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The impact of the technology on the food industrial production: a case study of Brazil

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Abstract:
The object of this study is to analysis the effect of technology on the food industrial production: A case study of Brazil. The Brazilian food and beverage industry has great social and economic importance to the nation and technology represents a key factor for competitiveness in the sector. Learning about the past and recent technological dynamics of this industry enables the identification of trends and perspectives that enhance its competitiveness. The range of data use for estimation is from 1980 to 2018. The analysis is based on econometric techniques. First of all this study applied The ADF (Augmented Dickey Fuller 1979) test to verify the stationary values of the variables, Johnson co-integration technique to check the long run relationship among the variables, VECM to check the significant values of the variables. This study concluded that the technology has positive effect on the food industrial production. . The new technology within the sector has been integrated rather than created. Enterprise investment in R&D is still low and the sector's technology strategy is mostly imitative. However, this period presented positive effect of technological efforts, with the primary goal of increasing productive efficiency and effectiveness This study suggests that the government to subsidies the food industries that it can easily get approach to technology and revises food export restriction policy.

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1. Introduction

Brazil is a country with a population estimated at 210 million; a number which has earned it the fifth largest country in the world (Statista, 2018). The Brazilian economy is industry driven by the manufacturing sector playing a pivotal role. Its manufacturing sector includes chemical product, apparels and textiles, metal, fabricated metal products, and food, beverage and tobacco industry. However, the largest of all these subsectors is the food, beverages and tobacco industry having a production value of about 10.8 billion dollars. Since 2010, the South American food and beverage revenue have grown twice the size, representing 10% of its 2017 Gross Domestic Product- GDP while its revenue remains among the ten highest grossing in the world (Statista, 2018). In 2014 in total 34,800 companies were active in the food industry from which 93.1% were micro or small companies, 5% are medium-sized companies, and 1.9% are big companies. The distribution of the different types of companies present in the Brazilian market has remained stable over time. Important sectors within the food industry with regards to the net revenues are the meat sector, coffee, tea and grains, sugar, dairy, oils and fat, wheat and its derivatives and fruit and vegetables. Sugar is still essential but is decreasing over time while ready to eat mealsand frozen food is increasing sharply. Major foreign firms have gained entry into the market including Kraft, Nestlé, Cargill, Syngenta, Pepsi, and Coca-Cola are all players in the industry. However, the industry is also home to an indigenous firm. Alternatively, instance; JBS, is the largest multi-national food firm in the country. Market shares have also been retained by National companies such as Dolly, Guarana Antarctica also play a vital role in the food and beverage industry. Irrespective of large, often foreign-owned are firms, the structure of the food, beverage, and tobacco industry is still majorly driven by small and medium enterprises which make up about 85% of food and beverage firms in Brazil. Figure 1 presents the evolution along the years of Food Industrial Production expressed % of GPP.

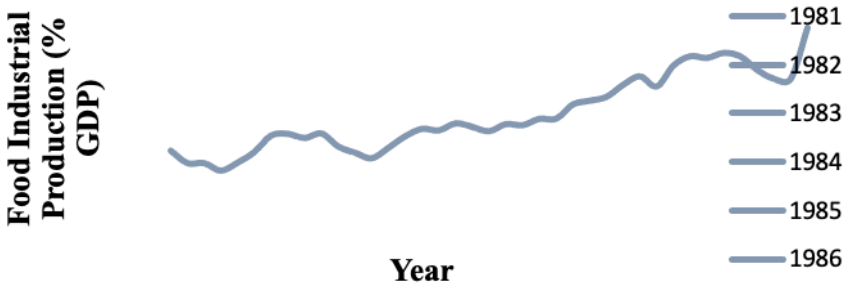

Figure 1 Food Industrial Productions in Brazil from 1980 to 2018 (The Word bank, 2019)

Seemingly, all industry play a tremendous social and economic role to the nation, and technology represents a principal factor for its competitiveness. The public domain is awash with knowledge of the past and current efforts aimed at providing concrete support and perspectives to technological reformation; those believed to be the drivers of competition within the sectors. In the scientific parlance, technology comprises a framework of knowledge which is utilized in the course of production. It is an integral component in the production process and determines the way and manner a firm interact with their environment including the one essential element; competition (Flipse et, al 2014). Profitability criteria often define and inform the decision of a firm to adopt new technology. The profit gain generated from the introduction of new technologies will arise either from cost reductions or from increases in revenue (or some combination of both) over the expected lifetime of the technology. Discussions on firm performance as it relates to technology are one that has evolved from earlier studies to current ones. For instance; earlier

studies by Milgrom and Roberts (1990), had in no small extent envisaged the benefits of technology to manufacturing firms. The duo assessed and confirmed the complementary nature of technology: they postulated that if the level of use of any innovation rises, then the marginal return increases in any or all of complementary innovations of the firm leading to increased productivity. The introduction of technology makes it cheaper to improve on products and introduce new ones more often. However, for the innovation to be sufficiently profitable, a technology which allows the production of a broader range of goods may be required, which in turn may only be worthwhile if a change other strategy is introduced (Milgrom and Roberts, 1990). There are also complementarities in inter-firm relations, making coordination not only within enterprises but also between them a key aspect of technology. Other earlier studies by Kaplinsky (1984), Hoffman and Kaplinsky (1988) and Perez (1985) took this view further and argued that the introduction of the full range of new technology assist activities of the firm and its relationships with suppliers and consumers thus; producing synergies i.e., the total gains are more than the sum of the individual benefits. Yet still, some other early studies argued that the application of new technology to the manufacturing industry is, in the view of the 'modern technology' literature, changing its nature in several respects including the accommodation of specific sectoral features (Bessant, 1991; Ferraz et al., 1991; Kaplinsky, 1984, 1990a, 1991; Piore and Sable, 1984; Perez, 1989).

