to create an equilibrium state (create the balance between electricity tariffs and labour cost). The energy crisis put an adverse impact on the economic growth of Pakistan and this adverse impact is 2% in the shape of no organizational production and 2% is due to high subsidies (90% part of subsidy given for electricity) given by the government to overcome the tariffs rate of electricity (M. A. Khan & Ahmad, 2008). To enhance economic growth and export performance, the Pakistani government has to invest more in the energy sector and has to make innovations in the energy sector in order to reduce the tariff cost of electricity and to make competition

possible for the domestic industry in the global economy (M. A. Khan & Ahmad, 2008).

Innovation in the energy sector (wind, solar, coal, biomass and nuclear power production) is helpful to overcome the unit production cost of organization and is very much needed because more than 70% of the total production of electricity in Pakistan is through fossils fuels (Farooq & Shakoor, 2013). Fluctuations in oil prices across the globe increase the tariff rate of electricity and it becomes eventually impossible for manufacturing organizations to keep the cost of the product under control (Farooq & Shakoor, 2013).

Policy Implications

This research paper presents an integrated framework for innovation in the energy sector and its impact on economic growth and export performance. The research study provides a significant approach for policymakers that the economic growth of the country can be enhanced by making innovation in the energy sector, which is the main factor of every organization for production function. Furthermore, being a part of the global market and to compete in this market, it is compulsory for the government to take initiatives in order to invest in alternate sources i.e. wind and solar energy, that are available in huge amounts within the country to produce cheap electricity. This research paper has implications for two public policy interest areas. One is the impact of innovation in the energy sector on economic growth and export performance. Second is the impact of not doing innovation in the energy sector on economic growth and export performance. The energy crisis in Pakistan is due to the continuous increase of electricity demand by 8% per annum, while investment regarding this demand is less than 2% per annum. It is apparent that need of consistent investment policy is required in order to overcome the energy crisis in Pakistan and to enhance economic growth. Government firstly have to make an electricity conservation policy to overcome the increasing demand day by day and secondly have to invest more in alternate cheap sources (solar, wind, coal and biomass) to overcome the energy crisis prevailing in the country and to support the industry by reducing the tariffs rate of electricity.

Conclusion

The manufacturing industry enables a country to achieve a high economic growth rate and the government has to put emphasis on the significant role of industry in economic development. Government has to make policies, which support the manufacturing industry to enhance export performance and economic growth. Since the 1980s, the manufacturing sector of Pakistan having a good record of economic growth and this growth slowed down after 1995 due to a severe energy crisis and a reduction in productivity. To overcome the energy crisis and to reduce the electricity tariffs, the government has to make a policy to invest more in alternative energy sources, which are available in a huge amounts within the country. Lower tariffs rate of electricity makes it possible for a manufacturing organization to compete in the global market and enhance their exports, which ultimately helps to improve the economic growth of a country. Investment in oil and gas-based power production plant can play a significant role in order to overcome the energy crisis only in short term and fluctuations in oil prices and minimum available resources of natural gas increase the tariff rate of electricity. In long run, the government has to make policies to reduce dependence on oil generation plants and put more focus on alternate energy sources i.e. wind and solar energy, to reduce the tariff rate. Supportive policy by the government can make it possible for the manufacturing organization to keep their cost under control in order to compete in the international market.

References

Abou-Stait, F. (2005). *Working Paper 76-Are Exports the Engine of Economic Growth? An Application of Cointegration and Causality Analysis for Egypt, 1977-2003.*

Abraham, V., & Sasikumar, S. (2011). Labor Cost and Export Behavior of Firms in Indian Textile And Clothing Industry. *Economics, Management & Financial Markets, 6*(1).

Ahmad, Z., & Ahmad, J. (2018). Role of Export and FDI in Economic Growth (GDP): A Case of Asian Countries.

