

# Analyzing the Efficiency of Dairy Production in the Philippines

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**Abstract** — *The efficiency of the dairy industry in the Philippines is determined by the sector's productivity in relation to investments, imports, and exports that it is making. The use of Total Factor Productivity (TFP) in this paper is to examine the connection between the dependent variable and independent variables. More so, this research aims to evaluate the efficiency of the dairy industry along with the objective of assessing the impact that investments, imports, and exports have. Quarterly data from 2006 to 2017 helps to obtain results and use for further interpretation using regression analysis. The study shows that investments, imports, and exports do affect the productivity of the dairy industry in the Philippines. It leads to rejecting the null hypothesis in this paper. The research findings may address these issues by giving attention to exports and investments mainly to machineries and other technologies that contribute to dairy operations. The researchers also recommend that to be able to improve productivity, investments, imports, and exports of the dairy industry, the government should provide more funding and assistance to dairy farmers.*

**Keywords** — *Investments, Imports, Exports, Productivity, Efficiency, Dairy*

## I. INTRODUCTION

To be categorized as a dairy product, food must be produced from the milk of cows, buffalo, goats, etc. (Burke et al., 2018). The dairy sector includes food such as liquid milk, milk powders, cheese, butter, and yogurt, as well as ice cream and several factors including genetics, and breed of animal, environment, stages of lactation, parity, and nutrition, together determine the final composition of milk (Burke et al., 2018). According to the National Dairy Authority, the dairy industry in the Philippines started during the 15th century where Filipinos and Spaniards enjoyed the soft cheese made out of the carabao's milk. Later on, in the 1900's two American businessmen, N. S. Schober and M. Teague built the first milk processing plant in the Philippines, then 25 years later, a local company named San Miguel Corporation bought the plant and up until now it is still in the market known as the Magnolia Dairy Plant. After five years, three milk processing and bottling plants were established alongside with the growing demand for milk, then Philippines started to import milk such as Marca Oso (now "Bear brand") and Senorita (now "Milkmaid"), then through the years different local and foreign companies entered the market to supply dairy products. The dairy industry continues to find ways on maximizing the available resources through efficiency in production to be able to meet local demand for dairy products.

The world's milk is predominantly cow's milk, followed by buffalo milk. The leading producers include, Asia (30%), followed by the EU (28%), North and Central America (18%), South America (9%), other European countries (9%), Africa (5%), and Oceania (5%) (burke e al., 2018). However, during the start of 2019, USDA said that the Philippines will set its highest record for imports of dairy products adding 21% to the last year's number of imports. Dairy products are currently the country's third largest agricultural import after wheat and soybean meal and the major suppliers are New Zealand at 39 percent, US 21 percent and Australia seven percent (Simeon, 2019). The Philippine is incapable of sustaining local demand because it only produces less than 1% of its annual total demand for dairy products and depending on the remaining balance from the imports.

According to the Food and Agriculture Organization of the United Nations (2016), milk is one of the most produced and valuable agriculture commodities worldwide. Globally, the dairy sector is rapidly growing. It is

projected that milk production around the world would increase by 177 million tons by 2025, at an average growth rate of 1.8% per annum in the next 10 years. The consumption of dairy is also expected to increase per capita by 0.8% and 1.7% per year in developing countries, and between 0.5% and 1.1% in developed countries.

People have been drinking milk coming from dairy animals for a thousand years, and even up until now, milk is one of the most demanded necessities by many households all over the world. Its wide range of usage and its nutritious components are what makes it more demandable by people; it is consumed by babies, teenagers, adults, and old people. According to FAO (2013), milk contains numerous nutrients and it makes a significant contribution to meeting the body's needs for calcium, magnesium, selenium, riboflavin, vitamin B12 and pantothenic acid (vitamin B5), supported by Burke et al. (2018), milk and dairy products are significant sources of protein, essential minerals (calcium, potassium, magnesium, phosphorous, sodium, iodine) and several vitamins, (the fat-soluble vitamins A, D, E, K, and B1, B3, B6, B12). The milk proteins contain the nine essential amino acids required by humans, making it an important human food (Burke et al., 2018). However, milk does not contain enough iron and folate to meet the needs of growing infants, and the low iron content is one reason animal milks are not recommended for infants younger than 12 months old (FAO, 2013). When investigating the relationship between dairy products and health, it is important to consider that the human diet is complex and is not defined by the inclusion or exclusion of one food, but by its totality (FAO, 2013). Dairy industry is not only focused on the production of milk, rather there are many other dairy products that are commonly consumed by people namely; cheese, butter, yogurt, cream, ice cream, etc. These dairy products have been known to be useful in many different ways; for cooking, for baking, for beauty products, bath products, etc. Not only are milk and dairy products a vital source of nutrition for these people, they also present livelihood opportunities for farmers, processors, shopkeepers and other stakeholders in the dairy value chain. (Muehlhoff et al., 2013). The rapid rise in aggregate consumption of meat and milk is propelled by millions of people with rising incomes diversifying from primarily starch-based diets into diets containing growing amounts of dairy and meat and the underlying forces driving these trends are set to continue, and the potential for increased demand for livestock products remains vast in large parts of the developing world (FAO, 2013). According to FAO (2013), growing consumption of dairy and other livestock products is bringing important nutritional benefits to large segments of the population of developing countries, although many millions of people in developing countries are still not able to afford better-quality diets owing to the higher cost.

Based on the data of the United States Department of Agriculture, the annual consumption level of dairy products in the Philippines increased from 10.31% in 2018 to 20.56% in 2019 but it decreased by 10.85% in the year 2020. Unfortunately, when COVID-19 pandemic happened in the year 2020, the country's economy declined, people's purchasing power had weakened, citizens lose their jobs and some were laid-off, some businesses were forced to close due to bankruptcy; many industries were greatly affected and the dairy sector wasn't different from them. Bosire et al. (2019) stated that Crosson and Anderson (1994); Herrero et al. (2014); Regmi and Dyck, (2001); Schneider et al. (2011) said that consumption can be expected to increase in countries with accelerating urbanization and economic development.

This supporting research aims to evaluate the efficiency of the dairy industry in the Philippines. This research intends to: (1) identify the factors that contribute to the productivity of Philippine dairy industry (2) assess the impact of investments, imports, and exports on the efficiency of the Philippine dairy industry (3) measure the dependent variable and independent variables by using the gathered data.

The content of this research will contribute to the improvement of the overall productivity of the dairy industry in the Philippines. It can also contribute knowledge to various dairy-related organizations as well as to the higher institutions.

### **1.1 Scope and Limitations**

The study focused on the efficiency of dairy production in the Philippines by considering productivity, inventory, imports, and exports as the variables. The collected data was secondary and it only covered years from 2006 to 2015. Majority of these gathered data came from the Philippine Statistics Authority. Other independent variables that were not mentioned but may possibly impact productivity will not be discussed in this paper. Each variable has its corresponding measurement. However, due to data insufficiency, Total Factor Productivity (TFP) as the chosen indicator for productivity was not measured by using the ratio of input and output index. In that case, the volume of production index of the manufacturing sector in dairy products was used as a proxy in order to determine TFP.

## Research Problem

Dairy is the third largest agricultural import of the Philippines after wheat and soybean meal. Clearly, the dairy sector of the Philippines is dominated by imported products. Given this information, the research problems that will be discussed are (1) The Philippines heavily relies on imported dairy products rather than its local production; (2) the dairy industry in The Philippines lacks funding and technological investments; and (3) The Philippines is not self-sufficient when it comes to its dairy products.

## II. LITERATURE REVIEW

### 2.1. Efficiency

According to Oliveros (2019), dairy improves nutritional status of people and the dairy industry brings about socio-economic transformation by providing employment and contributes to the Gross Domestic Product (GDP) of the country. There is so much room for growth for dairy farming in Asia and they recognize the need to expand the industry to address issues on food security (Oliveros, 2019). According to Ondarza et al. (2017), in today's marketplace, sustainability is a new indicator of quality. It can be tempting to use dairy efficiency metrics to address consumer and retailer questions about sustainability, however, although each measure has merit for describing a segment of dairy efficiency, no one measure can entirely describe a dairy's efficiency or be applicable across all farms (Ondarza et al., 2017). According to Ondarza and Tricarico (2017), each calculated measure of dairy efficiency has its own advantages and limitations, and dairy efficiency goals should be considered to be moving targets that are specific for the current situation of individual dairy enterprises with the focus placed on continuous progress.