In contrast with the old technological paradigm,' the introduction of new technology leads to qualitatively different command and control structures, work organization patterns and competitive strategies. Bureaucratic, centralized lines of command and communications are replaced by flatter hierarchies and informal control mechanisms based on goal setting and participatory decision-making. Separate functional departments, standard routines, procedures, and individual job definitions are also displaced by interactive and cooperative links as well as adaptableprocesses between departments, groups, and individuals. Production facilities can now produce a far wider range or scope of products than before. Flexibility has an 'operational' element which is related to the capacity to adjust output proportions easily for a given range of individual goods. It also has a 'strategic' element which refers to the capacity to alter the product mix by introducing new products or modifying the quality of existing ones. Greater production flexibility or scope is reflected in the increase in product variety witnessed in recent years through technology. In more recent research, Flipse et, al (2014) also consolidated gains of technology in specific industry. They opined that industrial and agribusiness growth is a function of technological innovation available in the market place. For instance; the innovative ability of the various agents in the food industry and the extent of coordination existing among them to drive technological trends in specific areas helps in changing the dynamics. These areas include additives, packaging, equipment and machines, and information technology. Apparently, the problems faced by industries including the beverage and food industry exist in the desire to achieve the scaling gains and product differentiation to consolidate value and arrive at market segmentation. Carvalho et al. (2013) supported Flipse et, al (2014) opined that the food industry is scale-intensive but stable growth in competition and surging consumer needs characterized by the desire for quality, variety, and convenience, continue to direct the decision of the food and beverage industry to differentiate their products and improve the output quality through business innovation approaches.

In other climes, the low dynamics of food processing technologies makes them more susceptible to innovation (Batterink, 2006) with the Brazilian food industry not being an exception. The sector is defined by a considerable presence of technological product destruction; both imports and exports. DeMori (2011) opined that research about technical

level and technical variations in the Brazilian food-related environment including agroindustrial production systems encourages understanding of the evolution and sectoral dynamics. De Mori (2011) furthered that it allows firms to monitor and direct strategic engagements aimed at maximizing productivity and however concluded on the essentiality of specific sectoral technological requirements. Since the features domiciliary in production and product segmentation suggest the need to institute technological innovation, then the food industry must evolve and develop its processes towards this line. Seemingly,companies in the industrial economies including brazil seem to invest considerably in technological research development (R&D) with the aim of producing new commodities including new production approaches. R&D and technology innovations have been proved to positively correlate with profitability in developed countries, though, in most instances, these investments take time to realise (hanel and st-pierre, 2002; roper et al., 2006). For example, Hanel and St-pierre (2002) found out that R&D investment has a positive impact on profitability, especially in sectors with significant levels of patent protection. Brazilian government has made good expenditure to increase the level of the research and development. Figure 2 presents the evolution of research and development expenditure in Brazil over the years.

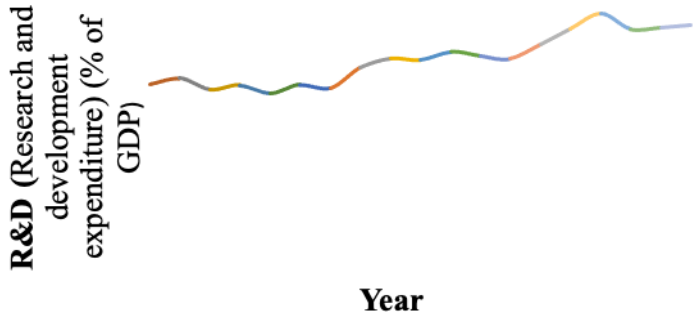

Figure 2.Research and development expenditure over the years 2000 to 2017(The Word bank, 2019).

Nevertheless, traditional wisdom opines that the association between technological efforts and technological imports is necessarily that of substitution; a surge in imports of technology means a decrease in local research and development activity. The relationship may also be that of complementarity, and complementarity may be much significant. For instance; Japan demonstrated this concept very well; their initial capacity to adapt and absorb alien technology resulted in more technological research. Many have even opined that technological imports had been the driver to Japan's Research and development evolution (Ozawa, 1985). Undoubtedly, the sector has had its fair share of technological evolution, both imports and export. Brazil has a population estimated at 210 million people in 2018, a number which has earned it the fifth largest country in the world (Statista, 2018). Its food industry has surged its revenue to remain among the ten highest grossing in the world. It accounts for about 105 billion U.S. dollars. Since 2010, the South American food and beverage revenue have grown twice the size, representing 10% of its 2017 Gross Domestic Product-GDP (Statista, 2018). Such a level of productivity will not come without investing consciously. Irrespective of this level of investment in the food-related production and agribusiness, Brazil continues to grapple with food insecurity. Constanza et al. (2009) observed the rapid socioeconomic shifts in the Brazilian food sector: the movement of labor from rural centers to urban thus; presents a new challenge to the food-related industry including the agribusiness. This shifts in commodity demand and subsequent changes in economic signals. Consequently, there is a production challenge; that of meeting the demand. Facilities and infrastructural

bottlenecks are also significantobstacles to agriculture's capacity to supply the food industry with raw material required for processing. Poor infrastructure including poor roads results to high costs on farmers. This is witnessed mostly in the agricultural frontier and areas where the crops have maximum productivity in the country. A considerable investment in technological design, expansion, and maintenance of transport and production infrastructure are needed if the surging food demands must be met, delivery time reduced, cost minimized and product quality retained. In years past, technological investment and infrastructure have been more than the federal investments; Public-Private Partnerships (PPPs) have been fixing technological requirements including that of port facilities, roads and product innovation. An estimate by the Brazilian Government reveals that an approximately, $200 billion is needed to boost technology and infrastructure for the next decade. It is only essential to seek an understanding of the technological component which will drive sectoral productivity.

From this forego, the importance of technology cannotbe underscored. There is a need to pay attention to the technological needs of the sector if the food productivity of Brazilian economy should be improved. Improve technology will reduce wastages, improve accuracy, make processes simpler and increase market value as well as competitiveness. The previous study by IBGE, (2002; 2005; 2007; 2010; 2013) has recorded technological related programs instituted in the past to include; acquisition of machines, and software's, training, procurement of external knowledge, internal research and development, external research and development, the introduction of new products and innovation. Clearly, there could be inherent positive results from technological efforts, and technological imports with the primary goal of increasing production efficiency and effectiveness, but with additional goals of reducing environmental impacts and meeting regulatory standards. The previous empirical literatures have elaborated strong association between technological innovations and food industrial production. But these studies have been criticized for many reasons, like quality of data, influence of misplaced variables and the possible non-inclusion of policies. Mostly previous studies used primary data and researchers used patents or Intellectual Property Rights Index as the proxy of the technology. Away from the 'traditional' innovation determinants identified by previous relevant research, there has been extensive theoretical literature on the potential of information and communication technologies (ICT) to drive innovation; (Arvanitis et al. (2011). However limited empirical investigation of it has been conducted. So, Main contribution of this study is proxy and data of the study. This study will use ICT as the proxy of technogical innovation by using secondary data from 1980 to 2018. ICT is one of the vital drivers of the innovations in the firms (Yunis et al., 2018), the dearth in empirical studies regarding technological innovation and the food industry creates a gap between policymakers and practitioners that warrants attention. It becomes essential that a study on the subject is necessary if the Brazilian food industry should get it right with their technological policies. Again, the result will assist with the courses of action to be taken to develop the sector better. The present study is expected to contribute to a better understanding of technology and industrial production and proffer recommendations on the subject. This is the thrust of this study. It will helpful to accomplish the objectives of study and find the following answers.

