Agricultural Sciences, 2022, 13, 467-490
https://www.scirp.org/journal/as
ISSN Online: 2156-8561
ISSN Print: 2156-8553

Short-Term and Long-Term Price Forecasting Models for the Future Exchange of Mongolian Natural Sea Buckthorn Market

Yalalt Dandar[1], Liu Chang[2]

[1]Faculty of Economics and Management, Northeast Agricultural University, Harbin, China
[2]Education Center of College of Economics and Management, Northeast Agricultural University, Harbin, China
Email: dandaryalalt2021@gmail.com, 389203678@qq.com

How to cite this paper: Dandar, Y. and Chang, L. (2022) Short-Term and Long-Term Price Forecasting Models for the Future Exchange of Mongolian Natural Sea Buckthorn Market. *Agricultural Sciences*, **13**, 467-490.
https://doi.org/10.4236/as.2022.133032

Received: January 7, 2022
Accepted: March 26, 2022
Published: March 29, 2022

Abstract

Sea buckthorn market floated uncertainly within a narrow range. The market situation provided upward pressure on prices, and producer and consumer interest were poor, coupled with weak prices in the regional markets. The objectives of the study are: 1) to estimate the relationship between wild Sea buckthorn (SB) price and Supply, Demand, while some other factors of crude oil price and exchange rate by using simultaneous Supply-Demand and Price system equation and Vector Error Correction Method (VECM); 2) to forecast the short-term and long-term SB price; 3) to compare and evaluate the price forecasting models. Firstly, the data was analyzed by Ferris and Engle-Granger's procedure; secondly, both price forecasting methodologies were tested by Pindyck-Rubinfeld and Makridakis's procedure. The result shows that the VECM model is more efficient using yearly data; a short-term price forecast decreases, and a long-term price forecast is predicted to increase the Mongolian Sea buckthorn market.

Keywords

Short-Term and Long-Term, Price Forecasting Models, Simultaneous System Equation, VECM, Sea Buckthorn, Mongolia

1. Introduction

With the recent great wild Sea buckthorn (SB) price volatility, it is significant to statistically and accurately forecast the prices of SB. In that case, the significance of accurate price forecasting has become even more critical for decision-makers, producers, traders, and consumers who are involved in the Sea buckthorn industry. Therefore, this study fundamentally applies the econometric price forecasting methodology for issues of Sea buckthorn research relating to the relationship between the fundamental factors influencing SB price, *i.e.*, Supply, Demand, and stock. At the same time, some other indirect effects such as this will be crude oil price and exchange rate. The price forecasting model would also be recommended, which is more efficient and has broader pertinency.

Generally, wild Sea buckthorn has been consumed a lot. In 2013, [1] studied the wild sea buckthorn distribution in Mongolia (Ministry of Food and Agriculture—MOFA, 2015). They conclude that the species covered about 13.500 hectares of Land in Selenge, Bulgan, Zavkhan, Govi-Altai, Khovd, and Uvs provinces in Mongolia. In 2019 Sea buckthorn accounted for 1512 t or roughly 85% of the total harvest in Mongolia. Statistically shown that production volumes and values have fluctuated in recent years; after falling considerably from 2011 to 2012, they have increased since then (**Figure 1**: Sea buckthorn harvested volumes in Mongolia from 2011 to 2019 and **Figure 2**: Sea buckthorn market values in Mongolia from 2011 to 2019). Altogether, approximately 64% of the production occurred in Mongolia's western provinces between 2011 and 2019, dominated by Uvs provinces (53%) [2]. The role of the agricultural sector in our economy has

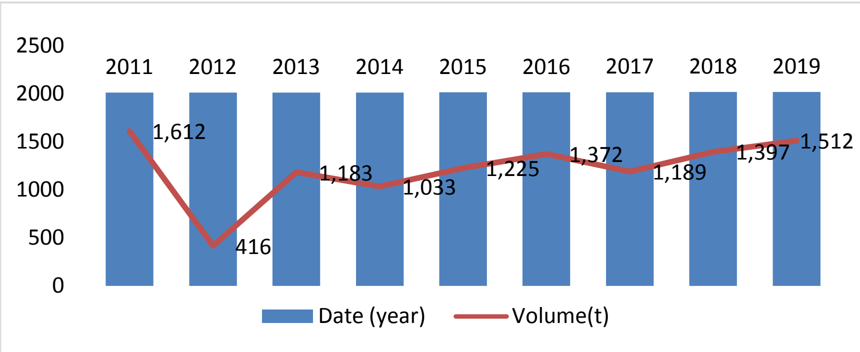

Figure 1. Sea buckthorn harvested volumes in Mongolia from 2011 to 2019.

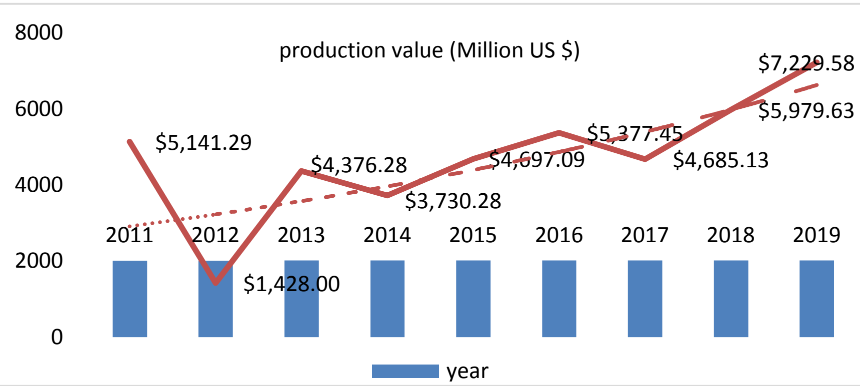

Figure 2. Sea buckthorn market values in Mongolia from 2011 to 2019. Source: National Statistical Office of Mongolia and estimated calculation for production value in million US $. The total production value is calculated as harvested quantity multiplied by the national average price. The annual exchange rate of 2012 is used for converting MNT to US $ (1 US $ = 1359 MNT).

always been high. The agricultural sector accounted for 12 percent of GDP in 1990. Other sectors fell sharply during the economic downturn of the early 1990s, and other sectors recovered slowly during the transition, raising the sector's share of GDP to 38 percent in 1996. The share of GDP declined to 14% in 2014 due to the rapid growth of the mining sector in recent years and a large number of livestock deaths during the dzuds of 2000-2002 and 2010 [3]. Moreover, fluctuations in commodity prices, an essential export commodity, have increased the Mongolian government's budget deficit. In recent years, Mongolia's budget deficit and public debt have increased significantly due to the decline in Mongolia's copper exports due to the collapse of Mongolia's primary export commodities, coal and copper. In 2017, the Mongolian government entered into a $5.5 billion financial assistance program with international organizations to stabilize the economy, restore investor confidence, and revitalize the economy. Under this program, there is a need to reduce the budget deficit and improve fiscal discipline. The expansionary monetary policy pursued in 2012-2014 to mitigate the adverse effects of falling commodity prices has significantly increased government debt (It was 24.1 percent in 2011 and 87.2 percent of GDP in 2016). As a result, the Mongolian government will have limited access to public investment in critical sectors. There is a need to focus on foreign direct investment and increase its efficiency to support economic development. It also affected the Price of sea buckthorn, an agricultural product [4]. The Ministry of Food, Agriculture, and Light Industry implemented the Sea buckthorn Program in two phases (Phase 1, 2010-2012, Phase 2, 2013-2016). and create a favorable economic environment. They were improving the technology of processing and development, developing the capacity of specialists, increasing the export of products that support financial and investment and credit policies, increasing domestic production, and improving market competitiveness. Since 2010, a total of 3240.7 million MNT has been spent, and 809.4 thousand sea buckthorn seedlings worth 1789.3 million MNT have been provided to 620 citizens, economic entities, and organizations in 21 aimags on a 5-year loan. In addition, 5 companies in Uvurkhangai, Uvs aimag, and Ulaanbaatar received a discount of 70.5 million MNT by providing 30 sets of greenhouses with fogging equipment with an area of 180 m^2 at a 50 percent discount. As a result, it is possible to multiply 1.2 million seedlings per year. In addition, MNT 469.4 million has been provided under the "Green Jobs—Sea buckthorn" sub-program. Scientists and experts are from 6 western aimags and Tuva Khakassia, Russia, exchanged technology and experience in Ulaangom, Uvs province. In Darkhan-Uul aimag, a project on "Seabuckthorn and other fruit and berry varieties research" was implemented with a funding of 20 million MNT. As a result of the 1st program, the area of orchards reached 3886.9 ha in 2011, and 881.1 tons of sea buckthorn and other fruits were harvested, which is 1166.0 ha or 43 percent more than last year and 1.5 times more than in 2009, the harvest increased by 291 tons or 49.3 percent, and produced 2.1 million fruit seedlings and created 2248 new green jobs. Under the second program, two sea buckthorn processing plants with a capacity of 600 tons per year in Uvs aimag and 1500 tons in Ulaanbaatar were established with a loan of 1.1 billion MNT. In addition, Gifarelli's SC-800 and V77s have been tested in Batsumber soum of Tuv aimag and Tsagaan Nuur soum of Selenge aimag [5].