In contrast to cost accounting, efficiency analysis takes the whole farming system into account, including non-monetary inputs (Allendorf, Wettemann, 2015). Technical efficiency is based on the concept of the production frontier, which represents the maximum output allowed by technology (Cachia, et. Al, 2018). The major interest behind measuring technical efficiency levels is to know what factors determine the inefficiency differences among farmers (Yilmaz, Gelaw, Speelman, 2020). Several methods can be used when quantifying technical efficiency and all of them aim to identify the share of productivity growth resulting from efficiency changes through the measurement of the distance between observed productivity and a theoretical, optimal, or average productivity (Cachia, Lys, Mechri, 2017). These methods can provide farm-level estimates of technical efficiency. Researchers have spent much effort examining managerial performance in agriculture, which is often proxied by technical efficiency (TE), and a considerable share of this work has focused on dairy farming (Moreira et al., 2016).

Technical efficiency is a different concept from productivity. Technical efficiency is one factor that contributes to productivity growth and measures how well a farm is able to combine the different inputs and factors of production to be able to produce a maximum amount of output. Meanwhile, productivity measures how much output can be produced out of a given amount of resources. The US dairy industry has realized tremendous improvements in efficiencies of production (Martin and Mitra, 2001, 2013), achieved in part by investing in technology and productive assets, and paid for by economies of scale (von Keyserlingk et al., 2013).

On the other hand, agricultural productivity and efficiency are also at the forefront of debates, policies, and measures when it comes to the agricultural sector. Productive efficiency is one of the key prerequisites for the competitiveness of enterprises in every business (Spicka, Smutka, 2014). Meanwhile, production efficiency improvements can come from minimizing waste, maximizing the dairy milk production of a dairy cow, and maximizing the proportion of their life spent in peak milk production without sacrificing animal health and well-being (Place, Mitloehner, 2010). Moreover, for developing countries facing an increasingly globalized economic environment, productivity growth and improving competitiveness is essential to ensure the prosperity of agriculture and contribute to poverty reduction (Thirtle et al., 2003, 2016; World Bank, 2003, 2008, 2016). Although, despite the importance of agricultural productivity, data has been scarce and inadequate in developing countries. There is a lack of statistics in regards to agricultural productivity. However, over the years, significant contributions have been made towards the better understanding, measuring, and analyzing of agricultural productivity.

One factor that can affect the productivity of the dairy animals is their feeds. According to Kiel (2013), from an economic point of view, feed cost is the single most important factor affecting the profitability of dairy farms. The cost of feeding usually accounts for more than 50% of the total cost of milk production (Hemme, 2010, 2013). However, through feed efficiency and according to Food and Agriculture Organization of the United Nations (FAOSTAT, 2013), such improvements have allowed for a two-fold increase in total global milk production in the last 50 years alone and have consistently placed whole fresh cow milk among the first- or second-ranked agricultural commodity in the world for production value during the last decade. Research focusing specifically on feed efficiency of dairy cattle is less prevalent and only recently has appeared consistently in the scientific literature (Berry, 2009, 2014). One reason for the lag is that dairy cows present an additional challenge in estimating net feed efficiency because of the large fluctuations in their energy balance that occur throughout the annual lactation cycle, particularly the contribution of energy mobilized from body fat during early lactation (Connor, 2014). In their investigation of the technical efficiency of dairy farms in Australia, for example, Kompas and Che (2006, 2020) found that total grains and concentrates used per cow has a positive and significant effect on technical efficiency, although the effect was small in absolute value. Furthermore, the dairy processing sector is continually upgrading its plant to handle greater volumes of milk, produce a wider range of products for domestic use and export and improve efficiency (New Zealand Institute of Economic Research, 2017).

Agricultural intensification is technically defined as an increase in agricultural production per unit of input such as labor, land, time, fertilizer, seed, supplementary feed, or cash (FAO, 2004; Salou et al., 2017, 2020). As land is a strongly limiting input for agricultural production, the trend toward intensification seems unavoidable globally (Ma W. et al., 2020). In the dairy sector, intensification involves different strategies such as increasing off-farm inputs (e.g., fossil fuels, chemical fertilizer, pesticides, and the amount of supplementary feed) and using better plant cultivars that are lower in fiber and higher in protein and energy (Lean et al., 2008; Chobtang et al., 2017; Salou et al., 2017, 2020). Intensification often requires increased investment by the smallholder farmers, thereby also increasing the risk of losing this investment if production fails (Udo et al., 2011, 2019). According to Ma, Bicknell, Renwick (2020), these strategies allow producers to increase stocking rates (the number of cows milked per hectare of land), which is often associated with higher levels of productivity and profitability. Several reasons for this transformation have been identified, including to increase the volume of production, to respond to seasonal weather patterns, and to react to public pressure concerning animal welfare through a desire to improve cow body condition (Stafford and Gregory, 2008; Mounsey, 2015; Ma et al., 2019, 2020). Second strand analyzes the effect of intensification on technical efficiency (i.e., the effectiveness with which a given set of inputs is used to produce an output) of dairy production (e.g., Kompas and Che, 2006; Abdulai and Tietje, 2007; Alvarez et al., 2008; Basset-Mens et al., 2009, 2020)

Quite a few studies have been devoted to the estimation of the total factor productivity (TFP) growth in the Indian dairy industry (Ohlan, 2013). SINGH (2004, 2013) sought to scrutinize the performance of the Indian dairy industry applying a non-parametric method called data envelopment analysis using the data for the period 1980-1997. According to Ohlan (2013), they briefly outline the Tornqvist index used for estimating total factor productivity (TFP) growth and data envelopment analysis (DEA) models, viz. CHARNES et al. (1978) and BANKER et al. (1984) applied for efficiency measurement.

A farm is said to be technically inefficient if it does not produce the maximum level of output that can be expected given the resources available (Global Strategy, 2017, 2018). Moreover, results from Brazilian dairy industry suggested that the focus on specialization in added-value products and operating in high scales may contribute to higher pure technical efficiency scores. However, in the long term, it could demonstrate that the inefficiencies will be much more concentrated in the small dairies as they do not have specialized added-value products. Therefore, it can be one of the main causes of the recent decrease in the number of small dairies and the production concentration in a small number of large dairies (Lima et al., 2018). An increase in technical efficiency raises productivity as well since more output can be produced using the same resources. Improvement in technical efficiency in milk production requires adequate and quality veterinary services, augmentation of feed and fodder resources at the farm, integration with a formal marketing system, and scaling-up of the dairy enterprise (Spicka, Smutaka, 2014).

## 2.2. Production

According to Lokuruka (2016), worldwide, the dairy sector is one of the fastest growing food sectors both in terms of volume output, sales and real commodity prices. In parallel to global initiatives, such as the 2030 Agenda for Sustainable Development, several countries have introduced policies to improve agricultural

productivity, especially in countries where agriculture is a major economic sector and the productivity gap among the primary sector and other industries and services is the widest and Enhancing productivity in agriculture is important because of its effective contribution to poverty reduction through better food security and higher farm incomes (FAO, 2017). Sustainable dairy production must return a profit for the dairy enterprise and produce quality milk for consumers while maintaining optimal cow well-being and practicing environmental stewardship (von Keyserlingk et al., 2013, 2017). While the national government has continuously adopted a “stop-gap” measure, it also recognizes that developing the local dairy sector is a more sustainable and empowering approach for Filipinos, thus, current government initiatives are anchored on multi-pronged strategies that include massive herd build-up, provision of support to post-production infrastructure, establishment of market linkages, human resource development, and deployment of livestock research and development instruments (Palacpac, 2010).

According to the United Nations Food and Agriculture Organization (2014), production is led by the United States; they are the largest producer of cow’s milk in the world. At the same time, there is growing demand from consumers and policymakers for milk that is produced sustainably and with low environmental impact (Niles et al., 2019).

The demand for dairy products is expected to increase at a rapid rate in the Asian countries and changing food habits will have an important role to play in the increase in the demand for dairy production in the Asian market (Ingavale, 2012). According to Burke et al. (2018), changing consumer demand patterns are affecting food production. The “Traditional” value drivers of price, taste, and convenience have been complemented by newer and “Evolving” drivers such as health and wellness, safety, social impact, and experience and central to all of these drivers is a need for transparency from food companies, thus given the ever-changing nature of the consumer food value drivers, dairy producers must look to their production processes to innovate with new products and to optimize output without compromising on quality and safety (Burke et al., 2018). Many developing countries aim to increase production to meet both the growth in demand by the wealthy consumers and concurrently commit to poverty alleviation through implementing interventions that enhance smallholder farmers’ engagement in market-oriented economic activities leading to improved livelihoods (Herrero et al., 2014; Schneider et al., 2011; Thorpe et al., 2000, 2019).