1. Is the use of technology helpful to enhance the production of food industries in Brazil?
2. Has the industry been able to records gains and efficiency from previous technological reforms?

The general objective of the study is, to assess and compare imported and indigenous technological efforts on the efficiency and productivity of the Brazilian food industry. The specific objectives of the study are: (i) To investigate the impact of technological imports on the Brazilian food industry, and (ii) To enlist some policy implications.

2 Literature review

The existing literature on the subject is examined taking into consideration the theoretical and methodological underpinned surrounding the subject. Having done this, previous empirical studies on the subject are also examined. Abdul Rehman et al. (2016) investigated the Modern Agricultural Technology Adoption its Importance, role and usage for the Improvement of Agriculture. This study used data of agricultural out and GDP (gross domestic product) of 15 developing countries in the year of 2015. This study examined that the technology is very important for the enhancement of agricultural output. The cultivation with the modern technology, efficient tractors and harvesters increased the food production than their predecessors. This study concluded that the technology has positive effort on the food production. ABIA (2015) Explained that FDI has important role of technological evolution, both imports and export. Foreign direct investment to the sector; food, beverage, and tobacco industry stood at 1.9 billion dollars in 2002.In 2014, the equivalent of BRL 96.9 billion of food and beverages was exported. 18.3% of all exports were from the sector. At this time, Food importation was given less attention with exceptions to wheat summing up to about BRL 13.5 billion. For this reason, the sector was instrumental in returning a favorable balance of trade totaling about USD 83.4 billion as of 2015. This value was more significant than the balance of trade of the country which recorded a negative USD 4 billion. With the level of competitiveness and the evolution in consumption of greater aggregated value products, a considerable level of technology is required of firms. This study made available data showing that at the time, industrially processed food stood at 75%. This proportion was higher than the 70% proportion of 1990 and 1980s 56%. This implies that new market trends are surging, with evidence of production boom, differentiation and market segmentation. Flipse et, al (2014) also consolidated gains of technology in specific industry. This study investigated that industrial and agribusiness growth is a function of technological innovation available in the market place. For instance; the innovative ability of the various agents in the food industry and the extent of coordination existing among them to drive technological trends in specific areas helps in changing the dynamics. These areas include additives, packaging, equipment and machines, and information technology. Apparently, the problems faced by industries including the beverage and food industry exist in the desire to achieve the scaling gains and product differentiation to consolidate value and arrive at market segmentation. Carvalho et al. (2013) examine that the food industry is scale-intensive but stable growth in competition and surging consumer needs characterized by the desire for quality, variety, and convenience, continue to direct the decision of the food and beverage industry to differentiate their products and improve the output quality through business innovation approaches. Marelli and Signorelli (2011) investigated the increasing industrial productivity due to trade, in case of China and India. This study selected economic growth, trade, gross domestic product per capita, trade openness, foreign direct investment and gross capital formation lagged as variables. This study used panel data from 1980 to 2007 and applied ordinary least square and two stage least square (2SLS) technique. The results showed positive relation among the variables. The overall results were favorable for China and India with flourishing trade and foreign direct investment. Khan and Ahmed (2011) analyzed the impact of trade liberalization on the economic growth and industrial productivity a case study of Brazil, the study used time series data from 1972 to 2010. This study selected the trade, trade liberalization index, industrial productivity of Brazil and the economic growth is dependent variable. The OLS is applied to conclude the result. This study investigates that the 1% increases in trade liberalization increase the industrial productivity 0.164%. The trade liberalization has impact on export manufacturing good and import goods capital 0.18% and 0.17% respectively. The paper also suggested that If the capability of technology is increased the import and export will increase 17-18% overall. **Yam** et al.

(2011) investigated the relationship between the regional innovation system and production of firms. This study used information source, external expert organization, KIBS (knowledge intensive business service) are variables. This study selected primary data. The data is obtained through the mailed survey. This study concluded that innovation and expert organization affects the capabilities of the firms. Kijima et al. (2011) investigated "An inquiry into constraints on green revolution in Sub-Saharan Africa: The case of NERICA rice in Uganda". This study examined that main determinant of continue acceptance of the technology in the food department is the profitability affordability of technologies. The usage of the technology would be abandon, in the case of low benefits and high cost of production. This study also concluded that globally decline in the price of food and subsidies on the food industries also decrease the profitability of the product in developing countries. Foster and Rosenzweig (2010) examined the microeconomics of technology adoption. There are many factors that insist a country to use modern technology. But two divers are most important; one is availability and affordability of modern technology in the country. Other one is expectations of the farmer, that using of this new technology remain the profit and productivity same. These both factors make farmers risk averse. So, this study concluded that the technology adoption positively affect the production of the food. Constanza et al. (2009) observed the rapid socioeconomic shifts in the Brazilian food sector: the movement of labor from rural centers to urban thus; presents a new challenge to the food-related industry including the agribusiness. This shifts in commodity demand and subsequent changes in economic signals. Consequently, there is a production challenge; that of meeting the demand. Facilities and Infrastructural bottlenecks are also significantobstacles to agriculture's capacity to supply the food industry with raw material required for processing. Poor infrastructure including poor roads results to high costs on farmers. This is witnessed mostly in the agricultural frontier and areas where the crops have maximum productivity in the country.

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3 Theoretical backgrounds

Adam Smith proposed the absolute advantage theory in 1976. He argued against mercantilism. He favored the opinion of free trade as more beneficial instrument for countries. The theory advocated that specialization of resources for producing a specific good could give more output, from which other nations can be benefited by free trade.

Table 1

Work hour to produce one unite commodity		
countries	clothes	barley
Brazil	80	100
Japan	120	90

According to this Figure 1, Brazil use 80 hours to produce one unit of cloth and Japan use 120 hour to produce one yard of cloth. Brazil can produce al low price using less time than Japan

because of absolute advantage in it. Assume there countries are expert in producing the good and exchange it through the trade. They can get absolute advantage from the trade and production. A classical trade theory, presented by David Ricardo, was based on comparative advantage and relative prices. The objective of Ricardo was to describe the benefits of trade among states and the significance of trade liberalization policy. The Labor was the only variable which was considered as an immovable factor according to the Ricardian Model. The major element that was discussed in Ricardo's Model was the advantage of producing a good with specialized factor rather than consuming it for any other good for which it was not specified. This theory describes the scarcity of resources that leads to the trade-off among the manufacturing of commodities. Trade- off is related to the opportunity cost. The unit of one commodity which is given up for the manufacturing of one unit of another commodity is the opportunity cost.