It is essential to calculate demand calculation and based on a survey of fruit consumption in Mongolia, a demand survey was conducted. In 2011 demand of Sea buckthorn accounted for 566.544 in US $ in Mongolia. Statistically shown that from 2013 to 2019 have increased but in 2012 have decreased (**Figure 3**).

This paper was also based on the annual average Price of Sea buckthorn in Mongolia by [2]. They have done the various Sea buckthorn prices for private prices for tradable outputs and inputs: market prices, social prices for tradable output, and CIF import prices or FOB export price. This is only for short-term price analysis individually regarding their comparative price forecasting accuracy using 2011 to 2019. However, they did not analyze which will be the more efficient price forecasting model using yearly data with extended the estimation period until 2011 for short-term and 2019 for long-term price analysis. This is the gap of the study and also the good reason to do this for how to forecast the Sea buckthorn price for the future's exchange market. A comparison of simultaneous Supply-Demand and Price system equation model and Vector Error Correction Method (VECM) will be evaluated by using Root Mean Square Error (RMSE), Mean Absolute Error (MAE), Root Mean Percent Error (RMPE), and Theil's Inequality Coefficients (U) criteria.

Sea buckthorn cultivation began in 1965 with the first orchard in Mongolia. There is evidence that sea buckthorn grew on 29,000 hectares. It is estimated that 1200 - 1600 shrubs can be planted per hectare, yielding 5 - 30 kg per tree and 5

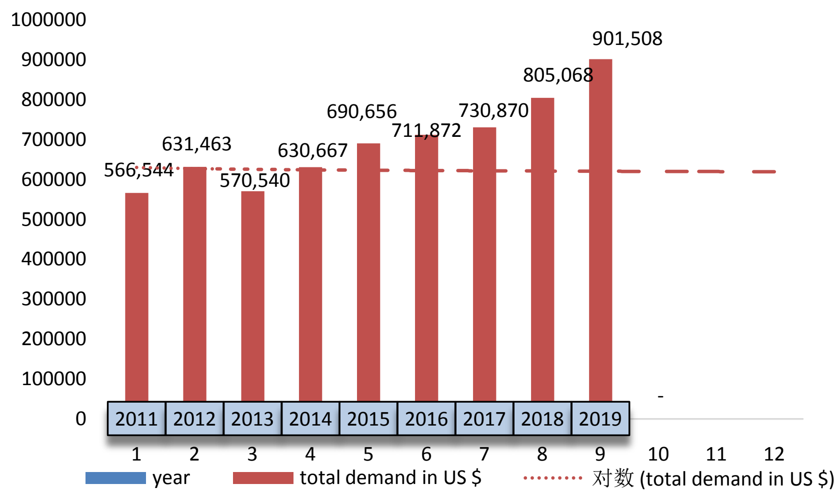

Figure 3. Seabuckthorn demand in Mongolia according to author`s estimated calculation.

tons of fruit per hectare. From 1965 to 1990, the fruit sector operated continuously, but from 1990-2010, it was stagnant due to systemic changes and resumed in 2010. This is directly related to the sea buckthorn program implemented in 2010-2016. As of 2015, sea buckthorn accounted for more than 90 percent of the country's 5900 hectares of fruit crops. Of the 2041.2 tons of fruit harvested, sea buckthorn accounted for 81 percent. A total of 2,494,000 seedlings were produced, of which 2,296,000 were sea buckthorn seedlings [6]. Sea buckthorn (*Hippophae rhamnoides*, L.) is a thorny, deciduous shrub named Elaeagnaceae. It bears yellow to orange berries, used for centuries in Europa and Asia. The natural habitat of Sea buckthorn extends widely in China, Mongolia, Russia, Finland, Sweden, and Norway. It is also essential to notice the chemical composition of Sea buckthorn oil varies with growing conditions, locally, and the variety of Sea buckthorn. Sea buckthorn pulp oil is unique among other vegetable oils, having a high level of unsaturated fatty acids, phenolic alcohol, and flavonoids [7]. The most common sea buckthorn plant in West Mongolia is Uvs aimag, and saplings are grown in an open field or a green house. After one year, saplings are transferred to the field. About 800 trees per hectare planted and takes three years for a tree to mature and starts giving fruits. Sea buckthorn trees continually give fruits for 15 years, harvested usually in October until December. In the first year of harvest, about 5 kg of fruit is obtained from one tree. As the tree gets older, the amount of fruit it produces increases, and it takes about 20 - 35 kg of fruit from a 10 - 15-year-old tree, mainly has been produced juice and oil, its products highly nutritious rich in vitamin C, used for medical service likely curing cancer, skin problems, burns, and digestive tract disorders. Its qualification was registered as a GI (Geographical limits) in 2007, in terms of producers and processors highly cooperative and work closely, especially joined their effort under an umbrella association, growing sea buckthorn trees is well-received by consumers and is no more economical to prevent from desertification, contribution to the preservation of the traditional product, etc., by appearing as GI there is an alternative potential tool to improve the recognition of traditional products rooted on local resources, experiences, and knowledge of local people. Furthermore, supporting the development of locally embedded value chains creates better income and employment opportunities for local people [8]. In 2018, Mongolia's economy rose to 7.7% compared to 2.1% in 2017. The agriculture sector contributed 6.8% to the GDP this year in terms of share. In the fourth quarter of 2019, Malaysia's economy reduced by 5.6% compared to 6.8% in the third quarter of 2019. On a quarter-on-quarter seasonally adjusted, the economy decreased 1.2% (**Table 1**). For 2019, Mongolia's economy shrunk 5.6% (2018: 7.7%), with a value-added stand at MNT 18.11 million at constant prices and MNT 19.05 million at current prices.

Additionally, According to Mongolian National Statistical Office reporting, considering the reserves of primary agricultural products, in 2019, 416.9 thousand tons of wheat, 192.5 thousand tons of potatoes, and 182.2 thousand tons of

Table 1. GDP at constant 2010 prices.

	Percentage change from the corresponding quarter of the preceding year							
	Q12018	Q22018	Q32018	Q42018	Q12019	Q22019	Q32019	Q42019
GDP	7.7	5.6	7.0	7.7	8.6	7.6	6.8	5.6
			Percentage change from preceding quarter					
Seasonally adjusted GDP			2.1	0.7	0.9	1.0	0.8	1.2

Source: Department of Statistics Mongolia (2019).

vegetables were supplied to the domestic market. And the rest is imported, and fruit production decreased by 0.2 - 703.5 ha or 0.8 - 96.8 percent in Sukhbaatar, Bayankhongor, Gobi-Altai, Uvs, Umnugovi, Orkhon, Ulaanbaatar, Selenge, Tuv, Zavkhan, and Uvurkhangai aimags, and by 0.2 - 205.2 ha or 1.8 in other aimags was increased by 4.5 times and fruits increased by 0.1 thousand tons or 5 percent. However, the Sea buckthorn oil and the sea buckthorn production will contribute more soon.