According to the Food and Agriculture Organization of the United Nations (2018), the measurement of productivity has been the subject of several academic papers, manuals and guidelines, since the foundational work of Solow (1957) and Diewert (1980). Productivity is at the centre of economic growth, at the micro- (farm), meso- (sector) and macro-levels (economy- wide) and with everything else equal, higher productivity results in higher production (more output is produced out of the same input base) and higher profits or income (FAO, 2018). According to Moreira et al. (2016), analysis of productivity growth over time and productivity differentials between countries, regions, and farms have been and remain important subjects of formal analysis in agricultural and development economics (Berry and Cline, 1979; Carletto et al., 2013).

According to Gollin (2018), a large literature in development economics has focused on the so-called “inverse relationship” between farm size and land productivity (typically measured as physical output per unit of land, which is more simply termed “crop yield”). Sen (1962, 2018) suggests that this relationship arises from imperfections in land and labour markets, such that poor households use family labour intensively on small plots, leading to high land productivity – but also associated with low labour productivity.

Productivity, as discussed by the Organisation for Economic Co-operation and Development (2001), is the relationship between the volume of inputs and outputs used to produce another output. The output that is being considered in measuring productivity can be in terms of the number or volume of goods and services produced using the factors of production or inputs available. Productivity should be increased in a sustainable manner so that the environment is not further degraded, management practices are both socially acceptable and economically favorable, and future generations are not disadvantaged (Toma et al., 2013).

Productivity is one of the bases of economic growth. Higher productivity means higher production and when the economy is able to produce more using the same number of resources as the previous production, it will yield an increase that can help boost the economy. The growing population of the world created a continuous increase in demand for agricultural goods which also includes dairy products over the years and due to the increasing number of demands, a huge increase in agricultural productivity is needed and it has been

proven by Ruttan (2002), Rao and Coelli (2004), Chen, Yu, Chang, and Hsu (2008), and Fuglie (2010). Productivity is used as a measurement of performance of various sectors and industries in a country. Data from statistical agencies or companies that produce data are used to measure the productivity of a certain sector or industry; data collection/data gathering is the first step to measure productivity together with the derivation of other variables that affects the level of productivity. Thus, it can be described as the ratio of inputs and outputs; substantial ratio of inputs and outputs is associated with great performance. It also determines whether a certain industry is able to sustain the demands of the growing market using limited resources, that is why it can also be used as a measure for sustainability. In a macroeconomic perspective, the more efficient use of resources and the reallocation of the surplus to the other economic activities lead to an increase in national income. As stated by the Food and Agriculture Organization of the United States (2016) the procurement process of data and statistics gathered by agencies, method of data collection, instruments used to gather data up to the establishment of related variables and to its proper interpretation must be reliable, relevant, and of best quality in order to produce a good measure of productivity.

Productivity indicators are generally found in two forms: partial factor productivity and multifactor factor productivity. When only one input is considered, the term “single productivity indicators” is used, while “multifactor (or total factor) productivity” considers all major factors of production and intermediate inputs (Food and Agriculture Organization of the United Nations, 2016). Partial productivity or Single-factor productivity simply refers to the measurement of the volume of outputs produced using only one particular input. There are many factors that need to be considered to be able to show the productivity level of a farm. This method of measuring productivity is prone to misrepresentation of the farm that is being studied because inputs are interconnected with one another. Solely basing the level of productivity of a farm using a measurement that only considered single input and completely ignoring all the other major factors of production that might be affecting the farm and the chosen input to be considered in the study is not advisable to use in measuring agriculture level of productivity. This method should be used together with other major indicators that can measure all the related inputs which is accounted for in the second form of productivity indicators known as the Multifactor Productivity (MFP) or also called the Total Factor Productivity (TFP). However, these two have a difference with each other, the former accepts the fact that it is not possible to include all inputs and TFP only apprehends the main ones. TFP is often considered as a growth rate, and that it only represents the change in agricultural output but it doesn't speak for all or some of the inputs that were included namely; land, labour, capital, and intermediate inputs.

The dairy sector includes food such as liquid milk, milk powders, cheese, butter, and yogurt, as well as ice cream. In many respects, dairy production may be viewed as being in a unique position compared with the other sectors in agriculture (Doughrati et al., 2013). The dairy industry has several features that distinguish itself from the other sectors of agriculture. An example would be how much transportation costs for milk. Since milk is harvested every day and is perishable with a limited shelf life, high-transportation costs are needed. Another unique characteristic of the dairy industry is the socioeconomic position of dairy producers. Majority of farmers are small-scale producers who have a vulnerable place in the dairy market. The nature of the business does not allow them to adjust to market changes freely. They are only allowed to adjust in a limited, slow, and gradual way. Due to these limitations, dairy producers are considered as price takers and not price setters.

On the other hand, since milk is harvested every day, this provides a daily income for dairy farmers despite its limitations in production and marketing process. Milk production also provides a lot of employment opportunities since it is labor-intensive. Opportunities can be found not only on the farming aspect of milk production but also in the transport and processing of milk and the agricultural supplies and services sectors. This is also the reason why the dairy industry is considered vital for the sustainability of rural areas.

China had experienced changes in their dairy farm structure ever since there was a drastic decrease in the number of backyard farms and had caused a decrease in the number of dairy cows. However, despite these changes, herd numbers of large farms increased all at the same time; numbers were increased by 18.8% for the small farms, 22.2% for medium farms, and 80.8% on large farms. China changed their method of measuring technical efficiency from total factor productivity to stochastic production frontier. The estimated results indicate that patterns of productivity growth appear to have shifted in the 2000s compared with the 1990s, from generally driven by technological change to exclusively driven by technological change on backyard and small farms and uniquely driven by the improvement of technical efficiency on large farms (Ma et al., 2012).

Analysis of productivity growth over time and productivity differentials between countries, regions, and farms have been and remain important subjects of formal analysis in agricultural and development economics (Berry and Cline, 1979, 2016; Carletto et al., 2013, 2016). The measurement and analysis of productivity has attracted the attention of economists for a long time, and has resurfaced as a topic of interest particularly in the context of poverty alleviation within the Millennium Development Agenda (Hazell et al., 2007, 2016) and more recently the Sustainable Development Goals (United Nations, 2015, 2016).

Volume of production or total output in connection with efficiency was also acknowledged. According to Aristovnik et al. (2012), the measurement of efficiency generally requires an estimation of output. It also determines the link between input, output, and outcome as a main component of efficiency indicator. Furthermore, the greater the output for a given input or the lower the input for a given output, the more efficient the activity. Efficiency analysis in agricultural production is generally associated with the possibility of farms producing a certain level of output from a given bundle of resources or a certain level of output at least cost (Girei et al., 2013). According to Simonyan et al. (2012, 2013), a production process may be technically inefficient if it fails to produce maximum output from a given bundle of inputs. Also, it is known that a unit can be made efficient by increasing the output level with the same input level (output orientation) (Banaeian et al., 2011).

### 2.3. Imports

According to Borawski et al. (2015), international trade is an important factor in the development of a country and the formation of the Gross Domestic Product and is often regulated by laws and policies. The development of foreign trade in agri-food is influenced by demand growth abroad, the competitive prices of products, and product quality (Borawski et al., 2015)

In 2020, liquid milk imports have dropped as the use of liquid milk in food in coffee shops has declined due to COVID-19 lockdowns (Ang, 2020). Similarly imports of butter and other dairy spreads as well as cheese, mainly from New Zealand and Australia due to the duty-free of those suppliers are also seen to drop due to the economic slowdown and reduced food service operation (Ang, 2020).

According to Ang (2020), dairy products are currently the country's third largest agricultural import after wheat and meal. Post projects total dairy in 2020 to to 2,800 MMT (in Liquid Milk LME) due to a slowdown in demand for dairy products caused by the COVID induced economic slowdown, however, 2021 dairy imports are forecast to increase marginally as economic activity starts to recover, as the outbreaks are contained (Ang, 2020).