3.1 Harrod-Domar Model

Harrod in 1939 and Domar in 1946 presented this model to enlighten the economic growth. It also named as AK Model. This model predicted that growth is dependent function of capital as well as labour. As investment increases then capital surges which tends towards economic growth. In the following expression S is considered as a proportion of output (Y).

$$S = sY \quad \ldots (3.1)$$

Net investment is well-defined as the variation in the change in the capital stock, K and can be symbolized by ΔK;

$$I = \Delta K \quad \ldots (3.2)$$

But as the entire capital stock, K, accept a positive relationship to entire domestic revenue, Y, as specified by the capital output

Ration, k, it monitors that $K = kY$

The identity of saving equalling investment can be described as

$S = sY = k\Delta Y = \Delta K = I \ldots (3.4)$

Or simply can be demonstrated as

$sY = k\,\Delta Y \ldots (3.5)$

Now, dividing both sides of equation 3.6 first by Y and later by k, we get

$$\frac{\Delta Y}{Y} = \frac{s}{K} \quad \ldots (3.7)$$

Investment is considered as the key variable in this model which creates capital accumulation. The main findings of this model showed that saving and capital output of a country determines the growth rate.

3.2 Cobb-Douglas Production Function

The theoretical bases for this study are an abstraction from the production function which is a way of calculating what comes out of production to what has gone into it. The function attempts to calculate the maximum amount of output you can get from a certain number of inputs. The production function is expressed by Equation 1.

$$\boldsymbol{Q = f\,(K, L,)} \qquad \textbf{(1)}$$

Where the quantity produced is a function of the combined input amounts of each factor. Of course, not all businesses require the same factors of production or number of inputs. Another form of the production function reduces the inputs to just labor and physical capital. The formula for this form is Q = f (L, K), in which labor and capital are the two factors of production with the most significant impact on the quantity of output. In 1928, Charles Cobb and Paul Douglas presented the view that production output is the result of the amount of labor and physical capital invested. This analysis produced a calculation that is still in use today, mostly

because of its accuracy. The Cobb-Douglas production function shows the relationships between its inputs - namely labor physical and capital and - and the amount of output produced. It is a means for calculating the impact of changes in the inputs, the relative efficiencies, and the yields of production activity. Equation 2 shows the primary form of the Cobb-Douglas production function:

$$Q\ (L, K) = A * L^{\beta} * K^{\alpha} \qquad (2)$$

In this formula, *Q* is the amount produced from the inputs *L* and *K. L* is the amount of labor expended, which is commonly represented in hours. *K* stands for the amount of physical capital input, such as the number of hours for a particular machine, operation, or perhaps factory. *A,* which appears as a lower case *b* in some versions of this formula, represents the total factor productivity (TFP) is the result of an improvement in efficiency or technology. The Greek characters *alpha* and *beta* reflect the output elasticity of the inputs. Output elasticity is the change in the output that results from a change in either labor or physical capital.

3.3 The decomposition theory: a fallout of the Production Function

Grossman and Krueger (1993) introduced a decomposition theory which is now widely used in literature. He decomposed the effects of economic activity and trade on pollution and production into the scale, a composition, and a technique effect. Antweiler et al. (2001) supported a formal theory and was furthered by Copeland and Taylor (2003). Cole (2006) found a similar application of this theory to production. By adopting this concept which was developed by Antweiler et al. (2001), firm productivity, therefore, could be examined under the scale, composition and technique effects. If total economic activity is divided into two sectors with different production intensities: industry and non-industry. Let production intensity in the non-industry sector relative to its output value be defined by e(A) with the properties e(A) > 0 or e(A) < 0, where A is a proxy for the average technology in use. Assuming that the production in the industrial sector is always μ times higher than e(A), total output is FPRO and the share of industrial value added be (VA), then the total output can be written as per Equation. Ei= FPRO. (μ.VA + 1-VA). e(A) **(3)**

It follows from Equation 3 that total output in a firm can be decomposed into three effects: the scale of overall productivity (FPRO), the relative importance of the sectors in economic activity (VA), and the technology in use e(A).

4 Data and methodology

The data of the variables is collected from different web sites like handbook of statistics, WDI. This study selected the data from 1980 to 2018. First of all this study applied The ADF (Augmented Dickey Fuller 1979) test to verify the stationary values of the variables. This study also applied Johnson co-integration technique to check the long run relationship among the variables. This study developed two models for the analysis. This analysis is based on econometric techniques like VECM to check the significant values of the variables, LM test to check the auto or serial-correlation among the variables. These results are based on E- Views 10 estimations.

MODEL 1

$$IND = \alpha_0 + \alpha_1 TECH + \alpha_2 ELE + \alpha_3 FIMP + \alpha_4 FEXP + \alpha_5 FDI + \varepsilon_t ----(1)$$

MODEL 2

$$IND = \beta_0 + \beta_1 AGRI + \beta_2 GFCF + \beta_3 TECH + \beta_4 FIMP + \beta_5 FEXP + \beta_6 LF + \varepsilon_t --(2)$$

Table 2 Brief Description of Variables and Data Sources

Variable	Symbols	Description/ Unit	Data Source
Food Industrial production	IND	It is as food industrial output and measured as value added industrial. (annual growth rate)	WDI
Technology	TECH	Technology in this study indicates the (ICT) Information and communication technology goods imports include computers and peripheral equipment, communication apparatus, consumer electronic equipment, electronic components, and other information and technology goods (percentage to total imports)	WDI
Food import	FIMP	Its means the imports of the commodities like wheat, corn, fresh fruits and dairy product etc	WDI
Food export	FEXP	Its mean the export of food that consist on the food item, beverages, tobacco, animal, oil, vegetable etc	WDI
Agricultural production	AGRI	Agricultural production means the output from land, rising crop, managing live stock etc	WDI
Foreign direct investment	FDI	It is investment of the different countries in the home country for numerous projects.	WDI
Electricity	ELC	The electricity consumption means that the use of energy in industries. It is measured as energy per capita.	WDI
Labor force	LF	The number of person participating in economic activities between the age of 15 to 60. it is measured as "(% of total population ages 15+) (national estimate)"	WDI
Gross fixed capital formation	GFCF	Gross fixed capital formation includes spending on land improvements, plant, machinery, and equipment purchases; the construction of roads, railways and commercial and industrial buildings. Disposal of fixed assets is taken away from the total. It is measure as % to GDP.	WDI

4.1 Diagrammatic expression of the model

The following diagram indicates that technology has direct and indirect effect on the food industrial production.