Indeed, the fundamental factors influencing Sea buckthorn price *i.e.* Supply, Demand, and stock, while all other factors had indirect effects such as technological innovation, weather, crude petroleum oil price, currency movements especially exchange rate, futures markets activities, the cyclical movement of the world economy and slowing growth in agricultural productivity, as well as government policies and so on. Mongolia's natural wild sea buckthorn production total recorded a decrease from 2011 (1612 tonnes) to 2012 (416 tonnes;) and an increase from 2014 (1033 tonnes) to 2019 (1512 tonnes). And Demand situation research for consumers has shown that 360 households - 95.6 percent like fruit, 1.7 percent do not like it, and 2.8 percent do not know. The maximum weekly expenditure of fruit-loving households is MNT 55,000, and 31.4 percent of all households have been consuming fruit regularly since 2000. 84.2 percent of all households consume sea buckthorn products, of which 56.7 percent are natural sea buckthorn, 6.4 percent are cultivated sea buckthorn, and 36.9 percent are indistinguishable in consumption. Sea buckthorn is used by 76.9 percent of householdsin winter, 29.7 percent in spring, 14.2 percent in summer, and 20 percent in autumn. Household purchases of fruits were influenced by factors such as health (48.6%), taste (29.4%), Price (48.1%), availability (16.7%), and household income (13.9%) [6]. Since 2000, 31.4 percent of all households have consumed fruit regularly. 84.2 percent of all households consume sea buckthorn and its products, of which 56.7 percent are natural sea buckthorn, 6.4 percent are cultivated sea buckthorn, and 36.9 percent are indistinguishable in consumption. Sea buckthorn is used by 76.9 percent of households in winter, 29.7 percent in spring, 14.2 percent in summer, and 20 percent in autumn. It is used in autumn and winter because of its therapeutic value (53.3%). Household sea buckthorn consumption is dominated by juice (80%), fruits (65.8%), jams (28.6%), oils (24.4%), and medicinal products containing sea buckthorn (12.2%). Factors such as household health (48.6%), taste (29.4%), Price (48.1%), availability (16.7%), and household income (13.9%) were affected [6]. And also, according to the "Mongolian Fruit Growers Survey", a total of 308 farming companies and households participated in the survey, of which 36 were large growers. The average crop area was 13 hectares. Excluding the six most prominent companies, the area planted per organization was 9.93 hectares. It supplies 22.7 percent of its harvest to household production, 8.8 percent to bulk processing plants, 13 percent to trade networks, 19.8 percent to its own needs, and 8.8 percent to other markets such as storage. Fruit growers sell their products in trade chains (57.5%), processing plants (42.5%), schools and kindergartens (36.7%), hospitals and sanatoriums (31.2%), exports (25%), and mining companies (19.5%) and law enforcement agencies (4.9%). 44.8 percent of all farmers proposed establishing and developing a fruit market nationwide, 10.1 percent between aimags, and 13 percent within aimags and districts [6].

On the other hand, the GI system is valued for its potential to promote locally-made products. In Ulaanbaatar, Mongolia's capital, there are many upper-and middle-income residents, and expatriates working mainly in the booming mining industry. These customers prefer locally-made food products for health and security reasons, rather than imported products than spend a considerable time on the way to shop. And GI registration helps local producers inform consumers about the origin of a product and its corresponding qualities. The ability of the GI system to link the quality of a product to its geographical origin, embracing unique production practices, know-how, and social and natural assets, is therefore of particular interest to Mongolian producers. In 2008, about 15 products had received GI registration, and Uvs sea buckthorn juice and oil were one of these. Following issues have been resolved here. Firstly, it promotes registration, development, and advocacy of the benefits of GI registration among producers and their partners. Secondly, it uses GIs to develop markets and increase the access of local producers to the international market. Thirdly, it develops a timetable to implement a GI system in Mongolia. Additionally, The European Union's TRAM report highlights the need to bring Mongolian standards in line with European standards, increase the benefits of GSP+, and regulate trade policy concepts and protections. In March 2020, the National Committee for Trade Facilitation approved the 2019 Implementation Report and the 2020 Action Plan due to cooperation with the Mongolian Institute of Sinology to improve the implementation of the European Union's TRAM Economic Corridor Program. The main tasks for 2020 are to fulfill the obligations of the World Trade Organization's trade facilitation agreements within the framework of customs, control, standards and to increase the benefits of GSP+. As the Mongolian Sea Buckthorn Cluster Group noticed, Sea buckthorn is the most important fruit in the fruit industry and is considered a particularly prestigious asset in Mongolia. It aims to develop sustainable development by exploring the benefits of developing production standards, training farms and processors, providing training, consulting, and informing customers and business partners. The association has initiated two phases of government programs, the first covering 2010-2016 and the second covering 2018-2022, which show a sharp increase in arable land and yields compared to the 1990s [9]. Developing countries, in general, specialize in the export of primary products. For instance, [10] estimated that the share of differentiated products in Latin American economies' total exports (excluding Mexico) was just 21.7 percent in 2007 compared to 62.3 percent in the case of developed countries. The authors argue that diversifying into these more complex goods represents an important challenge for firms in these countries. Differentiated goods are heterogeneous both in terms of their characteristics and their quality. Due to this, the signaling function of prices, which works well for homogeneous products, becomes much weaker, making it difficult to trade them in organized exchanges. Therefore, the information asymmetry problem about differentiated products' quality and characteristics is more severe than trading more homogeneous goods. Hence, the export promotion activities should focus on facilitating information issues. The Asian Development Bank (ADB) trade and industry sector assessment revealed that during 2004-2015, manufacturing value-added in Mongolia grew at a considerably lower average annual rate than real GDP, with its share falling from 10.0 percent of GDP in 2003 to 5.7 percent in 2015. Likewise, the share of manufactured goods in merchandise exports dropped from 37.9 percent to 5.6 percent during 2003-2013. The following figure demonstrates the relative shares of "homogeneous" and "differentiated" products in the non-mining export sector in Mongolia. From 2008-2017, homogeneous products amounted to 91.1 percent of the non-mining exports. In the last years, its share slightly increased, and as of 2017, it was 91.1 percent [3]. However, according to estimation of national statistics office of Mongolia, the total imports of agricultural products between 2008 and 2012 include 175,000 mt to 4000 mt of wheat, 97,000 mt to 26,000 mt of flour, 35,000 mt to 3200 mt of potatoes, 160 mt to 77 mt of vegetable products, and fruits, especially sea buckthorn. The import is almost non-existent. In terms of exports, it increased to $4.4 trillion in 2012 due to minerals and agricultural exports being $303 million. According to the preliminary results of 2019, the agricultural sector accounts for 10.9 percent of exports, 8.2 percent of exports, and exports of agricultural products. Therefore, Sea buckthorn productivity plays an essential role in Mongolia's economy as a raw material for local industry and a high amount of foreign exchange earnings by sea buckthorn exports. Thanks to the support of the sea buckthorn government program, the area increased from 1300 hectares in 2013 to 5000 hectares. The total production from this area will be 30,000 tons per year. Most industries are located in small areas, while some operate on a large scale. The cost of producing sea buckthorn is considered relatively low, but the start-up time is long and requires irrigation. The fruit industry needs tax breaks and financial support in the third year of production. The production of this fruit is incredibly labor intensive because of the high manual labor. To improve productivity, the Ministry of Foreign Affairs supports the study of genetics and varieties, and the Seabuckthorn Association has reported that eight institutes across the country have been selected to study economic characteristics [11].

The trade of term, the general terms of trade for Mongolian exports strengthened between 2006 and 2012, increasing from 115.5 to 131.5. However, this is not the case for agricultural products, usually exported as raw products, while imports are high-quality processed foods, footwear, and improved live animals. For live animals and original products, the term of trade has improved. The terms of trade index for food products increased from 0.96 to 2.06 while the index for textiles increased from 1.01 to 3.28. Promoting further value-added will enhance the term of trade in the future. However, according to the calculation of Mongolian western wild sea buckthorn prices for local can see in (**Table 2**).

According to the above calculation, the Average Price of sea buckthorn was US $3.1 per kg in 2012 and 2013, which is slightly lower than the national average. The estimated social Price of sea buckthorn was US $2.8 and was US $3.0 in 2012 and 2013. In terms of volatility, variations in prices become problematic when they are large and cannot be anticipated. As a result, they create uncertainty, which increases risks for producers, traders, consumers, and governments and may lead to sub-optimal decisions. Variations in prices that do not reflect market fundamentals are also problematic, leading to incorrect decisions. It has not been made to international SBB prices were caused by lower crude oil price and conducted in Mongolia.

The other factors of SB price depend on the currency movement, especially exchange rate change. If the producers expect Prices to increase, they would continuously make their long-term investments in SBB production. However, the buyers might be attracted to buy when SB price is low. If their anticipation is incorrect and future prices fluctuate, such behavior can lead to substantial losses. The currency exchange rate also affects the SB producing countries because most commodities, primarily SBB products, are traded in US dollars (US $). The exchange rate of a nation's currency is regarded as the value of one country's currency in terms of another currency. Therefore, the exchange rate has two components: the domestic currency (Mongolian togrog, MNT) and a foreign currency (US $), and can be quoted either directly or indirectly. The exchange rate was determined in the foreign exchange market, which was opened to a wide range of different types of buyers and sellers where currency trading was continuous. If the Price is expected to have a negative relationship with the exchange rate (MNT/US $), or if SB price is expected to have a significant relationship with the high exchange rate, it would consequently affect the profitability of SBB products' buying and selling. Currency appreciation and domestic inflation influence Mongolia's terms of trade.

Table 2. The price of sea buckthorn in western Mongolia.