According to Lokoruka (2016), improved milk output reduces importation of dairy products. This spares foreign exchange and makes milk more available to citizens which in return, improves the nutritional status of poor families and farmer households whose source of protein is usually milk. Net import demand for dairy products would grow faster than net export supply through 2013, with demand growth coming primarily from developing economies in Asia, Latin America, North Africa and the Middle East and this will lead to a "latent demand gap" (global shortfall between consumption and production forecasts) of ~100,000 metric tons of dairy protein by 2013 (equivalent to ~7 billion pounds of milk) (Vitaliano, 2016) supported by the study of Davis et al. (2018) that Southeast Asian countries with significant imports of SMP in 2015 included the Philippines, Indonesia, Malaysia, Singapore, Thailand, and Vietnam and with price, tariffs, and other trade policies being the factors to be considered when importing milk products, differences in the amount of imports per countries differ. Relationships between prices from one country to another are expected to have effects on the proportions of SMP imported from each country (Davis et al., 2018), for example Global Trade Atlas (2016) stated that the United States was the top supplier for skim-milk powder (SMP) in the Philippines accounting for 35% of the import share different to Singapore wherein US import share was only accounted for 5% in Singapore's total import share.

According to Sharma (2014), accessing a variety of imported inputs can potentially improve the productivity of firms. This channel could be vital in sectors requiring a large variety of specialized inputs in the production process. Imported inputs may also enhance the productivity of domestic firms by providing access to advanced technologies that are not available domestically (Lawrence & Weinstein 1999, 2014). Trade in general and imports in particular stimulate productivity growth through emulation. This happens because market competition and exposure to multinational firms speeds up technological acquisition, which lead to more rapid

technological and productivity improvements (Gerschenkron 1952, 2014). Main findings show that an increase in import competition spurs firm-level productivity growth. Furthermore, the productivity growth effect attributable to imported intermediate inputs is significantly stronger than the effect due to imported final products (Olper et al., 2016).

The abolition of milk quotas, which is in concordance with the World Trade Organization liberalization process, will expose EU farmers to international market competition, meaning an increase in milk production associated with raw milk price cuts (Areal et al., 2012). According to Areal et al. (2012) under the new scenario, only the most efficient producers will have the chance to remain in business, therefore, it is relevant, particularly for policy makers, to understand how the use of the quota market and its abolition may affect farm technical efficiency.

H01: Imports do not increase productivity.

#### 2.4. Exports

According to Borawski et al. (2015), exports allow countries to specialize in their strengths, which translates into better competitiveness for the economy. Economic theory identifies well-known channels through which trade can influence economic growth thus, international trade promotes efficient resource allocation, enables the country to realize economies of scale, facilitates knowledge diffusion, promotes technological advancement as well as fosters competition in domestic and international markets and new product development (Blavasciunaite et al., 2020). Due to the growing population of the world, demand for different types of goods also increases alongside the growing numbers of suppliers coming from all over the world. Some countries specialize in the production of one particular good and imports goods that are of limited supply in their country. In addition, an Indian dairy industry study of Ingavale (2012) expressed that export potential of any product depends largely on two factors: size of the foreign market & bargaining power of the exporting country. Thus, in developed countries, due to the slow growth of population coupled with negligible change in the existing dietary pattern, the demand for dairy products is less in these countries in the times to come.

Exports are expected to remain low despite duty-free advantages from the ASEAN free trade agreement due to increasing cost of imported dairy inputs and strong competition from other dairy producers (Ang, 2020). Substantial attention has been paid to the examination of trade balance effects on economic growth as it becomes an important indicator of a country's competitiveness and is important in assessing the country's economy and its relations with the rest of the world (Topalli and Dogan 2016; Kang and Shambaugh 2016; Akbas and Lebe 2015, 2020).

The complexity of national and global dairy chain structures and possible changes in export competitiveness are of increasing private sector and public policy concern (Piniot et al., 2012, 2014). Dairy chain export competitiveness on global markets is a crucial factor for the economic sustainability in the global marketing environment for the dairy sector (Bojnec, Ferto, 2014). According to MacDonald, Cessna, Mosheim (2016), the congress reorganized the policy in the Agricultural Act of 2014 (2014 Farm Bill) and it created a new program, the Dairy Margin Protection Program, aimed at providing farmers with financial protection against adverse movements in milk and feed prices, however, the Dairy Product Price Support Program, the Dairy Export Incentive Program, and the Milk Income Loss Contract Program expired after they were not renewed in the Act. The new program was initiated in response to wide fluctuations in milk and feed prices, and in particular to events in 2009, when falling milk prices combined with still-high feed prices exert unprecedented financial stress on the industry. Dairy policy has long been concerned with milk pricing and with financial risks facing dairy farmers, and the 2014 initiatives adjusted risk-management policies in light of ongoing changes particularly in farm structure and in dairy products that affect industry performance and influence dairy policy (MacDonald et al., 2016). Furthermore, according to MacDonald et al. (2016), gradual changes in U.S. and European Union (EU) dairy policies have helped drive the expansion of U.S. exports and the convergence of global dairy product prices. It also discussed that changes in EU dairy policies have had major effects on world dairy markets. Among other programs, the EU supported its dairy market through an intervention program (similar to the U.S. price-support program) and an export restitution program (similar to the U.S. DEIP program). Traditionally, EU dairy export subsidies had a strong influence on world prices. Dairy products are changing and (MacDonald et al., 2016) changes in the dairy product mix may also alter dairy price relationships, and hence may affect dairy price volatility.



Several studies find a positive correlation between TFP and exporting status (Casas et al., 2015). According to Casas et al. (2015), using data from Slovenia, De Loecker (2007, 2015) finds that firms that decide to export become more productive. See examples using data from Taiwan and Korea (Aw, Chung, and Roberts 2000, 2015), data from Chile (Pavcnik 2002, 2015), and data from sub-Saharan Africa (Van Biesebroeck 2005, 2015). Following the model presented by Clerides, Lach, and Tybout (1998, 2015), Lopez (2006, 2015) finds that exporters are more productive ex ante, and that the productivity of exporting firms increases with their exposure to international markets. Similarly, Echavarría, Arbeláez, and Rosales (2006, 2015) finds that total factor productivity increased with trade liberalization, since liberalization allowed for the technological progress of firms participating in foreign markets. Other studies that analyze the causes of this positive relationship between productivity and export status include Fernandes and Isgut (2005, 2015), Eslava et al. (2004, 2015), and Parra Oviedo (2003, 2015).

In order to benefit from the opportunities offered by demand and trade growth, to stabilize the dairy market and to ensure a fair functioning of the dairy supply chain a strong and efficient dairy industry is required. (Vlontzos et al., 2013).

H02: Exports do not increase productivity.

## 2.5. Investments

According to a study by Britt et al. (2018), the demand for dairy products and technologies will grow during the next 50 yr for 2 reasons, first, increased per capita income worldwide will boost demand for dairy and other food products from animals, and these products increasingly will provide essential nutrients in developing countries. Britt et al. (2018) also stated that in order to supply increased demand for dairy products in the decades ahead, there must be a sustainable balance between products produced within the country and imports. This provides opportunities for developed and developing exporting countries to provide dairy products as well as dairy equipment and technologies to expand dairy farming in countries where suitable land resources exist (Gerosa and Skoet, 2012, 2018). As demand for dairy products increases, it is important to understand global dairy production today and how it may change during the decades ahead (Britt et al., 2018).

According to Muia et al (2011), the increased costs of transportation and distribution systems due to the poor road network and long distance to markets resulted in high costs of inputs (supplements, animal drugs and vaccines, pesticides, fertilizers, and herbicides) and their unavailability. High cost and unavailability of electricity in rural areas reduced investments especially in cold storage facilities and processing of the highly perishable goods such as milk and dairy products and the cost of credit, limited use of land as collateral for financing farming, and the limited number of banks in the rural areas are some of the factors that made it difficult for farmers to access credit from the formal banking industry (Muia et al., 2011). According to Staal et al (2003, 2017) and Kibiego et al (2015, 2017), smallholder are able to remain competitive and has above normal profits than those of rural wages in Kenya, however, constrained by poor infrastructures and inadequate support like lack of collateral needed for bank loans (Kembe et al 2008, 2017). It is therefore important to note that carefully targeted development assistance to the dairy sub-sector especially the smallholder farmers is likely to translate into substantial benefits in terms of nutrition, improvement of livelihoods and creation of employment for rural poor (Waitituh, 2017).