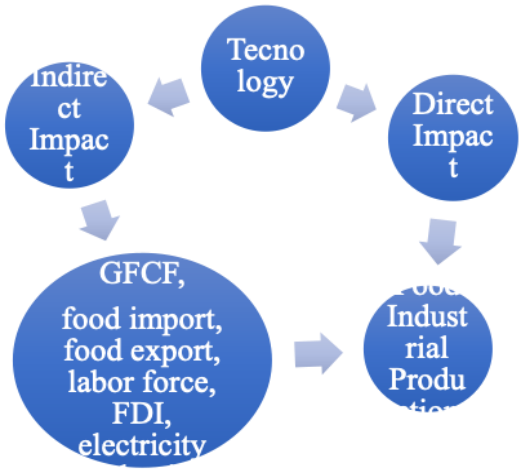


FIGURE 3 Direct and indirect effect of technology on food industries.

The technology bestows modernization to the food industries. The production of the industrial sector is increasing with the passage of the time. The augmentation in the production is due to the use of technology and research. On the other hand, technology brings innovation in the different fields that enlarge the food industrial production like modernization in the agricultural sector; the agricultural sector is back bone of the food industries it provide raw material to the industries. The use of the technology in the agrarian sector increases the ability of the production. So, the technology indirectly affected to food industries by dint of agricultural production. Just like this, technology brings novelty in GFCF (Gross fixed capital formation), labour force, and electricity production and these variables

further enhance the capabilities of industrial production. So, in this way the technology directly and indirectly effects the food industrial production.

4.2 Data analysis and estimation

This study selected the data from1980 to 2018 for the estimation. This study use food industrial production as the dependent variable. The independent variables are "food import, food export, agricultural production, technological imports, GFCF, labor force, electricity production and foreign direct investment. For the analysis, First of all this study applied The ADF (Augmented Dickey Fuller 1979) to verify the stationary values of the variables.

4.2.1 Unit Root Test of all variables

The unit root test is frequently used to stationer the data. The Dickey and Fuller proposed the unit root test in 1981. The ADF (Augmented Dickey Fuller 1979) test is applied to the stationer the data. The result of variables is based on the E- Views estimation.

Table 3 ADF TEST FOR ALL VARIABLES

Variables	Augmented Dickey-Fuller test							Result
	Values	Level			1st Difference			
		Trend	Without trend	None	Trend	Without trend	None	
Food industrial production	ADF value	0.27	2.77	1.74	3.91	3.72	3.51	I(1)
	Cr.value	2.94	3.53	1.94	2.94	3.53	1.94	
Technology	---	1.07	2.24	0.65	7.50	7.42	7.43	I(1)
	---	2.93	3.52	1.94	2.94	3.53	1.94	
Agricultural production	---	2.24	1.78	1.94	5.51	5.43	5.54	I(1)
	---	2.94	3.53	1.94	2.94	3.53	1.95	
Food import	---	2.65	3.52	0.98	8.17	8.08	8.28	I(1)
	---	2.94	3.53	1.95	2.94	3.53	1.95	
Food export	---	2.84	2.39	1.11	6.17	6.79	6.25	I(1)
	---	2.93	3.52	1.94	2.94	3.53	1.94	
Labor force	----	2.17	2.86	0.34	4.11	4.07	4.16	I(1)
	---	2.93	3.52	1.94	2.94	4.24	2.62	
GFCF	---	2.74	2.94	0.87	5.51	5.43	5.54	I(1)
	---	2.93	3.52	1.94	2.94	3.53	1.94	
Electricity production	---	0.21	1.65	1.29	7.17	7.68	6.86	I(1)
	---	2.93	3.52	1.94	2.94	3.53	1.94	
FDI	---	1.52	2.42	0.43	5.94	5.85	5.98	I(1)
	---	2.94	3.53	1.94	2.94	3.53	1.95	

- Note*at 5% level of significant based on **Mackinnon(1996) and ***E
- Null hypothesis all above unit root test is that series has a unit root.
- SBC and AIC criteria are used for optimal lag selection.

In this study ADF (Dickey and Fuller, 1979) is applied to find out the orders of integration. This table is reported that all three test of the UR of these variables τ_t statistics consequent to parameter P = 0 the calculated t value contrast with the critical τ_t value, the information show that all the variables i.e. (food industrial production, food import, food export, agricultural production, technology, GFCF, labor force, electricity production and foreign direct investment) are at 1%, 5% and 10% level of significance I(0) in their level and I(1) in the first difference. The result is showed that all variables are at I (1) first difference.

4.2.2 Co-integration

Johansson co-integration is used to find out long time dynamics in the data. It enables the study to know long run relationship among the variables. This is developed by Granger (1981) further it is explained by Engle and Granger (1981), Phillips (1986 and 1887), Phillips and Ouliaris (1990) and Johsan (1988, 1991, 1995).

Table4 Unrestricted Co-integration Rank Test (Trace)

Null Hypothesis	Eigen values	Trace statistics	Critical value at 5%	Prob.
None *	0.794169	255.3883	197.3709	0.0000
At most 1 *	0.769529	196.9023	159.5297	0.0001
At most 2 *	0.681181	142.5999	125.6154	0.0030
At most 3 *	0.610401	100.3040	95.75366	0.0234
At most 4	0.493032	65.42644	69.81889	0.1066

H_0 = Tabulated value less than value
H_a = Tabulated value greater than value

Above table shows the co-integration (trace value) and shows that there are 4 Co-integration has found, its mean there are 4 variables which are co-integrated. The variables with the symbol of * indicate that the null hypothesis will be rejected at 0.05% as the trace value should be greater than the critical values. In this table the 5th Column show the prob. value which should be less than 0.05%.

Table no 5 Unrestricted Co-integration Rank Test (Max.Eigen Values)

Null Hypothesis	Eigen values	Max. Eigen statistics	Critical value at 5%	Prob.
None *	0.794169	58.48590	58.43354	0.0494
At most 1 *	0.769529	54.30238	52.36261	0.0312
At most 2	0.681181	42.29593	46.23142	0.1245

H_0 = Tabulated value less than value
H_a = Tabulated value greater than value

Above table shows the co-integration (Max. Eigen value) and shows that there are 2 co-integration its mean there are 2 variables which are co-integrated. The variables with the symbol of * indicate that the null hypothesis will be rejected at 0.05% as the Max. Eigen value should be greater than the critical values. In this table the 5th Column show the prob. value which should be less than 0.05%.