			2012				2013			
Price per kg of SBB (US $)			Mean	SD	Min	Max	Mean	SD	Min	Max
	Private	21	3.1	0.6	1.8	4.4	3.3	0.6	2.2	4.4
	Social	21	2.8	0.5	1.7	4.1	3.0	0.5	2.0	4.0

Appreciation of the real exchange rate by 11 percent in the first quarter of 2012 reflected higher inflation rates in Mongolia relative to other countries. (WB, Mongolia Quarterly Update—June 2012/Measures the Price of a basket of Mongolian goods against the similar basket of goods in its leading trading partners/World Bank Mongolia Agriculture Productivity and Marketing Study). This inflation had essential effects on the competitiveness of Mongolian products, with negative consequences for the agriculture and agricultural processing sectors. Throughout 2013, the Mongolian exchange rate declined, easing this pressure on competitiveness. However, this threat of "Dutch disease" will re-emerge when the mineral sector rebounds and demand for the Mongolian togrog increases. [2] Also analyzed the world market prices to measure the social value. If the world market price was dominated (and distorted) by subsidies to China, it would be unfair from a Mongolian point of view.

In terms of cost, sea buckthorn production is considered a low cost but bears fruit after a long time and requires little watering. Therefore, farmers need tax breaks and financial support. The fruit production begins in the third year. Growing sea buckthorn is high labor costs, often performed by hand. The labor cost of picking sea buckthorn is 1000/kg. The most sought-after harvesting methods are sought, and in China, it is possible to harvest with hand shears 20 kg/day/person. Using a wood shaker, the harvest can be increased to 200 kg per day. The Italian Food Inspection Agency has purchased an olive harvester and a vacuum cleaner, tested in Mongolia. To increase the productivity of sea buckthorn production, the SPIO is supporting research. The research in genetics and varieties has identified a total of eight institutes of the Seabuckthorn Association [11]. China and Mongolia provide subsidies to farmers to promote the cultivation and collection of sea buckthorn berries; in Mongolia, sea buckthorn is one of the major fruit crops. The average annual income of a sea buckthorn collection household was reported to be 3413 US $. [12] studied the forecasting of SBB future price and the market efficiency by using the time-series data of the spot price of Mongolia. The results indicated that the daily futures prices served as unbiased estimators of future spot prices and daily price changes were independent. This result showed that Mongolian's sea buckthorn futures market was efficient and aided the price process. The analytical model was applicable and would be facilitated and related studies in forecasting the futures prices of other commodities.

Therefore, the objectives of the study are: 1) to estimate the relationship between SB price and fundamental factors of Supply, Demand, and stock, while some other indirect effects such as crude oil price and exchange rate by using simultaneous Supply-Demand and Price system equation model and Vector Error Correction Method (VECM), 2) to forecast the short-term and long-term SB price and 3) to compare and evaluate the price forecasting models individually in terms of their comparative forecasting accuracies.

To meet the first objective, the simultaneous Supply-Demand and Price system equation model and Vector Error Correction Method (VECM) will be analyzed with Ferris and Engle-Granger's procedure, respectively. For the second objective, both price forecasting methodology for the short-term and long-term will be tested by Pindyck and Rubinfeld's procedure. Both price forecasting models will be utilized using the data from 2011Q1 to 2019Q4 with a total of observations. They will be predicted for 2017Q1 to 2017Q4 on the short-term price forecast and until 2020Q1 2020Q4 on the long-term price forecast. Finally, for the third objective, the simultaneous Supply-Demand and Price system equation model and VECM model of the SBB price would be in terms of their forecasting accuracy based on Root Mean Square Error (RMSE), Mean Absolute Error (MAE), and Mean Absolute Percent Error (MAPE) and (U-Theil) criteria followed by Makridakis's procedure.

2. Methodology

2.1. SB Supply, Demand and Price

For this study, in a single-equation with multivariate model Vector Error Correction Model (VECM), the dependent variable is related to a set of explanatory variables. They do not explain the interdependencies between the explanatory variables or show how they are related to other variables. Here, it is needed to contemplatively justify the SB price forecasting VECM model specification and perhaps also some comparisons with other model specifications which are for the forecasting performance or forecasting accuracy of the estimated model *i.e.* simultaneous Supply-Demand and Price system equation is satisfactory and to diagnose the variation in the errors in a set of forecasts.

Based on earlier studies, the forecasting model equations can come from many sources: they can be simple identities, they can be the result of estimation of single equations, or they can be the result of estimation using any one of multiple equation estimators. As mentioned when discussing the specification of the forecasting single-equation model in verbal terms as spelled out in many previous studies, it is the intention to estimate the relationship between the price effect on SB Supply and Demand, while all other indirect effects such as crude oil price and exchange rate in the content of Mongolia, to forecast the short-term and long-term SB price and to compare and evaluate the price forecasting models individually in terms of their comparative forecasting accuracies.

The research earlier reviewed the Supply, Demand, and price relationship based on models developed by [13] [14] [15] [16] [17] presented a broad economic framework as depicted in (**Figure 4**). The overall SB industry where the Supply of SB was determined by the expected Price in the marketplace, together with its production capacity, input costs, and underlying technological progress.

It then interacted in a dynamic and recursive manner with Demand. Demand was set by the expected Sea buckthorn price as well as by the income level in the overall economy, prices of sea buckthorn substitutes, and prices of final goods, technology, consumer preferences, stocks, and manufacturing capacity utilization. They explained that the organizational structure of production, marketing

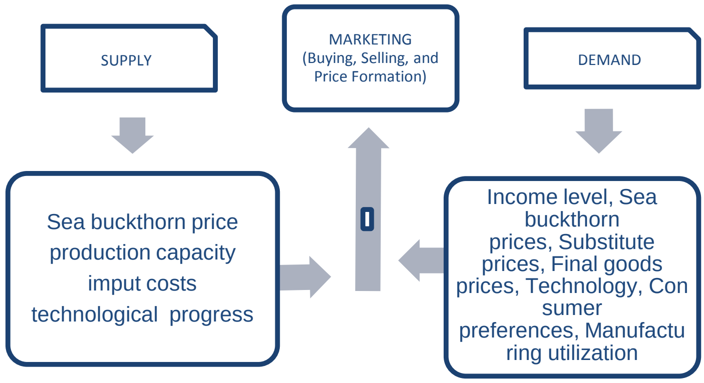

Figure 4. Theoretical framework of Sea buckthorn industry. Source: Barlow *et al.* (1994) [14].

and consumption, and government measures towards Seabuckthorn were also important, but they entered the sea buckthorn framework through the mentioned Supply and Demand factors. It was seemingly possible to study these relationships using a large econometric model with numerous simultaneous equations to capture the interdependencies between these factors.

Furthermore, this theoretical framework was a good starting point for discussion and perception of the general sea buckthorn economy, with the opportunity of using some of these factors later in the study for the conceptual framework. The study looked into the breakdowns of their Supply and Demand factors in detail, but with modifications made to change the functional form to total SB rather than a particular type of Sea buckthorn as depicted in their original forms.

2.1.1. SB Supply

A quarterly model of the Mongolian SB Supply, Demand, and Price is formulated comprising three behavioral single-equations and first identified the Supply of SB (SSB) equation. The Supply equation is the intention to estimate the relationship between the Supply effect on SB price SMR40 and the lagged variable of SSB in the content of Mongolia (in logs) as below:

$$SSB_t = a_0 + a_1 PSBSMR40_{t-1} + a_2 SSB_{t-1} + \varepsilon_{1t} \quad (1)$$

2.1.2. SB Demand

The Demand of SB (DSB) equation is the intention to estimate the relationship between the demand effect on SB price SMS20, the substitute SB product price of RSS1, and the lagged variable of DSB in the content of Mongolia. The DSB (in logs) can be written as below:

$$DSB_t = b_0 - b_1 PDSBMS40_{t-1} - b_2 PDSBRSS1_{t-1} + b_3 DSB_{t-1} + \varepsilon_{2t} \quad (2)$$

2.1.3. SB Price

The SB price (PSBSMS40) equation also intends to estimate the relationship between the price effect on SB Supply, Demand, stock and the lagged variable of PSBMS20, while all other indirect effects such as crude oil price and exchange rate in the content of Mongolia. It can be stated (in logs) as below:

$$PSBSMS40_t = c_1 + d_1 SSB_{t-1} - d_2 DSB_{t-1} + d_3 SBTO_{t-1} + d_4 PSBRSS1_{t-1} + d_5 COP_{t-1} + d_6 REER_{t-1} + d_7 PSBSMR40_{t-1} + \varepsilon_{3t} \quad (3)$$

where:

PSBSMS40 = Price of wild sea buckthorn SMS40 Price (USD/ton) deflated by the CPI.