Capper et al. (2009, 2011) highlighted the need to adopt management practices and technologies that improve productive efficiency to meet increasing product demand. Smallholder agricultural development in developing countries faces challenges and constraints related to persistent food insecurity, food price volatility, food safety and sustainability concerns, but also is experiencing increased opportunities arising from growing domestic and global agricultural market demand (McCullough et al., 2008; World Bank, 2006, 2007, 2012). According to Kilelu, Klerks, Leeuwis (2013), such a dynamic context requires the sector to continually innovate if it is to contribute to sustainable socio-economic development. In this regard, the agricultural innovation systems (AIS) approach has gained currency as a framework for understanding bottlenecks and identifying opportunities for enhancing the innovation capacity of agricultural systems, particularly in sub-Saharan Africa (SSA) (Houkonnou et al., 2012; Spielman et al., 2009; Sumberg, 2005; World Bank, 2006, 2013). AIS thinking recognizes that innovation occurs through the collective interplay among many actors – including farmers, researchers, extension officers, traders, service providers, processors, development organizations – and is influenced by factors such as technology, infrastructure, markets, policies, rules and regulations, and cultural practices (actors' values and norms) (Kilelu et al., 2013). Thus, innovations are not just about technology but also include social and institutional change, and have a systemic and co-evolutionary nature (Biggs, 1990; Leeuwis and van den Ban, 2004, 2013). According to Bosire et al. (2019), for smallholder farmers, it is thus

important to invest in practices that facilitate adaptation to increasingly limited land resources and water scarcity, failure to adapt would restrict their ability to produce the quantities of food demanded by the rising and urbanising populations.

The public sector has traditionally been the driving force behind these advances and represented the lion's share of agricultural research and development (R&D) expenditures, with global public sector R&D (Jaruzelski et al., 2017). But more recently, constrained fiscal policies in many countries have slowed public sector R&D growth. (Jaruzelski et al., 2017). According to Jaruzelski et al. (2017), private investment in agricultural innovation has resulted in new technologies and production techniques with significant promise to boost productivity. Coe et al. (2009, 2020) showed that domestic and foreign R&D capital stocks have a measurable impact on TFP, even after controlling for the impact of human capital and institutions.

Andersen and Babula (2009, 2020) identified the channels through which international trade may affect the economic growth: (i) it provides access to foreign intermediates and technologies; (ii) it facilitates the dissemination of knowledge internationally; (iii) it expands the market size for new product varieties. With the development of new technology, there are now equipment that could help in delivering fresh milk. In modern day dairy operations, certain tasks are being automated. New technologies include automatic feeding systems, cow separation systems, and robotic milking. Electronic cow identification is also in use. Electronic cow identifications are used to decide which pen a cow should be housed, if it needs to be separated for treatment or reproductive reasons, or simply because of how much feed it needs to receive based on its level of milk production and consumed feed. Other factors such as temperature, location, and movement sensors can also help provide information of cow health. Lack of technology can cause the milk to be perishable and fragile (Akbar et al., 2020).

There are three major types of production system when it comes to Dairy Farming in Asia (Moran, Chamberlain, 2017). These are classified as mixed farming, wherein milk production only contributes a relatively small proportion of total farm income. Second is the essentially smallholder dairy farms wherein milk production has improved and becomes a major contributor to farm income. Lastly is the larger specialist dairy farms which produce raw milk. Meanwhile, dairy development is also classified into two (Staal et. al., 2008, 2017). Traditional smallholder systems and commercial large-scale industrial systems are categories that were developed for the convenience of global dairy policymakers. Traditional smallholder systems are small-scale farm household systems often associated with informal milk marketing systems that predominate in many developing countries while commercial large-scale industrial systems represent industrialized production systems and marketing observed in most developed countries. Commercial large-scale industrial systems are usually single enterprises with large herds and high levels of farm inputs and outputs.

The way animals are raised on farms has changed greatly over the past century, including a growth in farm size and increased technology (Fraser, 2008, 2016). When it comes to milking systems, there are two types that are used in modern dairy production which are tie stall or stanchion and milking parlor systems. In a tie stall or stanchion system, milking units are brought to a tethered dairy cow for milking and milk is collected in a pipeline system. A worker will stand between a tethered cow and kneel or squat to attach a specialized milking equipment to the udder of the cow. This system is usually used in farms with smaller herd sizes. Meanwhile, the parlor systems involve cows being housed in dry-lot or loose housing facilities and moved into a milking parlor with stationary stalls where they are milked simultaneously with specialized milking equipment. Parlor systems can accommodate large numbers of dairy cattle and is ideal in large-herd dairy operations.

Social and technological developments of the past few decades have significantly influenced the variety of dairy products available (Food and Agriculture Organization of the United Nations, 2013). Membrane technology also plays a major role in modern day dairy processing. According to Kumar et. Al., (2013), membrane technology is used in the clarification of the milk, increase in the concentration of the selected components, and the separation of the specific valuable components from milk or dairy by-products. Membrane technology is a suitable alternative to many processing stages of milk in the dairy industry which are centrifugation, bacto-fugation, evaporation, and the demineralization of whey. Membrane technology also helps improve the economics of dairy by reducing the cost of production as well as generating new revenue resources (Siebert et al., 2001. 2013). Technological advances like My Dairy Dashboard. Virtus had previously acquired Farmeron, a Croatian startup that developed a cloud- based software platform for data management and agricultural pro- duction performance optimized for dairy farmers (Jaruzelski et al., 2017). According to Jaruzelski et al. (2017), My Dairy Dashboard will provide data aggregation for the dairy farm industry, to help enhance production and streamline operations. R&D activities or technology innovation abroad create new

intermediate goods that are different from or better than existing ones and by importing these new intermediate goods, domestic producers can improve their production efficiency (Choi, et al., 2010). Many empirical studies have found some evidence for this knowledge spillover effect through international trade by using either country-level data (Coe and Helpman, 1995, 2010) or industry-level data (Keller, 2002, 2010).

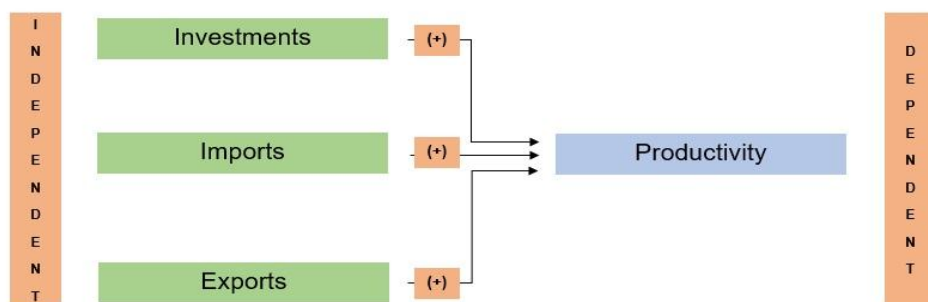
H03: Investments do not increase productivity.

## 2.6. Synthesis

From the literature that the researchers have gathered, studies show that demand for dairy products has increased in Asia, Latin America, North Africa, and the Middle East. This will lead to a latent demand gap or a global shortfall between consumption and production. However, a study by Blavasciunaite et al. (2020) states that international trade boosts the global economy and at the same time can become an important driver of the country's economic growth. International trade also promotes efficient resource allocation, enables a country to realize economies of scale, facilitates knowledge diffusion, promotes technological progress, and fosters competition in domestic and international markets, leading to production processes optimization and new product development. On the other hand, the development of new technology helps in increasing the productivity level of dairy farms. A study conducted by Jaruzelski et a. (2017) states that private investment in agricultural innovation has resulted in new technologies and production techniques with significant promise to boost productivity.

The research placed emphasis on three independent variables to see the significance on the productivity of the dairy industry in the Philippines and by which, to the efficiency as well. The dependent variable productivity represents the ability of a farm to convert production inputs into production inputs (Kimura, Sauer, 2015). It is measured through the use of Total Factor Productivity (TFP) by taking into account the volume of production index as a proxy to the index of total outputs and index of total inputs. TFP designs to capture how efficient a farm uses total inputs to produce total outputs. Moreover, imports, exports, and investments like FDI are impactful channels of external total factor productivity (TFP).

## 2.7. Conceptual Framework



## III. METHOD

### 3.1 Research Design

The study made use of regression research design. The method took into account the independent variables; investments, imports, and exports, and their respective significant relationship with the dependent variable, productivity. With the use of this method, the study was able to determine whether the independent variables affect or imply certain changes on the dependent variable. The study made use of the existing productivity measurement called Total Factor Productivity (TFP).