Table no 6 Johnson (1991) maximum Likelihood for co-integration

Null hypothesis	Trace statistics	Critical value at 5%	Prob.	Maximum Eigen value	Critical value at 5%	Prob.
R = 0	255.3883	197.3709	0.0000	58.48590	58.43354	0.049
R ≤ 1	196.9023	159.5297	0.0001	54.30238	52.36261	0.031
R ≤ 2	142.5999	125.6154	0.0030	42.29593	46.23142	0.124
R ≤ 3	100.3040	95.75366	0.0234	34.87757	40.07757	0.171
R ≤ 4	65.42644	69.81889	0.1066	25.13434	33.87687	0.376

H_0 = Tabulated value less than value

H_a = Tabulated value greater than value

This study found the variables are support the trace statistics and the maximum Eigen value are greater than its critical value then null hypothesis will be rejected. This able show that there is co-integration is found among the food industrial production, food import, food export, agricultural production, technology, GFCF, labor force, electricity production and foreign direct investment).

4.2.3 (VAR) Vector Autoregressive Model Specifications:

This study used unrestricted VAR on the bases of the co-integration result, to investigate the impact of technology on the food industrial production. The VECM test estimate the long run affect of variables on food industrial production. This study applied LM test, to check the auto or serial-correlation among the variables, VEC Correlogram to test the stationary and auto correlation of the following variables.

Food industrial production, food import, food export, agricultural production, technology, gross fixed capital formation, labor force, electricity production and foreign direct investment

Table no 7 VECM result

variables	Model 1		Model 2	
	Coefficient	t-statistics	Coefficient	t-statistics
Food Industrial pro.	1.000	___	1.000	___
Technology.	1.23	5.62	1.03	19.03
Electricity pro.	8.18	3.51	___	___
Food import	-4.18	-7.43	-0.99	-4.31
Food export	3.18	3.01	-0.07	-0.10
FDI	5.05	6.61	___	___
Agricultural pro.	___	___	6.33	12.43
GFCF	___	___	2.44	18.34
Labor force	___	___	1.69	7.21
C	369.36		45.28	
R-squared	0.57		0.64	
Adj. R squared	0.32		0.37	
F-statistic	2.27		2.40	
Akaike AIC	50.73		4.64	
Schwarz SC	51.34		5.34	
Mean dependent	8.55		0.62	

MODEL 1

$$IND = \alpha_0 + \alpha_1 TECH + \alpha_2 ELE + \alpha_3 FIMP + \alpha_4 FEXP + \alpha_5 FDI + \varepsilon_t ----(1)$$

MODEL 2

$$IND = \beta_0 + \beta_1 AGRI + \beta_2 GFCF + \beta_3 TECH + \beta_4 FIMP + \beta_5 FEXP + \beta_6 LF + \varepsilon_t --(2)$$

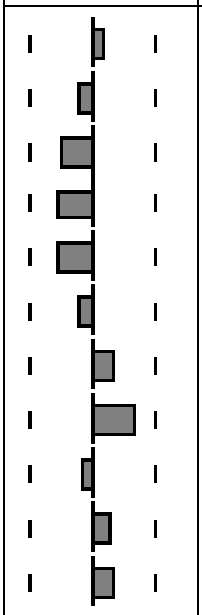
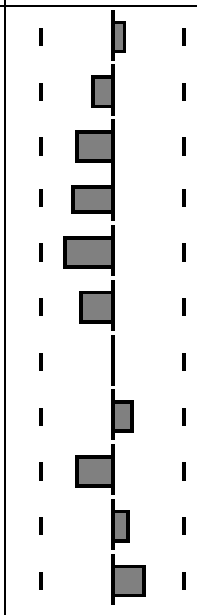
In both models, the value of technology indicates positive relation with industrial sector. the technology plays vital role to enhance the production of the industrial sector. the innovative ability of the various agents in the food industry and the extent of coordination existing among them to drive technological trends in specific areas helps in changing the dynamics. These areas include additives, packaging, equipment and machines, and information technology. This result is supported by Flipse et, al (2014), . Carvalho et al. (2013) Kaplinsky (1984), Hoffman and Kaplinsky (1988) and Perez (1985) .The electricity is necessary to run the machinery or the technology in the industries. It has significant role to control automated

process and electronic equipment when the production of the electricity increases, the supply of the electricity also increases. More supply/ production of the electricity mean provision of energy to the industries at low price. If the food industries take electricity in reasonable price, the cost of production of the food industries will decrease and its production capacity will increase. So, the electricity production is important for the more production in food industries. O.J. Soto Marín et al. (2014) supported this result. The value of the food import shows the negative effect to food industries of the Brazil. Brazil import vine, beer, dry fruit, olive oil and beverages. These imports are threat for the food industries of the home country. Food imports increase the burden of government and home industries have to face competition of the commodities with other imported goods due to quality difference. Home food industries have to sell the products in low prices. This result supported by Michel R. Mullen (1993) and Matt turner (2016). The coefficient value of the food export shows the positive effect to food industrial production in the model 1. If the export of the country boost up the industries tries to increase the production to meet the needs. One hand the country get good balance of payment and other hand the food industries increase its production and can get abnormal profit. Through the food export the country enable to get revenue than less risk because these industries sells their goods to different customers at different price outside the local market. This result is supported by Marelli and Signorelli (2011) Khan and Ahmed (2011). The foreign direct investment explains the positive relation with the food industrial production, according to ABIA (2015) Foreign direct investment to the sector; food, beverage, and tobacco industry stood at 1.9 billion dollars in 2002. It enhance the food production more than last years. FDI increase the abiltity of the industrislist to purchase more advance technology that helps to boost up the prodcution and brings the innovation. The agricultural production is independent variable in model 2. As it is fast relation between the agricultural production and food industries. The agricultural sector provides the raw material to food industries. The novelty and inventions are one of the major factors that bring about the revolution in Industrial sector. Modernization in agricultural field increases the capacity of this sector to supply the raw material. The production surplus in agricultural production declines the price of commodities which decrease cost of output in industrial products. The result is supported by David Fox (2012). The value of the gross fixed capital formation shows the positive effect to food industries of the Brazil. In any country Infrastructural bottlenecks are significant obstacles to agriculture's capacity to supply the food industry with raw material required for processing. gross fixed capital formation inculding, equipment purchases, commercial and industrial buildings, new technology, the construction of roads, railways, private residential dwellings, enable the food industries to boost up its production. Constanza et al. (2009). Labor force is very imperative asset of any country. If the labor force of any country is well educated and technical trained, it makes country develop in industrial way. As the industrial sector needs technical trained people because they can understand all the requirements. The product innovation and performance are related to better education and skill. The technical and vocational trained labor force can understand the new phenomena to enhance the quality of products in food industries. Dickson (2008) and Vehees et al. (2004) support this result. The result of this study is supported by the Solow Swan theory that new technology is necessity for the production.