PSBRSS1 = Price of wild sea buckthorn RSS1 price (USD/ton) deflated by the CPI.

SSB = Supply of wild sea buckthorn (‘000 tonnes).

DSB = Demand of wild sea buckthorn (‘000 tonnes).

COP = Crude oil price (USD/barrel).

REER = Real effective exchange rate in foreign currency per MNT (USD/MNT); a_0, b_0, and c_1 = Intercept; a_s, b_s and d_s = the coefficient values of the independent variables.

T = Time trend 2011 to 2020 quarterly data.

t and e_{ti} = Time period and error terms respectively.

2.1.4. Data Source

The sea buckthorn related time-series data, such as Supply, Demand and stock will be collected from International Sea buckthorn Study Group, and then all the SB prices—SMR40, and RSS1 Price will be sourced from Mongolian Sea buckthorn Association (MSA), Association of Wild Sea buckthorn Producing Countries (APC) and International Sea buckthorn Study Group (ISSG). Finally, the crude oil price and the real effective exchange rate will be collected from the International Monetary Fund (IMF) and the Bank of Mongolia (BNM). Data analysis will be used by running EViews 12 software, an excel spreadsheet.

2.2. SB Price Forecasting Models

According to the first objective of this study, it is to estimate the relationship between SB price and fundamental factors of Supply, Demand, and stock, while some other indirect effects such as crude oil price and exchange rate by using simultaneous Supply-Demand and Price system equation model and VECM. Firstly, it will explain the VECM model.

2.2.1. Vector Error Correction Model (VECM)

[18] and [19] pointed out the residual pattern. If residual is stationary, the two variables are co-integrated, and there is *a long-term relationship* between the two variables. It is called the *error correction model (ECM)*. If residuals are random walk, the two variables are not co-integrated, and there is no long-term relationship between the two variables. VECM model also includes two parts: first is cointegration equation (ECM) for long-term relationship and second is VECM model for a short-term relationship. Both are called VECM models. In the cointegration equation, the only right-hand side variable is the error correction term, and if residual is no error, this term is zero. And also, *co-integrating equation* is

no lagged difference terms. Besides, VECM models have a vector of intercept terms (a_i) and the disturbance terms (ε_i). Referring the price Equation (3), this study is only focused on and estimated the Price of SB by using the VECM with residual analysis of cointegration effect. SB price equation of cointegration equation is in Equation (4), and VECM equation is in Equation (5)

$$\begin{aligned} CointEq: & d_8 PSBSMS20_t + d_9 SSB_{t-1} + d_{10} DSB_{t-1} + d_{12} PSBRSS1_{t-1} \\ & + d_{13} COP_{t-1} + d_{14} REER_{t-1} = 0 \end{aligned} \tag{4}$$

$$\begin{aligned} PSBSMS20_t = & \alpha_2 + d_{15} SSB_{t-1} - d_{16} DSB_{t-1} + d_{18} PSBRSS1_{t-1} + d_{19} COP_{t-1} \\ & + d_{20} REER_{t-1} + d_{21} PSBSMS20_{t-1} + \varepsilon_{4t} \end{aligned} \tag{5}$$

2.2.2. Simultaneous Supply-Demand and Price Equation Model

Secondly, the other price forecasting equation for this study is the simultaneous Supply-Demand and Price system equation referred by [19] [20] and [21]. The simultaneous equation model is a two-equation model based on the market Demand (Equation (2)) and Supply (Equation (1)) where Price and quantity are both endogenous variables. The model deals with directly the interaction of Supply and Demand in establishing price equations without separately using the single-equations of Supply, Demand and Price. Price and Supply are endogenous also; jointly determined Price and Demand are endogenous variables. Others are exogenous variables. They are also structural equations. Structural equations characterize the underlying economic theory behind each endogenous variable by expressing it in terms of both endogenous and exogenous variables. An alternative way of expressing a simultaneous equations system is through the use of reduced-form equations. It expresses a particular endogenous variable solely in terms of an error term and all the predetermined (exogenous plus lagged endogenous) variables in the simultaneous system. We can derive the model (in logs) with price dependent Supply and Demand simultaneously the dynamics of such models are as follow:

Based on the Supply of SB Equation (1) and Demand of SB Equation (2), if exports and imports are negligible, Supply = Demand. Therefore, Supply Equation (1) and Demand Equation (2) will be

$$SSB_t = a_0 + a_1 PSBSMS20_{t-1} + a_2 SSB_{t-1} + \varepsilon_{1t}$$

and

$$DSB_t = b_0 - b_1 PDSBMS20_{t-1} - b_2 PDSBRSS1_{t-1} + b_3 DSB_{t-1} + \varepsilon_{2t}$$

respectively.

Therefore, we can write the *price simultaneous equation* (in logs) on Equation (6) as below:

$$\begin{aligned} & a_0 + a_1 PSBSMS20_{t-1} + a_2 SSB_{t-1} + \varepsilon_{1t} \\ & = b_0 - b_1 PDSBMS20_{t-1} - b_2 PDSBRSS1_{t-1} + b_3 DSB_{t-1} + \varepsilon_{2t} PDSBMS20_t \\ & = -(a_0 - b_0)(a_1 - b_1) + a_2 SSB_{t-1} + b_2 PDSBRSS1_t - b_3 DSB_{t-1} \end{aligned} \tag{6}$$

Assuming the sign on as follow a_2 and b_2 are positive and b_3 is negative. a_0, a_1, and b_0, b_1 are intercepting. On the other hand, Two-Stage Least Squares (2SLS) helps main problem with simultaneity bias in simultaneous equation systems. 2SLS requires a variable that is: 1) a good proxy for the endogenous variable, 2) uncorrelated with the error term, and 3) such a variable is called an instrumental variable (e.g. intercept).

2.3. Model Identification, Simulation and Model Evaluation

Regarding the second and third objectives of this study, to forecast the short-term and long-term SB price and to compare and evaluate the price forecasting models; individually, in terms of their comparative forecasting accuracies, model identification is needed to check especially for time series data are stationary or not using with the unit root test [19]. The term unit root means that a given time series is non-stationary. Time series variables are non-stationary, with mean and variance non-constant (unit root). The two common unit root tests are Augmented Dickey-Fuller (ADF) and Phillip-Perron (PP) tests (**Table 3**). Ho (null hypothesis): The time series data is unit root (non-stationary) and HA (alternative hypothesis): The time series data is no unit root.

If a time series has to be differenced "*d*" times to become stationary, it is integrated of order "*d*", denoted as I (*d*). Level data (Original data) I (0) it's an undifferenced form; such a time series is nonstationary. 1st difference form is I (1) (symbol Δ), and 2nd difference form is I (2) (symbol Δ2). Check the ADF and PP unit root test t statistic's p-value and if it will be smaller than "α 0.05 level" of significance and also indicated that bigger than "MacKinnon critical values" at all three levels of significance, the differenced "*d*" times data is stationary, which means that the differenced "*d*" times of a random walk time series are stationary. Hence, ADF and PP are to be conducted on data to test for a unit root (**Table 3**). If data are non-stationary, they are to be treated to become stationary. This is done using differencing from data. **Table 3** indicates that SB price (PSBSM40) and variables with SSB, DSB, PSBRSS1, COP, and REER are stationary only after the 1st and 2nd difference. Results of ADF and PP tests confirm each other.

Table 3. The unit root test of SB price forecasting model.

	Augmented Dickey Fuller Test			Phillip Perron Test		
Variables	Level	1st Difference	2nd Difference	Level	1st Difference	2nd Difference
PSBSM40	−0.177	−7.051***	−9.946***	−0.847	−7.798***	−25.991
REER	−1.593	−7.609***	−10.101***	−1.609	−7.563***	−15.605
PSBRSS1	−1.168	−6.092***	−10.247***	−1.208	−6.092***	−13.723
COP	−1.565	−6.789***	−6.538***	−1.524	−6.832	−31.242
SSB	−1.774	−6.000***	−10.247***	−1.881	−6.000***	−17.536
DSB	0.027	−2.712***	−8.029	0.822	−7.320***	−25.430

Note: *, **, *** statistically significant at respectively 0.10, 0.05, and 0.01 acceptable levels.

Significantly, forecasting models are needed to check for heteroskedasticity problems. It is the residual diagnosis method and takes account of correcting the standard errors, and it has a constant variance [22] and [23]. Ho (null hypothesis) is said that the error term has a constant variance (no heteroskedasticity), and *HA* is vice-versa, respectively. If sig p-value > α 0.05, then fail to reject $H0$. There is no heteroskedasticity. Therefore, the forecasting model is satisfactory, and no need to revise.