Altinay, G., & Karagol, E. (2004). Structural break, unit root, and the causality between energy consumption and GDP in Turkey. *Energy economics, 26*(6), 985-994. https://doi.org/10.1016/j.eneco.2004.07.001

Amjed, S., Shah, I. A., & Riaz, A. (2022). Investigating the interactive role of demand side factors potentially responsible for energy crisis in Pakistan. *International Journal of Energy Economics and Policy, 12*(3), 236-246. https://doi.org/10.32479/ijeep.12930

Apergis, N., & Payne, J. E. (2009). Energy consumption and economic growth: evidence from the Commonwealth of Independent States. *Energy economics, 31*(5), 641-647. https://doi.org/10.1016/j.eneco.2009.01.011

Asafu-Adjaye, J. (2000). The relationship between energy consumption, energy prices and economic growth: time series evidence from Asian developing countries. *Energy economics, 22*(6), 615-625. https://doi.org/10.1016/S0140-9883(00)00050-5

Awokuse, T. O. (2003). Is the export-led growth hypothesis valid for Canada? *Canadian Journal of Economics/Revue canadienne d'économique, 36*(1), 126-136. https://www.jstor.org/stable/3131917

Becchetti, L., & Rossi, S. P. (2000). The positive effect of industrial district on the export performance of Italian firms. *Review of industrial organization, 16*(1), 53-68. https://www.jstor.org/stable/41798903

Bernard, A. B., & Jensen, J. B. (1999). Exceptional exporter performance: cause, effect, or both? *Journal of international economics, 47*(1), 1-25. https://doi.org/10.1016/S0022-1996(98)00027-0

Cleveland, C. J., & Stern, D. I. (2002). Indicators of natural resource scarcity: a review and synthesis. Handbook of environmental and resource economics, 89-108.

Costantini, J. A., & Melitz, M. J. (2007). *The Organization of Firms in a Global Economy, Chapter The Dynamics of Firm-Level Adjustment to Trade Liberalization.* Harvard University Press.

Doraszelski, U. and J. Jaumandreu (2011). R&D and productivity: Estimating endogenous productivity. Ethier, WJ (1979). Internationally decreasing costs and world trade. *Journal of International Economics, 9,* 1-24.

Crespo Cuaresma, J., & Wörz, J. (2005). On export composition and growth. *Review of World Economics, 141*(1), 33-49. https://www.jstor.org/stable/40441033

Crone, M., & Roper, S. (2001). Local learning from multinational plants: knowledge transfers in the supply chain. *Regional studies, 35*(6), 535-548. https://doi.org/10.1080/00343400120065705

Diks, C., & Panchenko, V. (2005). A note on the Hiemstra-Jones test for Granger non-causality. *Studies in nonlinear dynamics & econometrics, 9*(2). https://doi.org/10.2202/1558-3708.1234

Farooq, M., & Shakoor, A. (2013). Severe energy crises and solar thermal energy as a viable option for Pakistan. *Journal of Renewable and Sustainable Energy,* 5(1), 013104. https://doi.org/10.1063/1.4772637

Filippini, M., & Pachauri, S. (2004). Elasticities of electricity demand in urban Indian households. *Energy policy, 32*(3), 429-436. https://doi.org/10.1016/S0301-4215(02)00314-2

Ghaus-Pasha, A., Pasha, H. A., & Zubair, A. (2010). Fiscal equalisation among provinces in the NFC awards. *The*

Pakistan Development Review, 563-576. https://www.jstor.org/stable/41428676

Gorg, H., & Ruane, F. (2000). An analysis of backward linkages in the Irish electronics sector. *Economic and Social Review, 31*(3), 215-236. http://hdl.handle.net/2262/62433

Haq, Z. U., Nazli, H., & Meilke, K. (2008). Implications of high food prices for poverty in Pakistan. *Agricultural Economics, 39,* 477-484. https://doi.org/10.1111/j.1574-0862.2008.00353.x

Harrington, J. E., Vernon, J. M., & Viscusi, W. (1996). *Economics of regulation and antitrust: MIT press.*

Higgins, E. T. (1996). Activation: Accessibility, and salience. Social psychology: Handbook of basic principles, 133-168.