4.2.6 VEC Correlogram of data

The Correlogram is very effect econometrics method to test auto correlation of the variables. The Correlogram test shows the result in graphical form as well as tabulated form. The stationary value and correlation is checked for the lags 11.

Table no 8;

Auto-correlation	Partial-correlation	Lags	AC	PAC	Q-STAT	Prob. values
		1	0.058	0.058	0.1379	0.710
		2	-0.079	-0.083	0.4036	0.817
		3	-0.170	-0.162	1.6630	0.645
		4	-0.187	-0.182	3.2281	0.520
		5	-0.181	-0.208	4.7386	0.449
		6	-0.077	-0.150	5.0222	0.541
		7	0.114	0.007	5.6587	0.580
		8	0.206	0.093	7.8149	0.452
		9	-0.056	-0.163	7.9806	0.538
		10	0.082	0.068	8.3481	0.595
		11	0.104	0.141	8.9595	0.626

Hypothesis

- $\mathbf{H_0}$ = there is no serial or auto-correlation
- $\mathbf{H_a}$ = there is serial or auto-correlation

In this table the vertical solid line indicates the zero axes. There are positive observation in the right side of line and negative in the left side of this line. As the prob. Value is greater than the 0.05. So, the null hypothesis is accepted and alternative is rejected. On the other hand, it is very clear from this diagram that serial correlation at some lag is around to zero. Its mean the model is free from serial or auto-correlation and time series is probably stationary.

4.2.7 VEC Auto or Serial Correlation LM Tests

The auto-correlation is referred as the serial co-relation or lagged correlation. In the VAR model through the VEC Residual Serial Correlation LM Tests, the study finds the auto-correlation in the model. The LM (Langrangian Multiplier) is developed by the Breusch and Pagan (1979).

Table no 9

Lags	LM. Stat	Prob. Values
1	69.44936	0.2990
2	82.55422	0.0592
3	104.1497	0.0011
4	81.02998	0.0739
5	69.57971	0.2953
6	77.78653	0.1153
7	52.19493	0.8544
8	102.9614	0.0015
9	75.14767	0.1607
10	80.20816	0.0831

Hypothesis

H_0 = there is no serial or auto-correlation

H_a = there is serial or auto-correlation

The null hypothesis of is test is there is no serial or auto-correlation the alternative hypothesis is there is auto-correlation the model. The prob. Value should be greater than the threshold level 0.05 in the table; it shows the significance of the model. It has been seen that the prob. Value is very high in all the lags and the degree of freedom is 64. These results are indicating that there is no auto–correlation among the variables. So, according to result the H_0 is accepted and H_a is rejected. So, model can be used for the forecasting at 10 lags hypothesis. .

5 Conclusion and policy recommendation

Brazil is a country with a population estimated at 210 million; a number which has earned it the fifth largest country in the world. The industrial sector play important role in the Brazilain economy. Its manufacturing sector includes chemical product, apparels and textiles, metal, fabricated metal products, and food, beverage and tobacco industry. However, the largest of all these subsectors is the food, beverages and tobacco industry having a production value of about 10.8 billion dollars. Since 2010, the South American food and beverage revenue have grown twice the size, representing 10% of its 2017 Gross Domestic Product- GDP while its revenue remains among the ten highest grossing in the world (Statista, 2018). Other earlier studies by Kaplinsky (1984), Hoffman and Kaplinsky (1988) and Perez (1985) argued that the introduction of the full range of new technology assist activities of the firm and its relationships with suppliers and consumers thus; producing synergies i.e., the total gains are more than the sum of the individual benefits. Yet still, some other early studies argued that the application of new technology to the manufacturing industry is, in the view of the 'modern technology' literature, changing its nature in several respects including the accommodation of specific sectoral lfeatures (Bessant, 1991; Ferrazet al., 1991; Kaplinsky, 1984, 1990a, 1991; Piore and Sable, 1984; Perez, 1989).

This recent study has explained the FDI (foreign direct investment), import and export of food, technology, labour force, agricultural production and electricity production as independent variables which have never been used at same time. This study selected the data from 1980 to 2018 from WDI. First of all this study applied The ADF (Augmented Dickey Fuller 1979) to verify the stationary values of the variables. This study also applied Johnson co-integration technique to check the long run relationship among the variables. This study developed two models for the analysis. Further, this study applied econometric technique, VECM. These results are based on E- Views 10 estimations.

Over all finding of the study indicates that null hypothesis of the study are rejected. This analysis shows that technology has positive effect on the food industries. The other variables (Food industrial production, food export, agricultural production, technology, GFCF, labor force, electricity production and foreign direct investment**)** also show the positive effect on the food industrial production; but imports of food, it has negative relation with food industrial production. This study is supported by the Solow Swan theory that new technology is necessity for the production

This study explained, the technology has direct and indirect positive impact on the food industrial production. The total gains are more than the sum of the individual benefits. The technology plays vital role to enhance the production of the industrial sector. the innovative ability of the various agents in the food industry and the extent of coordination existing

among them to drive technological trends in specific areas helps in changing the dynamics. These areas include additives, packaging, equipment and machines, and information technology. The country gets comparetive advantag in the trade, this result support to Comparative advantage theory by David Ricardo.

5.1 Policy recommendations

On the base of conclusion of the study there are following policy these policies are necessary and need of time.

- The export restriction should be revised to save the country from the food scarcity.
- The government should enable the food industries to produce food which use to import from other countries.
- Government should provide subsidies to food industries that these industries use modern technology for output.