### 3.2. Data and Sources

The study utilized the report made by the Philippine Statistics Authority and the United States Department of Agriculture. The report was annual time series data for the Philippine Dairy Industry; its volume of production, imports, and exports starting from year 2006 up to year 2015.

### 3.3. Research Model

The relationship of independent variables specifically, investments, imports, and exports together with the dependent variable, productivity were measured using the regression analysis.

$$TFP = \beta_0 + \beta_1 INV + \beta_2 IMP + \beta_3 EXP + \mu$$

The model above was adopted from the study of Ohlan (2013) which is entitled “Efficiency and Total Productivity Growth in Indian sector. The adopted model was modified by using different measurements in each variable and by narrowing the number of independent variables from 8 to 3. By which, it shows TFP as the volume of production index in dairy products (proxy for the ratio of output index and input index), INV as the inventory in machineries of the dairy sector, IMP as the total volume of dairy product imports, EXP as the total volume of dairy product exports, and as the error term.

## IV. RESULTS AND DISCUSSION

The research placed emphasis on three independent variables to see the significance on the productivity of the dairy industry in the Philippines and by which, to the efficiency as well. The dependent variable productivity represents the ability of a farm to convert production inputs into production outputs (Kimura, Sauer, 2015). It is measured through the use of Total Factor Productivity (TFP) by taking into account the index of total outputs over an index of total inputs. TFP designs to capture how efficiently a farm uses total inputs to produce total outputs. Moreover, imports, exports, and investments like FDI are impactful channels of external total factor productivity (TFP).

The results using Gretl application can be found below: (refer to appendices Table 1).

It is clear that imports played a very important role in production as the dependent variable as can be seen in the coefficient below as well as in the t ratio and p value. In the case of imports, the predictor variable coefficient is  $-4.54739e-07$  that means as import decreases, production decreases by  $-4.54739e-07$ . However, as exports increases by  $1.46897e-05$ , production increases by  $1.46897e-05$ . Finally, for investments as it decreases by  $-0.000346256$ , production increases by  $-0.000346256$ . As such, the significant predictor here is imports with a standard error of only  $1.33067e-06$ . However, the p value is not significant since it is greater than 0.05. However, exports are statistically significant with a p value lower than 0.05.

Several studies find a positive correlation between TFP and exporting status (Casas et al., 2015). According to Casas et al. (2015), using data from Slovenia, De Loecker (2007, 2015) finds that firms that decide to export become more productive. See examples using data from Taiwan and Korea (Aw, Chung, and Roberts 2000, 2015), data from Chile (Pavcnik 2002, 2015), and data from sub-Saharan Africa (Van Biesebroeck 2005, 2015). Following the model presented by Clerides, Lach, and Tybout (1998, 2015), Lopez (2006, 2015) finds that exporters are more productive ex ante, and that the productivity of exporting firms increases with their exposure to international markets. Similarly, Echavarría, Arbelaez, and Rosales (2006, 2015) finds that total factor productivity increased with trade liberalization, since liberalization allowed for the technological progress of firms participating in foreign markets. Other studies that analyze the causes of this positive relationship between productivity and export status include Fernandes and Isgut (2005, 2015), Eslava et al. 2004, 2015), and Parra Oviedo (2003, 2015).

According to Lokoruka (2016), improved milk output reduces importation of dairy products. This spares foreign exchange and makes milk more available to citizens which in return, improves the nutritional status of poor families and farmer households whose source of protein is usually milk. Net import demand for dairy products would grow faster than net export supply through 2013, with demand growth coming primarily from developing economies in Asia, Latin America, North Africa and the Middle East and this will lead to a “latent demand gap” (global shortfall between consumption and production forecasts) of ~100,000 metric tons of dairy protein by 2013 (equivalent to ~7 billion pounds of milk) (Vitaliano, 2016) supported by the study of

Davis et al. (2018) that Southeast Asian countries with significant imports of SMP in 2015 included the Philippines, Indonesia, Malaysia, Singapore, Thailand, and Vietnam and with price, tariffs, and other trade policies being the factors to be considered when importing milk products, differences in the amount of imports per countries differ. Relationships between prices from one country to another are expected to have effects on the proportions of SMP imported from each country (Davis et al., 2018), for example Global Trade Atlas (2016) stated that the United States was the top supplier for skim-milk powder (SMP) in the Philippines accounting for 35% of the import share different to Singapore wherein US import share was only accounted for 5% in Singapore’s total import share.

According to a study by Britt et al. (2018), the demand for dairy products and technologies will grow during the next 50 yr for 2 reasons, first, increased per capita income worldwide will boost demand for dairy and other food products from animals, and these products increasingly will provide essential nutrients in developing countries. Britt et al. (2018) also stated that in order to supply increased demand for dairy products in the decades ahead, there must be a sustainable balance between products produced within the country and imports. This provides opportunities for developed and developing exporting countries to provide dairy products as well as dairy equipment and technologies to expand dairy farming in countries where suitable land resources exist (Gerosa and Skoet, 2012, 2018). As demand for dairy products increases, it is im- portant to understand global dairy production today and how it may change during the decades ahead (Britt et al., 2018).

At any rate, based on the results run by Gretl, the independent variables, imports, exports, and investments were significant in the over-all as computed through ANOVA (Analysis of Variance) with a significant p value lower than 0.05 which is 0.0027. However, in terms of the most significant predictor variable, it is exports that had the most predictor value with a p value that is lower than 0.05.

Table 1. Ordinary Least Squares

<b>Model 1: OLS, using observations 1-48</b>				
<b>Dependent variable: Production</b>				
<b>Variable</b>	<b>Coefficient</b>	<b>Std. Error</b>	<b>t-ratio</b>	<b>p-value</b>
const.	203.387	104.962	1.938	0.0591 *
Imports	-4.54739e-07	1.33067e-06	-0.3417	0.7342
Exports	1.46897e-05	5.18051e-06	2.836	0.0069 **
Investments	-0.000346256	0.000532177	-0.6506	0.5187 *

The other regression variables were computed by Gretl as follows:

Table 2

<b>Other Regression Variables</b>			
Mean dependent var	247.7063	S.D dependent var.	114.3217
Sum squared resid	446756.4	S.E. of regression	100.7648
R-squared	0.272697	Adjusted R-squared	0.223108
F(3, 44)	5.499161	P-value (F)	0.002691
Log-likelihood	-287.4347	Akaike criterion	582.8694
Schwarz criterion	590.3542	Hannan-Quinn	585.6979

The confidence interval for coefficients are as follows:

Table 3a

Confidence Interval for Coefficients		
t(44, 0.025) = 2.015		
Variable	Coefficient	95% confidence interval
constant	203.387	(-8.14930, 414.923)
Imports	-4.54739e007	(-3.13652e-006, 2.22704e006)
Exports	1.46897e-005	(4.24905e-006, 2.51303e005)
Investments	-0.000346256	(-0.00141879, 0.000726277)

Table 3b

Coefficient Covariance Matrix				
Constant	Imports	Exports	Investments	
11016.9	-0.000111640	-0.000304922	0.0165591	Const
	1.77067e012	3.84779e013	-5.34058e010	Imports
		2.68377e011	6.49917e010	Exports
			2.83213e007	Investments

According to a study by Britt et al. (2018), the demand for dairy products and technologies will grow during the next 50 yr for 2 reasons, first, increased per capita income worldwide will boost demand for dairy and other food products from animals, and these products increasingly will provide essential nutrients in developing countries. Britt et al. (2018) also stated that in order to supply increased demand for dairy products in the decades ahead, there must be a sustainable balance between products produced within the country and imports. This provides opportunities for developed and developing exporting countries to provide dairy products as well as dairy equipment and technologies to expand dairy farming in countries where suitable land resources exist (Gerosa and Skoet, 2012, 2018). As demand for dairy products increases, it is important to understand global dairy production today and how it may change during the decades ahead (Britt et al., 2018).

The collinearity test can be seen in Table 4 below:

Since the indices for the independent variables were less than 10, no collinearity problems were detected.