Hinnant, C. C., & O'Looney, J. A. (2007). IT innovation in local government: Theory, issues, and strategies Modern public information technology systems: Issues and challenges (186-203): Igi Global.

Hye, Q. M. A., & Riaz, S. (2008). Causality between energy consumption and economic growth: the case of Pakistan. *The Lahore Journal of Economics, 13*(2), 45-58. https://www.jstor.org/stable/24813043

Kalaitzi, A. (2013). *Exports and economic growth in the United Arab Emirates. Paper presented at the Submitted to RIBM Doctoral Symposium.* Manchester Metropolitan University Business School.

Kamran, M. (2018). Current status and future success of renewable energy in Pakistan. *Renewable and Sustainable Energy Reviews, 82*, 609-617. https://doi.org/10.1016/j.rser.2017.09.049

Khan, B. (2010). What drives interest rate spreads of commercial banks in Pakistan? Empirical evidence based on panel data. *SBP Research Bulletin, 6*, 15-36.

Khan, M. A., & Ahmad, U. (2008). Energy demand in Pakistan: a disaggregate analysis. *The Pakistan Development Review*, 437-455. https://www.jstor.org/stable/41261233

Khoshroo, A., Mulwa, R., Emrouznejad, A., & Arabi, B. (2013). A non-parametric Data Envelopment Analysis approach for improving the energy efficiency of grape production. *Energy, 63*, 189-194. https://doi.org/10.1016/j.energy.2013.09.021

Kirbach, M., & Schmiedeberg, C. (2008). Innovation and export performance: Adjustment and remaining differences in East and West German manufacturing. *Econ. Innov. New Techn., 17*(5), 435-457. https://doi.org/10.1080/10438590701357189

Lariviere, I., & Lafrance, G. (1999). Modelling the electricity consumption of cities: effect of urban density. *Energy economics, 21*(1), 53-66. https://doi.org/10.1016/S0140-9883(98)00007-3

Larudee, M., & Koechlin, T. (1999). Wages, productivity, and foreign direct investment flow. *Journal of Economic Issues, 33*(2), 419-426. https://www.jstor.org/stable/4227454

Lee, C. C. (2005). Energy consumption and GDP in developing countries: a cointegrated panel analysis. *Energy economics, 27*(3), 415-427. https://doi.org/10.1016/j.eneco.2005.03.003

Lee, C. C. (2006). The causality relationship between energy consumption and GDP in G-11 countries revisited. *Energy policy, 34*(9), 1086-1093. https://doi.org/10.1016/j.enpol.2005.04.023

Leonidou, L. C. (2004). An analysis of the barriers hindering small business export development. *Journal of Small Business Management, 42*(3), 279-302. https://doi.org/10.1111/j.1540-627X.2004.00112.x

Lindgren, B.-M., Lundman, B., & Graneheim, U. H. (2020). Abstraction and interpretation during the qualitative content analysis process. *International journal of nursing studies, 108*, 103632. https://doi.org/10.1016/j.ijnurstu.2020.103632

Liu, X., Burridge, P., & Sinclair, P. J. (2002). Relationships between economic growth, foreign direct investment and

trade: evidence from China. *Applied Economics, 34*(11), 1433-1440. https://doi.org/10.1080/00036840110100835

Mahmood, Z., & Siddiqui, R. (2000). State of technology and productivity in Pakistan's manufacturing industries: Some strategic directions to build technological competence. *The Pakistan Development Review*, 1-21. https://doi.org/10.30541/v39i1pp.1-21

Masih, A. M., & Masih, R. (1996). Energy consumption, real income and temporal causality: results from a multi-country study based on cointegration and error-correction modelling techniques. *Energy economics, 18*(3), 165-183. https://doi.org/10.1016/0140-9883(96)00009-6

Masih, A. M., & Masih, R. (1997). On the temporal causal relationship between energy consumption, real income, and prices: some new evidence from Asian-energy dependent NICs based on a multivariate cointegration/vector error-correction approach. *Journal of policy modelling, 19*(4), 417-440. https://doi.org/10.1016/S0161-8938(96)00063-4

Mohamed, Z., & Bodger, P. (2003). *Analysis of the logistic model for predicting New Zealand electricity consumption.*

Moini, A. H. (1995). An inquiry into successful exporting: An empirical investigation using a three-stage model. *Journal of Small Business Management, 33*(3), 9.