The model simulation is based on [21] and as short-term and long-term price forecasts. Simulation of a model may be performed for a variety of reasons, including 1) model testing, 2) evaluation, 3) historical policy analysis, and 4) forecasting. Usually, the time horizon over which the simulation is performed depends on the objective of the simulation. The data is used for the estimation period from 2011 Q1 to 2017 Q4 for the short-term price forecast and followed by long-term price forecast from 2011 Q1 to 2020 Q4. The forecasting performance accuracy criteria are Root Mean Square Error (RMSE), Mean Absolute Error (MAE), Mean Absolute Percent Error (MAPE), and (U-Theil) criteria in Equations (7)-(9).

The values of RMSE and MAE are all small, the values of Theil's inequality coefficient (U-Theil) are all nearly zero, which is that the forecasting performance and accuracy of the forecasting model is satisfactory, and the model is no need to revise.

$$\text{Root Mean Error}\left(\text{RMSE}\right)=\sqrt{\frac{\sum\left(P_t-A_t\right)^2}{T}} \tag{7}$$

$$\text{Mean Absolut Error}\left(\text{MAE}\right)=\frac{\sum\left(\left|P_t-A_t\right|\right)}{T} \tag{8}$$

$$\text{Mean Absolute Percent Error}\left(\text{MAPE}\right)=\frac{\sum\left(\left|P_t-A_t\right|/A_t\right)\times 100}{T} \tag{9}$$

3. Results and Discussion

3.1. Simultaneous Supply-Demand and Price Equation

Equations (10)-(13) show the results of the SB simultaneous Supply-Demand and Price model by using the Two-Stage Least Squares (2SLS) method in (**Table 4**).

Based on objective (1) of the study, **Table 4** explains the results of simultaneous Supply-Demand and Price equation for SB price (*PSBSMS*40) model. Firstly, the explanatory variables accounted for about 97.4% of the variation in the PSBSM40 model (Equation (10)). Estimations reveal that the explanatory variables, namely the DSB (Demand) and PSBRSS1 (RSS1 Price) variables, were the most important explanatory variables with statistical significance at α 0.10, and 0.01 levels, respectively. Also, SBS (Supply) variable is significant at α 0.05 level in the SB price model.

If the Demand increases, SB's Supply will also automatically increase, which is

Table 4. The results of simultaneous Supply-Demand and Price forecasting model.

Method: Two-Stage Least Squares

Sample: 2011Q1 2021Q2; Date: 15/12/21 Time: 19:32

Included observations: 40

Instrument specification: PSBSM40 SSB DSB PSBRSS1

Dependent Variable *Independent Variable*		*Summary St* *Coefficient*	*atistics of the R* *Std. Error*	*egression Coeffic* *t-Statistic*	*Ients* *Prob.*
Price ($PSBSM40_t$)	SSB_{t-1}	−3.81	8.33	−4.57	0.001
Equation (10)	DSB_{t-1}	1.32	7.16	18.44*	0.000
	$PSBRSS1_{t-1}$	0.52	0.07	7.49***	0.000
	C	−0.16	0.17	−0.14	0.35
R-squared	0.974	Mean dependent var		3.961	
Adj: R-squared	0.972	S.D. dependent var		0.537	
S.E. of regression	0.089	Sum squared resid		0.288	
Durbin-Watson stat	0.428 (white test) Heteroskedasticity test Prob. F(3,36) = 0.0003***				
Supply (SSB_t)	DSB_{t-1}	12.779	3.00	4.252***	0.0001
Equation (11)	$PSBSM40_{t-1}$	−964,753.2	108,618.5	−4.57	0.0001
	$PSBRSS1_{t-1}$	859,497.3	210,767.0	7.912	0.0000
	C	−10,17130.	229,964.3	−4.423	0.0001
R-squared	0.777	Mean dependent var		7339	
Adj: R-squared	0.759	S.D. dependent var		2901	
S.E. of regression	142,400.4	Sum squared resid		7.30	
Durbin-Watson stat	0.429 (white test) Heteroskedasticity test Prob. F(3,36) = 0.0030***				
Demand (DSB_t)	SSB_{t-1}	0.026	0.006153	4.252***	0.0001
Equation (12)	$PSBSM40_{t-1}$	68,439.93	3711.019	18.442*	0.0000
	$PSBRSS1_{t-1}$	−30,733.6	6319.063	−4.863**	0.0000
	C	7180.616	12,872.38	0.557	0.5804
R-squared	0.961	Mean dependent var		179,691.8	
Adj: R-squared	0.958	S.D. dependent var		31,533.54	
S.E. of regression	6443.3	Sum squared resid		1.49	
Durbin-Watson stat	0.523 (white test) Heteroskedasticity testProb. F(3,36)= 0.0030***				
Price ($PSBRSS1_t$)	SSB_{t-1}	7.39	9.34	7.912	0.0000
Equation (13)	DSB_{t-1}	−1.29	2.65	−4.863***	0.0000
	$PSBSM40_{t-1}$	1.15	0.15	7.496***	0.0000
	C	1.05	0.19	5.332	0.0000
R-squared	0.909	Mean dependent var		3.888	
Adj: R-squared	0.901	S.D. dependent var		0.421	
S.E. of regression	0.132	Sum squared resid		0.627	
Durbin-Watson stat	0.368 (white test) Heteroskedasticity test Prob. F(3,36) = 0.3270***				

Note: *, **, ***: statistically significant at respectively 0.10, 0.05, and 0.01 acceptance levels.

shown in Equation (11). This is the simultaneous Supply-Demand effect, and there is a positive relationship between SB Supply and Demand shown in Equations (11) and (12). Equation (13) for PSBRSS1 (RSS1 price) is also similarly relationship that affects the Demand and SB price (PSBSMR40). There is a positive relationship between them. Moreover, in the White test, all sig p-value is more significant than α 0.01, failing to reject H0. There is no heteroscedasticity of residuals. Therefore, the forecasting models are satisfactory, and no need to revise.

Therefore, based on both price models, we can say that SB price is mostly related to SB Demand and other SB product price. Significantly, if we can increase the international and domestic Demand, SB price will go up near the future exchange of the Mongolian SB market.

3.2. Vector Error Correction Model (VECM)

3.2.1. Johansson Cointegration Test (Long-Term Price Forecasting)

In order to test the model, long-term relationship between SB price with other variables SSB, DSB, PSBRSS1, COP and REER are identified by means of *co-integration tests* shown in Equation (14). Results of Johansson cointegration test on the model (cointegration rank) are presented in Table 5.

Table 5. Johansson cointegration test on SB price forecasting.

Hypothesised No. of CE (s)	*Eigenvalue*	*Trace Statistic*	0.05 *Critical Value*	*Prof.***
None*	0.798284	146.6210	95.75366	0.0000
At most 1*	0.575152	87.38786	69.81889	0.0011
At most 2	0.492004	55.71502	47.85613	0.0077
At most 3	0.446686	30.65558	29.79707	0.0397
At most 4	0.208997	8.757854	15.49471	0.3883
At most 5	0.002243	0.083094	3.841465	0.7731
Hypothesised No. of CE (s)	*Eigenvalue*	*Max-Eigen Statistic*	0.05 *Critical Value*	*Prof.***
None*	0.742018	59.23312	40.07757	0.0001
At most 1*	0.609180	31.67284	33.87687	0.0896
At most 2	0.462470	25.05944	27.58434	0.1018
At most 3	0.424253	21.89773	21.13162	0.0390
At most 4	0.220276	8.674759	14.26460.	0.3142
At most 5	0.000267	0.0835094	3.841465	0.7731

Notes: Trace and Max-Eigen statistics indicate 2 cointegrating equations at the 0.05 level. *denotes rejection of the hypothesis at the 0.05 level. **Mackinnon-Haung-Michelis (1999) p-values.

It provides Johansson cointegration results obtained from both methods of Trace and Maximum Eigenvalues. Results of trace method suggest existence of two cointegration equations; similarly, maximum Eigenvalue suggests there are also two cointegration equations. In other words, both methods confirm that there are two long-term equilibrium *equations* between SB price and other variables SSB, DSB, PSBRSS1, COP and REER exists within a multivariate framework.