Table 4

Collinearity

Variance Inflation Factors

Minimum possible value = 1.0

Values > 10.0 may indicate a collinearity problem

Imports	2.678
Exports	1.223
Investments	2.826

VIF(j) = 1/(1 - R(j)^2), where R(j) is the multiple correlation coefficient between variable j and the other independent variables

Belsley-Kuh-Welsch proportions	collinearity lambda	cond	diagnostics: const	variance Imports	Exports	Investme~
3.700	1.000	0.001	0.001	0.007	0.005	
0.251	3.842	0.001	0.001	0.219	0.132	
0.041	9.554	0.160	0.052	0.702	0.463	
0.009	20.589	0.838	0.946	0.072	0.401	

lambda = eigenvalues of inverse covariance matrix (smallest is 0.00872815) cond = condition index note: variance proportions columns sum to 1.0

According to BKW, cond >= 30 indicates "strong" near linear dependence, and cond between 10 and 30 "moderately strong". Parameter estimates whose variance is mostly associated with problematic cond values may themselves be considered problematic.

Count of condition indices >= 30: 0

Count of condition indices >= 10: 1

Variance proportions >= 0.5 associated with cond >= 10: const Imports  
0.838 0.946

The analysis of variance (ANOVA) were computed in Table 4:

In the over-all, the predictor variables are significant with a p value of 0.027 which is lower than 0.05 (see Table 4).

Analysis of Variance:

	Sum of squares	df	Mean square
Regression	167508	3	55836
Residual	446756	44	10153.6
Total	614264	47	13069.5

$$R^2 = 167508 / 614264 = 0.272697$$

$$F(3, 44) = 55836 / 10153.6 = 5.49916 \text{ [p-value } 0.0027]$$

Test for normality of residual -

Null hypothesis: error is normally distributed Test statistic: Chi-square(2) = 4.87475 with p-value = 0.0873899

Heteroskedasticity

What is heteroskedasticity test used for?

It is used to test for heteroskedasticity in a linear regression model and assumes that the error terms are normally distributed. It tests whether the variance of the errors from a regression is dependent on the values of the independent variables.

The test for heteroskedasticity can be found below;

Table 5

White's test for heteroskedasticity  
OLS, using observations 1-48  
Dependent variable: uhat<sup>2</sup>

	COEFFICIENT	STD ERROR	T-RATIO	P-VALUE
Const	-30995.8	104192	-0.2975	0.7677
Imports	0.00125495	0.00240314	0.5222	0.6046
Exports	-0.00624323	0.00913580	0.6834	0.4985
Investments	-0.175779	0.792660	-0.2218	0.8257
sq_Imports	-1.03980e-011	1.61943e-011	-0.6421	0.5247
X2_X3	7.25073e-011	8.70256e-011	0.8332	0.4100
X2_X4	2.70630e-09	1.00772e-08	0.2686	0.7897
sq_Exports	2.41387e-010	3.14707e-010	0.7670	0.4478
X3_X4	-1.34398e-08	4.03874e-08	-0.3328	0.7411
sq_Investments	-1.97387e-07	1.88694e-06	-0.1046	0.9172

Unadjusted R-squared = 0.267388

Test statistic:  $TR^2 = 12.834611$ , with p-value =  $P(\text{Chi-square}(9) > 12.834611) = 0.170234$

#### Autocorrelation

Autocorrelation analysis measures the relationship of the observations between the different points in time, and thus seeks for a pattern or trend over the time series. The measure is best used in variables that demonstrate a linear relationship between each other. The test found autocorrelation significant since the p values were lower than 0.05.

#### IV. CONCLUSION AND RECOMMENDATION

The research intends to identify the factors that contribute to the productivity of Philippine dairy industry, assess the impact of investments, imports, and exports on the efficiency of Philippine dairy industry, and measure the variables using the gathered data. Regression analysis is used as the research method to determine the relationship between the independent and dependent variables. The study used secondary data by utilizing reports from the Philippine Statistics Authority. Thus, quarterly time series data from 2006 up to 2017 of each variable was gathered.

With the use of regression and the result of analysis of variance, the researchers found that the relationship of investments, imports, and exports do affect the productivity of the Philippine dairy industry, leading to reject the null hypothesis of this study. It is visible that imports play an important role in the dairy industry of the Philippines as it shows that when imports decrease, production of the dairy industry decreases as well and that is why the Philippines is said to be more reliant on imported dairy products rather than the locally produced dairy products. Production and exports variables have a positive relationship as one increases the other increases as well. For investments, this variable has a negative effect on production because as investments decrease, production increases. For the Philippine setting, firms that decide to export become more productive, the same goes with countries such as Taiwan and Korea.

Since it appears that as investment increases, production decreases, the government should give more attention to investment and control the factors that cause the negative effects on the production level of the dairy industry in the Philippines. A possible reason that explains the negative relationship between investment and



production is that the money used for investment has a greater value than the value of the output produced from where the money was invested to. The return on investment should be greater than the amount of the investment itself so that productivity of the dairy industry increases alongside with the increase in investment. Another reason might be that the human capital investment is lacking and that the government is more focused on machinery and technology. The workers might be lacking in terms of skills and experiences when it comes to new machineries and technologies that might have affected their total productivity. When new machines and technologies are introduced, employees should have a proper understanding and knowledge on how to use this equipment so that they can produce the maximum number of output that a certain machinery can produce at a given time and amount of resources. In addition, no matter how many new machineries and technologies are available, there is still a need for qualified and skilled workers that can effectively and efficiently use these equipment and resources for them to have a higher total productivity.

### 5.1 Policy Implications

Given the research findings that independent variables do affect the dependent variable, it may help socio-economic issues of the dairy industry here in the Philippines such as limited access to dairy production, lack of working capital, and low spending on dairy. The research findings may address these issues by giving attention to exports and investments mainly to machineries and other technologies that contribute to dairy operations.

There have been several policies in regards to improving the dairy industry in the Philippines. Republic Act 4041 or An Act to Develop the Dairy Industry was passed in 1964, with the goal of promoting and encouraging the development of the dairy industry in order to achieve self-sufficiency, at the very least in milk and dairy products, and to improve the health and standard of living of individuals, and to financially assist dairy farmers. Another policy is Republic Act 7884 or the National Dairy Development Act of 1995. This act was created in order to create the National Dairy Authority to help in accelerating the dairy industry in the Philippines. Also, according to the Australian Centre for International Agricultural Research, Australia and the Philippines created a project with regards to the status of the dairy industry in the Philippines. They published an article stating that the two countries launched a research initiative to unlock hidden potentials coming from the Philippine Dairy Industry. Several agencies such as ACIAR, the Department of Science and Technology - Philippine Council for Agriculture, Aquatic, and Natural Resources Research and Development (DOST-PCAARRD), the University of Adelaide's Centre for Global Food and Resources, and the Philippine Foodlink Advocacy Cooperative are collaborating on the project that aim to analyze available markets, value chains, strengths and weaknesses of the current programs for the dairy industry, and opportunities and challenges for the sector. The project will be focusing on smallholder dairy farmers who run about 80% of the Philippine's dairy firms.

### 5.2 Recommendation

To be able to improve productivity, investments, imports and exports of the dairy industry, the government should provide more funding and assistance to dairy farmers. Dairy farmers are typically small-scale producers who own five to ten cows. They also farm on a small plot of land. Improved equipment and machinery should be provided to them to help them produce dairy products more efficiently.

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## APPENDICES

Table 1

Production, Import, Export, and Investments 2006 to 2017 (Quarterly)				
Year	Production	Imports	Exports	Investments
2006 Q1	65	72,788,503	9,023,242	32,977
2006 Q2	233	78,619,175	8,640,016	40,867
2006 Q3	329	80,628,015	10,013,847	44,018
2006 Q4	403	77,837,155	11,351,296	45,878
2007 Q1	160	76,808,409	10,189,556	38,904
2007 Q2	257	85,342,608	9,819,373	49,014
2007 Q3	356	70,124,355	12,316,046	52,362
2007 Q4	473	71,779,762	10,810,475	57,547
2008 Q1	210	71,942,110	10,109,379	48,141
2008 Q2	316	63,125,615	12,967,700	61,707
2008 Q3	429	65,211,357	11,517,021	61,903
2008 Q4	560	73,144,533	12,185,677	54,248
2009 Q1	202	68,852,206	7,612,241	47,356
2009 Q2	279	90,898,326	6,484,344	45,196
2009 Q3	370	72,966,148	7,635,402	65,574
2009 Q4	447	96,879,521	8,519,971	51,708
2010 Q1	224	88,441,440	8,223,600	67,780
2010 Q2	339	82,145,605	10,796,741	68,300
2010 Q3	468	80,562,649	9,114,925	72,541
2010 Q4	585	88,199,459	11,507,188	81,959
2011 Q1	173	85,756,567	11,637,852	68,988
2011 Q2	229	82,259,605	10,428,598	53,444
2011 Q3	186	77,889,523	12,273,801	79,394
2011 Q4	195	77,455,349	11,846,712	67,179
2012 Q1	187	77,270,644	9,505,143	78,672
2012 Q2	195	83,862,163	9,361,860	82,846
2012 Q3	179	86,490,844	2,291,561	74,059