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Appendix

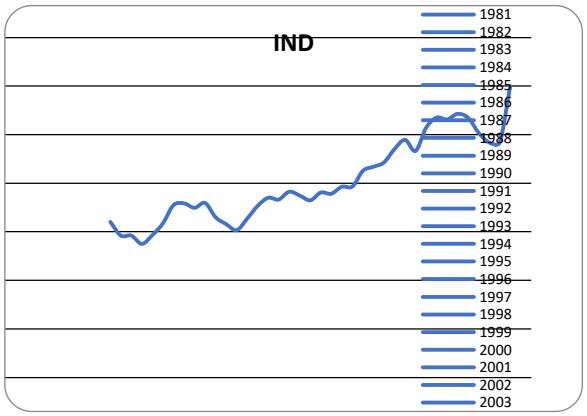

Figure 2 Food Industrial Productions from 1980 to 2018

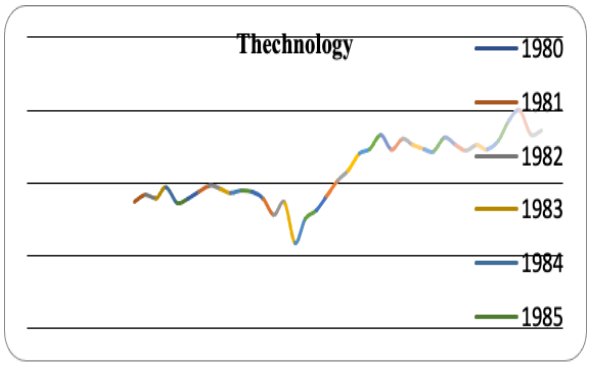

Figure 3 Technological imports from 1980 to 2018

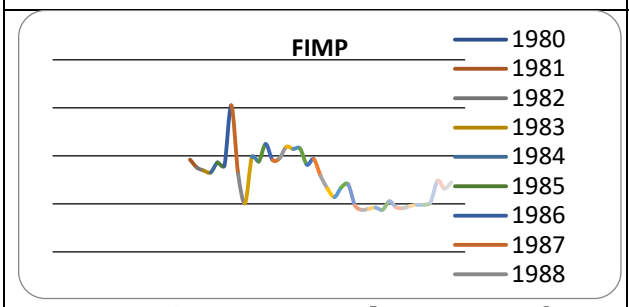

Figure 4 Food Imports from 1980 to 2018

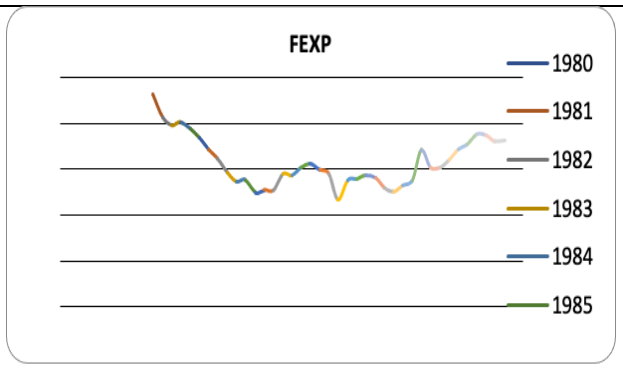

Figure 5 Food export from 1980 to 2018

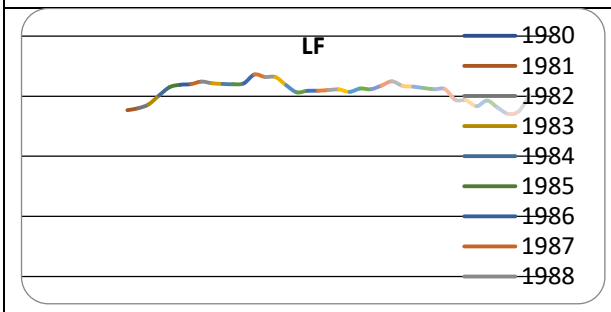

Figure 6 Labor forces from 1980 to 2018

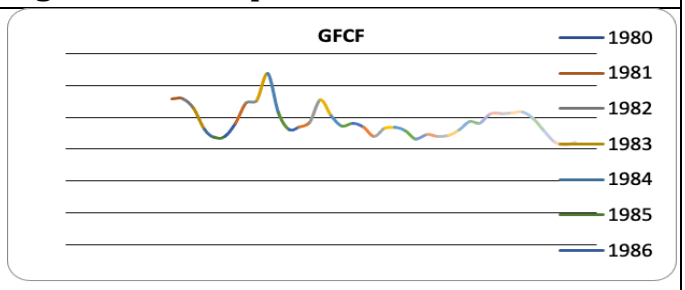

Figure 7 GFCF from 1980 to 2018

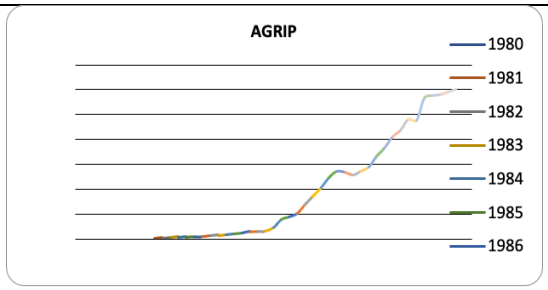

Figure 8 Agricultural Productions from 1980 to 2018

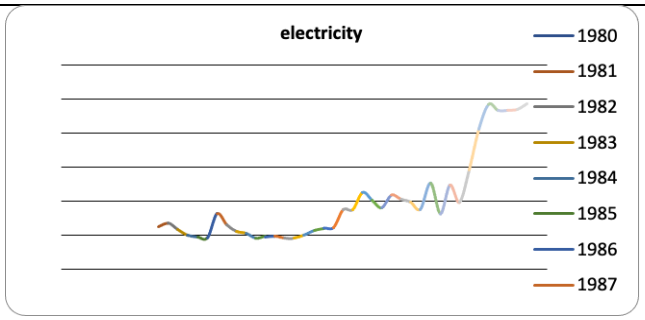

Figure 9 Electricity Productions from 1980 to 2018

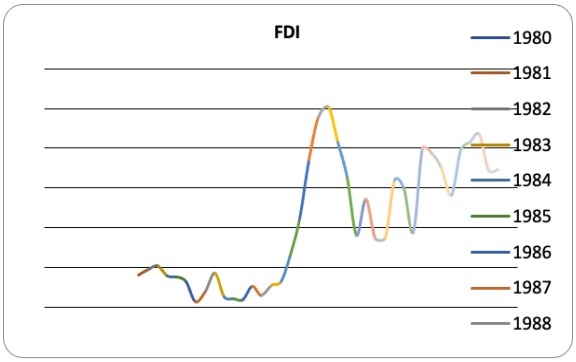

Figure 10 FDI from 1980 to 2018

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