As illustrated by Equation (14), which suggests that long-term relationship between SB price and SSB (Supply), DSB (Demand), PSBRSS1 (RSS1 price) and REER (exchange rate) are only statistically significant. This is due to respective *t*-statistics of 2.762, 0.362, 0.014 and 0.402, which suggest a significant relationship between SSB, DSB, PSBRSS1 and REER at α 0.01, 0.05 and 0.10 statistically significant level. On the other hand, *t*-statistic of 0.445 and fails to support any form of relation COP price in the equation. The sign of coefficients is right signs with SB price model. Hence, one may infer a direct long-term relationship between SB price with other variables SSB, DSB, PSBRSS1 and REER.

$$\begin{aligned} & -0.118PSBSM40_t - 8.0002SSB_{t-1} - 2.0004DSB_{t-1} \\ & \text{t-statistic} = \left[-2.2332^{**}\right] \quad \left[-2.762^{***}\right] \quad \left[-0.362^{**}\right] \\ & +0.005PSBRSS1_{t-1} - 0.001COP_{t-1} + 277.72REER_{t-1} = 0 \\ & \left[+0.014^{*}\right] \quad \left[-0.445\right] \quad \left[0.402\right] \end{aligned} \tag{14}$$

3.2.2. VECM Model Equations (Short Term Price Forecasting)

$$\begin{aligned} & PSBSM40_t = -0.192 - 1.0004SSB_{t-1} - 2.0008DSB_{t-1} - 0.180PSBRSS1_{t-1} \\ & \text{t-statistic} = \quad \left[-0.453^{**}\right] \quad \left[-0.351^{***}\right] \quad \left[-0.433\right] \\ & +0.0006COP_{t-1} + 153.48REER_{t-1} + 1.028PSBSM40_{t-1} - 0.022e_t \\ & \left[0.220\right] \quad \left[0.229^{**}\right] \quad \left[0.497\right] \end{aligned} \tag{15}$$

$R^2 = 0.099$ Adjusted $R^2 = -0.544$

Heteroskedasticity Test: White

F-statistic 1.153 Prob. F(2, 21) 0.3343

In Equation (15), it provides the results of VECM equation about SB price forecasting model. The result reveals that there is a short-term relationship between SB price with only SSB (Supply), DSB (Demand) and REER (real exchange rate). In other words, it shows the forecasting power of SB price with other variables' lag selection is on one period (lag) ahead in time. Results are significant at 0.05 acceptance levels with R-Square value of 0.099, indicating that up to 9.9% of the variation in short-term changes of SB price model. It was explained by variation in the lagged variables and SSB, DSB, PSBRSS1, COP, and REER. Therefore, this is a concrete model in predicting and explaining the short-term movement of SB price of Mongolia. Moreover, the existence of such a relationship is statistically supported. *T*he T-statistic of −0.229 indicates that the SB price affects REER significantly at α 0.05 level. Moreover, *t*-statistics of 0.453 and 0.351 suggest that the SB Demand and SB Supply are negative, and REER is positively statistically significant at α 0.05 level.

Moreover, in the White test, the sig p-value 0.3343 > α 0.01, fails to reject Ho. There is no heteroskedasticity of residuals. Therefore, the VECM forecasting model is satisfactory, and no need to revise.

A previous forecasting study was done by [24]. They found that the fundamental factors of the SB economy included the Supply, Demand and Price and indirect effects were the currency of exchange rate, Price of market SB, improvements in the world economy, and uncertainty of weather. The Asian crisis also provided strong evidence on how exchange rates affected SB price (MNT/USD) in the world market. They mentioned that the SB price should cause Demand and Supply to balance, based on the exogenous movements of consumer prices and exchange rates in the long-term. The exchange rates may directly affect the world SB market prices. A theoretical model showed exchange rate changes on SB prices incorporating market shares. Exchange rate changes should have an inverse effect on prices. Their research papers provided a theoretical basis for establishing a link between the exchange rates and the SB price for this study.

[2] investigated the determinants of the SB price volatility in Mongolia. He mentioned that Mongolia was the largest producer of SB after China. Moreover, she determined the factors that would affect SB (latex) price volatility in Mongolia. The objectives of describing the high volatility in SB price might be a result of international trade (export and import), exchange rate, inflation, and crude oil price. The data used for this study was from 2011 to 2020 every three months obtained from statistic Sea buckthorn Mongolia and data stream. Multiple regression was used to test the hypothesis and identify the relationship between variables; another test with the static test, hetero, correlation, multicollinearity, and Ramsey. The dependent variables for this study were volatility SB price in Mongolia, while the independent variables were crude oil price, exchange rate, inflation, export, and import. She found that the import variables had a negative relationship with the sea buckthorn price in Mongolia. The result showed that crude oil price had a positive relationship with volatility SB price in Mongolia. Based on this significant implication of the article's findings, dependence on one commodity as a source of export earnings was subject to risk; in other words, the diversification of export berry promotion must be continued. According to objectives (2) and (3) of this study, **Figure 5** explains the short-term and long-term SB price forecasts and the selection of the SB price forecasting model. The model selection is significantly contributed to the forecasting accuracy criteria such as Root Mean Square Error (RMSE), Mean Absolute Error (MAE), Mean Absolute Percent Error (MAPE) and (U-Theil) criteria of a combined forecast using a simultaneous Supply-Demand and Price system equation model and VECM model.

Both models used the quarterly data from 2011 Q1 to 2020 Q4 as estimation period, and data from 2011 Q1 to 2020 Q4 was estimated as a short-term price forecast and followed by the long-term price forecast was to 2011 Q1 to 2020 Q4. The results showed that the comparative forecasting powers criteria' values such as Root Mean Square Error (RMSE), Mean Absolute Error (MAE), Mean Absolute Percent Error (MAPE) and (U-Theil) criteria of *VECM model with cointegration equation* for short-term and long-term price forecast *by using the quarterly data* were smaller than the values estimated by the simultaneous Supply-Demand and Price system equation model. It meant that the forecasting performance of *VECM model with cointegration equation* model was more efficient and *satisfactory*, and thus, a revision of the model was not necessary.

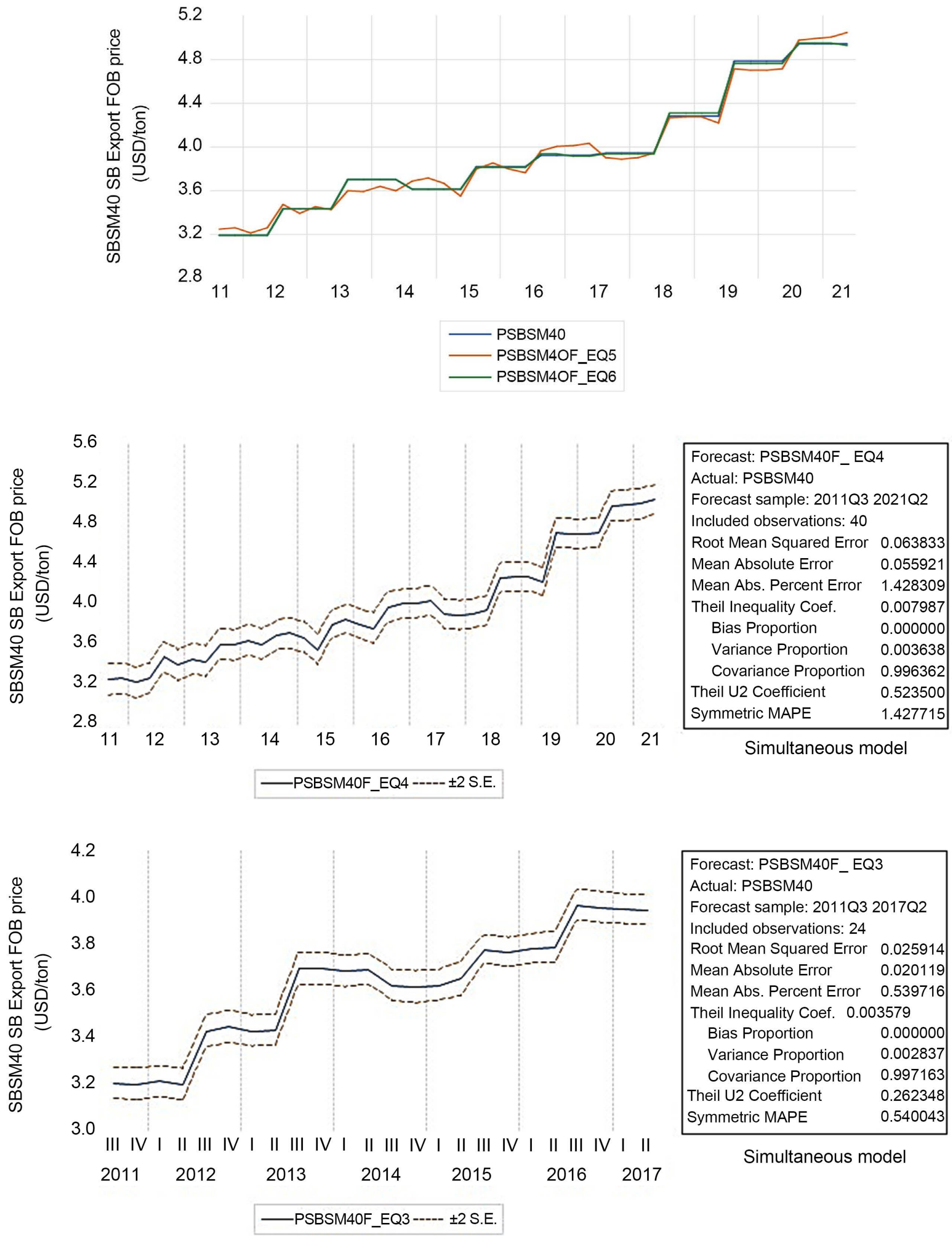

Figure 5. Long-term (2011-2020) and short-term (2011-2017) price forecasting models.