2012 Q4	197	83,284,571	2,846,952	92,902
2013 Q1	165	77,106,664	2,793,431	73,843
2013 Q2	186	84,833,775	2,732,945	87,117
2013 Q3	179	89,368,199	4,949,596	103,654
2013 Q4	197	88,577,904	2,231,591	136,939
2014 Q1	197	83,677,153	5,589,547	112,197
2014 Q2	191	66,914,527	7,042,938	97,115
2014 Q3	188	78,359,898	3,685,878	115,119
2014 Q4	197	91,909,228	3,783,321	104,942
2015 Q1	165	106,731,659	2,854,412	109,274
2015 Q2	191	111,244,986	3,250,810	92,266
2015 Q3	185	93,819,501	7,679,950	114,613
2015 Q4	168	99,592,173	8,454,092	127,628
2016 Q1	170.33	118,441,958.73	7,860,556	133,475
2016 Q2	189.67	123,331,026.94	7,358,578	126,619.00
2016 Q3	174.37	131,544,345	8,369,164	173,898
2016 Q4	177.43	121,169,997.21	4,560,608	204,591
2017 Q1	164.57	120,946,081	5,869,007.89	165,008.00
2017 Q2	185.20	112,885,917.32	5,594,151.90	166,587.00
2017 Q3	183.77	136,481,476.02	7,952,945.77	193,197.00
2017 Q4	192.37	108,004,908.76	7,405,269.69	224,776.00

The model estimation range of Production as well as the fitted and residual estimates were computed by Gretl as follows:

Table 2

<b>Model estimation range: 1 - 48</b>			
<b>Standard error of residuals = 100.765</b>			
<b>Year</b>	<b>Production</b>	<b>fitted</b>	<b>residual</b>
2006 Q1	65.1333	291.417	-226.284
2006 Q2	232.970	280.404	-47.4343
2006 Q3	329.230	298.581	30.6491
2006 Q4	402.870	318.853	84.0175
2007 Q1	159.600	304.670	-145.070
2007 Q2	256.530	291.850	-35.3201
2007 Q3	356.230	334.287	21.9432
2007 Q4	472.570	309.622	162.948
2008 Q1	209.930	302.506	-92.5765
2008 Q2	315.770	343.806	-28.0362
2008 Q3	428.700	321.480	107.220
2008 Q4	560.300	330.345	229.955
2009 Q1	202.430	267.501	-65.0712
2009 Q2	279.030	241.655	37.3747
2009 Q3	369.930	259.663	110.267
2009 Q4	446.870	266.583	180.287
2010 Q1	224.300	260.502	-36.2020

2010 Q2	338.500	300.983	37.5167
2010 Q3	467.730	275.529	192.201
2010 Q4	585.470	303.937	281.533
2011 Q1	172.500	311.459	-138.959
2011 Q2	228.900	300.668	-71.7676
2011 Q3	186.300	320.775	-134.475
2011 Q4	194.700	318.928	-124.228
2012 Q1	186.700	280.636	-93.9357
2012 Q2	194.800	274.088	-79.2884
2012 Q3	179.400	172.075	7.32502
2012 Q4	196.700	175.167	21.5329
2013 Q1	164.500	183.790	-19.2896
2013 Q2	185.800	174.791	11.0092
2013 Q3	179.400	199.565	-20.1649
2013 Q4	196.700	148.472	48.2277
2014 Q1	196.900	208.595	-11.6953
2014 Q2	190.800	242.790	-51.9899
2014 Q3	188.100	182.037	6.06259
2014 Q4	197.200	180.831	16.3690
2015 Q1	164.500	158.946	5.55444
2015 Q2	190.800	168.605	22.1948
2015 Q3	185.200	233.854	-48.6541
2015 Q4	168.200	238.094	-69.8943
2016 Q1	170.330	218.779	-48.4492
2016 Q2	189.670	211.556	-21.8860
2016 Q3	174.370	206.296	-31.9256
2016 Q4	177.430	144.439	32.9909
2017 Q1	164.570	177.467	-12.8968
2017 Q2	185.200	176.548	8.65225
2017 Q3	183.770	191.254	-7.48397
2017 Q4	192.370	185.224	7.14625

Note: \* denotes a residual in excess of 2.5 standard errors The forecast can be found in **Table 3** below:

For 95% confidence intervals, $t(44, 0.025) = 2.015$				
Observation	Production	Prediction	Std. Error	95% Interval
2006 Q1	65.1333	291.417	103.491	(82.8440, 499.990)
2006 Q2	232.970	280.404	103.304	(72.2093, 488.599)
2006 Q3	329.230	298.581	103.311	(90.3712, 506.791)
2006 Q4	402.870	318.853	103.502	(110.259, 527.446)
2007 Q1	159.600	304.670	103.355	(96.3710, 512.968)
2007 Q2	256.530	291.850	103.524	(83.2103, 500.490)

2007 Q3	356.230	334.287	104.268	(124.148, 544.426)
2007 Q4	472.570	309.622	103.188	(101.660, 517.585)
2008 Q1	209.930	302.506	102.923	(95.0794, 509.934)
2008 Q2	315.770	343.806	106.621	(128.926, 558.686)
2008 Q3	428.700	321.480	104.902	(110.063, 532.896)
2008 Q4	560.300	330.345	103.937	(120.874, 539.817)
2009 Q1	202.430	267.501	103.426	(59.0602, 475.942)
2009 Q2	279.030	241.655	105.833	(28.3619, 454.949)
2009 Q3	369.930	259.663	102.823	(52.4373, 466.888)
2009 Q4	446.870	266.583	106.006	(52.9415, 480.225)
2010 Q1	224.300	260.502	102.472	(53.9842, 467.020)
2010 Q2	338.500	300.983	102.728	(93.9492, 508.017)
2010 Q3	467.730	275.529	102.083	(69.7945, 481.264)
2010 Q4	585.470	303.937	103.394	(95.5595, 512.315)
2011 Q1	172.500	311.459	103.477	(102.915, 520.002)
2011 Q2	228.900	300.668	103.014	(93.0569, 508.278)
2011 Q3	186.300	320.775	104.361	(110.449, 531.101)
2011 Q4	194.700	318.928	103.570	(110.196, 527.661)
2012 Q1	186.700	280.636	102.569	(73.9222, 487.349)
2012 Q2	194.800	274.088	102.081	(68.3574, 479.819)
2012 Q3	179.400	172.075	106.703	(-42.9710, 387.121)
2012 Q4	196.700	175.167	105.456	(-37.3665, 387.701)
2013 Q1	164.500	183.790	106.440	(-30.7270, 398.306)
2013 Q2	185.800	174.791	105.519	(-37.8697, 387.451)
2013 Q3	179.400	199.565	102.888	(-7.79133, 406.921)



2013 Q4	196.700	148.472	107.228	(-67.6310, 364.576)
2014 Q1	196.900	208.595	103.649	(-0.294739, 417.485)
2014 Q2	190.800	242.790	106.735	(27.6801, 457.900)
2014 Q3	188.100	182.037	106.621	(-32.8425, 396.917)
2014 Q4	197.200	180.831	103.727	(-28.2179, 389.880)
2015 Q1	164.500	158.946	105.695	(-54.0696, 371.961)
2015 Q2	190.800	168.605	108.247	(-49.5517, 386.762)
2015 Q3	185.200	233.854	102.161	(27.9621, 439.746)
2015 Q4	168.200	238.094	102.823	(30.8681, 445.321)
2016 Q1	170.330	218.779	105.308	(6.54585, 431.013)
2016 Q2	189.670	211.556	107.217	(-4.52553, 427.637)
2016 Q3	174.370	206.296	108.830	(-13.0373, 425.628)
2016 Q4	177.430	144.439	108.071	(-73.3645, 362.243)
2017 Q1	164.570	177.467	105.247	(-34.6441, 389.578)
2017 Q2	185.200	176.548	104.620	(-34.3006, 387.396)
2017 Q3	183.770	191.254	110.295	(-31.0305, 413.538)
2017 Q4	192.370	185.224	115.186	(-46.9177, 417.365)