Narayan, P. K., & Singh, B. (2007). The electricity consumption and GDP nexus for the Fiji Islands. *Energy economics, 29*(6), 1141-1150. https://doi.org/10.1016/j.eneco.2006.05.018

Nocke, V., & Yeaple, S. (2006). *Globalization and endogenous firm scope: National Bureau of Economic Research Cambridge, Mass., USA.*

Robertson, C., & Chetty, S. K. (2000). A contingency-based approach to understanding export performance. *International business review, 9*(2), 211-235. https://doi.org/10.1016/S0969-5931(99)00037-2

Sahir, M. H., & Qureshi, A. H. (2007). Specific concerns of Pakistan in the context of energy security issues and geopolitics of the region. *Energy policy, 35*(4), 2031-2037. https://doi.org/10.1016/j.enpol.2006.08.010

Sari, R., Ewing, B. T., & Soytas, U. (2008). The relationship between disaggregate energy consumption and industrial production in the United States: An ARDL approach. *Energy economics, 30*(5), 2302-2313. https://doi.org/10.1016/j.eneco.2007.10.002

Schnable, P. S., Ware, D., Fulton, R. S., Stein, J. C., Wei, F., Pasternak, S., & Graves, T. A. (2009). The B73 maize genome: complexity, diversity, and dynamics. *science, 326*(5956), 1112-1115. https://doi.org/10.1126/science.1178534.

Shiu, A., & Lam, P. L. (2004). Electricity consumption and economic growth in China. *Energy policy, 32*(1), 47-54. https://doi.org/10.1016/S0301-4215(02)00250-1

Soytas, U., & Sari, R. (2003). Energy consumption and GDP: causality relationship in G-7 countries and emerging markets. *Energy economics, 25*(1), 33-37. https://doi.org/10.1016/S0140-9883(02)00009-9

Stern, D. I. (2000). A multivariate cointegration analysis of the role of energy in the US macroeconomy. *Energy economics, 22*(2), 267-283. https://doi.org/10.1016/S0140-9883(99)00028-6

Taylor, M., Tam, C., & Gielen, D. (2006). Energy efficiency and CO2 emissions from the global cement industry. *Korea, 50*(2.2), 61.67.

Theodosiou, M., & Leonidou, L. C. (2003). Standardization versus adaptation of international marketing strategy: an integrative assessment of the empirical research. *International business review, 12*(2), 141-171. https://doi.org/10.1016/S0969-5931(02)00094-X

Wolde-Rufael, Y. (2005). Energy demand and economic growth: the African

experience. *Journal of policy modelling, 27*(8), 891-903. https://doi.org/10.1016/j.jpolmod.2005.06.003

Yoo, S. H. (2005). Electricity consumption and economic growth: evidence from Korea. *Energy policy, 33*(12), 1627-1632. https://doi.org/10.1016/j.enpol.2004.02.002

Yoo, S. H., & Kwak, S. Y. (2010). Electricity consumption and economic growth in seven South American countries. *Energy policy, 38*(1), 181-188. https://doi.org/10.1016/j.enpol.2009.09.003

Zsidisin, G. A., Ellram, L. M., & Ogden, J. A. (2003). The relationship between purchasing and supply management's perceived value and participation in strategic supplier cost management activities. *Journal of business logistics, 24*(2), 129-154. https://doi.org/10.1002/j.2158-1592.2003.tb00049.x