However, [25] found that the simultaneous equation of Supply-Demand and Price system equation model was more efficient measured in terms of its statistical criteria than the other forecasting models such as univariate model of autoregressive-integrated-moving average (ARIMA), multivariate model of MARMA and Auto-regressive Conditional Heteroskedasticity (ARCH) types models and VECM model with cointegration equation *using monthly data*.

Moreover, estimations reveal that SB price forecasting models show that SB price is significant relationship with Supply, Demand, and real effective exchange rate in the short-term and Supply, Demand, real effective exchange rate in the long-term based on the study findings. The price trend of the Mongolian SB shows that SB price is predicted to increase trend from 2011 Q1 until 2020 Q4 *long-term price forecast* and however, at the end of 2017 Q2, the prices of SB were decreasing trend for *short-term price forecast* in **Figure 5**.

Meanwhile, Mongolian domestic politics are likely to weigh on sentiment for the currency. Mongolia's currency has already been under pressure from a political scandal, and also the crude oil price and commodity price had dropped. The central bank of Mongolia has a forecast for the US dollar to fetch 6.0% at the end of 2021. Fundamentally, the Mongolian economy is not that bad. Domestic political developments are just overshadowing it. Therefore, based on the SB price short-term and long-term forecast, it would be most effective for the long-term forecast, which may lead policymakers to alter their budgetary plans to invest further in the SB market. For the short term, weather, seasonal factors, US dollar, and Mongolian togrog (MNT) exchange rate volatility, domestic political situation, futures markets activities, market interventions, and irregular Demand ensured a brief interruption to the downward trend if some of the major automobile manufacturers could be planned to boost their production in the coming year as a result of low inventories, which would also aid price level stability.

4. Conclusions

Therefore, this study would help producers trade with more transparent and reliable prices to take "specific measures" and forecast and support future SB producing countries and the world market. This study was also fulfilled one of the 12 national critical areas of Mongolia, which aimed to improve upstream productivity and expand downstream expansion while focusing on its sustainability of the SB market.

Over the past decade, SB prices have increased from 3.1 us/kg to 4.9 us/kg. But the estimated Price of sea buckthorn was US $3.1 per kg in 2012 and 2013, which is slightly lower than the national average. The elevated price volatility following the 2012 to 2013 commodity booms caused international organizations and policy-makers concern. The volatility of SB prices, as a general rule, tends to be more volatile than other mainstream commodities. Exports mainly drove fluctuations in commodity prices, and the Mongolian government's budget deficit widened.

It is also significant to indicate that the Mongolian SB price reached $4.28 (us/kg) in 2018 and $4.78 (us/kg) in 2019. Therefore, the findings of the study are potential applications for the berry goods manufacturing industry such as reinforcement of SB market in Mongolia, encouraging to the largest producer and exporter of the fresh SB Latex and SB berry in the world, and finally, a novel method for easy forecasting methodology of the SB price.

Significantly, the price forecasting alternative models such as univariate model of autoregressive-integrated-moving average (ARIMA), multivariate model of MARMA and Auto-regressive Conditional Heteroskedasticity (ARCH) types models, not attempted for this study, could also be potentially beneficial for future work. Therefore, the study can be safely recommended that forecasts frequently are used as guides for public and private policy. Forecasts are also helpful as guidelines for model building. Being such an essential commodity to sea buckthorn oil, berry and cosmetics, an accurate estimation methodology for SB price forecasting is also vital to forecast together with Supply, Demand and Price for the decision-making process in economic planning, which could be significantly beneficial for further development study.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

References

[1] Oyungerel, D., Juuperelmaa, U., Nasanjargal, D., Altangoo, G. and Battumur, S. (2014) Distribution and Genetic Resource of Mongolian Natural Wild Sea Buckthorn/Hippophae.Rh. *Mongolian Journal of Agricultural Sciences*, **13**, 55-59.

[2] Gonchigsumlaa, G., von Cramon-Taubadel, S., Soninkishig, N. and Buerkert, A. (2020) Competitiveness of Sea Buckthorn Farming in Mongolia: A Policy Analysis Matrix. *Journal of Agriculture and Rural Development in the Tropics and Subtropics*, **121**, 77-88.

[3] Tuvshintogs, B., Bumtsesteg, G. and Bulganchimeg, D. (2015) Economic Research Institute. Mongolian Bank, Ulaanbaatar.

[4] Work Bank Group/IFC (2018) Investment Reform Map for Mongolia: A Foundation for a New Investment Policy & Promotion Strategy. Mongolia Investment Policy and Agriculture Investment Promotion (IPAIP) Project.

[5] Minister of Agricultual and Food (2010) Seabuckthorn Nationale Program. Ulaanbator, Mongolia.

[6] FAO and NSOM (2015) National Statistics Office of Mongolia Indicators for Food Security Statistics 2015. Ulaanbator.

[7] Цэвэлма, Х. (2017) Seabuckthorn Cadastre Initiative. *Proceedings of the Mongolian Academy of Sciences*, **57**, 221.

[8] Munkhbayar, D., Ariuntungalag, J., Delgersuuri, G. and Badamkhand, D. (2014) Enzymatic Technology for Sea Buckthorn Oil Extraction and Its Biochemical Analysis. *Mongolian Journal of Chemistry*, **15**, 62-65.

[9] Enkh-Amgalan, T. (2016) Uvssea Buckthorn' Geographic Indication (GI). Lessons

learnt and experiences.

[10] Nasanjargal, D. (2022) EU Trade Related Assistance for Mongolia (TRAM), Trade Policy. http://tram-mn.eu/

[11] Martincus, C.V. and Carballo, J. (2010) Is Export Promotion Effective in Developing Countries? Firm-Level Evidence on the Intensive and the Extensive Margins of Exports.

[12] Frempong, A. and Rasmuseen Debra, C. (2015) Agriculture in Transition Agricultural Productivity and Marketing Debra Rasmussen and Charles Annor-Frempong Mongolia.

[13] Ganzorig, G. (2016) Competitiveness of Pastoral Livestock Production and Sea Buckthorn Farming in Mongolia: Application of Policy Analysis Matrix, Dissertation Report.

[14] Tan, C.S. (1984) World Rubber Market Structure and Stabilisation : An Econometric Study. World Bank, Washington DC.

[15] Tan, S., Barlow, C.S., *et al.* (1914) The World Rubber Industry. Routledge, London.

[16] Arshad, F.M. and Mohamed, Z. (1980) Price Discovery through Crude Palm Oil Futures: An Economic Evaluation 1. Faculty of Economics and Management Universiti Putra Malaysia.

[17] Goodwin, J.W. (1994) Agricultural Price Analysis and Forecasting. Jon Wiley & Sons, New York.

[18] Khin, A.A. (2010) Econometric Forecasting Models for Short Term Natural Rubber Price. Research Gate.

[19] Engle, R.F. and Granger, C.W.J. (1987) Co-Integration and Error Correction: Representation, Estimation, and Testing. *Econometrica*, **55**, 251-276. https://doi.org/10.2307/1913236

[20] Gujarati, D.N. (2003) Basic Econometrics. McGraw Hill, New York.

[21] Labys, W.C. (2005) Commodity Price Fluctuations: A Century of Analysis.

[22] Robert, D.L.R. and Pindyck, S. (2013) Microeconomics. 8th Edition. https://www.myeconlab.com/

[23] White, H. (1980) A Heteroskedasticity-Consistent Covariance Matrix Estimator and Direct Test for Heteroskedasticity. *Econometrica*, **48**.

[24] Studenmund, A.H. (2014) Using Econometrics: A Practical Guide. Pearson Education Limited, Harlow.

[25] Khin, A.A. and Thambiah, S. (2015) Natural Rubber Prices Forecasting Using Simultaneous Supply-Demand and Price System Equation and VECM Model: Between Theory and Reality. *Proceeding of the 2nd International Conference on Agriculture and Forestry*, **1**, 10-12.