# Coffee, orange juice and milk: What is missing on your table?

Devmali Perera[*]
Jedrzej Bialkowski[†]
Martin T. Bohl[‡]

Revised: 02 December 2018

**Abstract**

Tea is one of the most popular beverages in the world. Its consumption exceeds the consumption of milk, coffee and orange juice. Despite its importance, tea is not considered as a commodity in financial markets and there is no futures contract on tea as well. Our paper contributes to the literature by providing a detailed overview of the structure of the oldest tea market in the world. Furthermore, we answer the question, whether it is feasible to introduce a derivative contract on tea that would be beneficial for the tea market participants. Finally, we examine the diversification benefits of tea as an asset in the portfolio of an investor.

*Keywords*: Agriculture Commodity Market, Futures Contract, Portfolio Choice

*JEL Classification:* G11, G13, Q02

[*] Department of Economics and Finance, UC Business School, University of Canterbury, Private Bag 4800, Christchurch 8140, New Zealand. Email: devmali.perera@pg.canterbury.ac.nz

[†] Department of Economics and Finance, UC Business School, University of Canterbury, Private Bag 4800, Christchurch 8140, New Zealand. Email: jedrzej.bialkowski@canterbury.ac.nz

[‡] Department of Economics, Westfälische Wilhelms-University Münster, Am Stadtgraben 9, 48143 Münster, Germany. Email: martin.bohl@wiwi.uni-muenster.de

## 1. Introduction

Futures contracts on agriculture commodities have been established and successfully traded for several decades now. Traditionally, commercial investors exposed to price risk related to agriculture commodities were the dominant investors in commodity futures markets before 2000. The commercial investors use commodity futures contracts to hedge their price risk and to smoothen the revenue from the unknown fluctuations in commodity prices. Erb and Harvey (2006) and Gorton and Rouwenhorst (2006) find that commodities have either negative or zero correlation structure with traditional assets such as stocks and bonds. Thereafter, investing in commodities became increasingly popular among non-commercial investors to achieve their portfolio diversification objectives. Due to that popularity, commodity markets encountered a large inflow of funds. Furthermore, previous studies find that large institutional investors played a major role in this financialization process of commodity markets (Basak and Pavlova, 2016; Domanski and Heath, 2007).

Non-commercial investors could obtain the exposure to the commodity markets either by directly investing in physical commodities or by indirectly investing in derivative products on commodities. Due to the high costs involved in obtaining the direct exposure, investors preferred obtaining commodity exposure via derivative products. Financialization of commodity markets has increased the number of positions, turnover and the number of contracts traded in the commodity derivative markets (Zaremba, 2015). The financialization process intertwined the commodity markets with financial markets and investors started considering commodities as an

asset class[1] along with stocks and bonds when they decide the strategic allocation of their portfolios.

At present, if you carefully look at the composition of the products on your breakfast table, you will notice that there are futures contracts on most of your food. For example, there are futures contracts on coffee, milk, orange juice, sugar, butter and even for wheat included in your bread. These agricultural commodities are well established as investable commodities in financial markets now. Despite the fact that the legend of tea dates back to the Sheng dynasty of China in 2737 BC (Hall, 2000), tea has been missing from the commodity markets for all these years. Tea does not have either an established price index or a futures contract on tea. It is surprising why tea has not yet elevated into an investable commodity regardless of being one of the oldest as well as one of the highly consumed beverages in the world.

Accordingly, this study has three contributions to the existing literature. First, we will provide a detailed overview of the oldest tea auction market in the world, i.e. Sri Lankan tea market. Second, we examine the feasibility of introducing a futures contract on tea to hedge the price risk faced by the tea markets participants. Finally, we investigate whether tea would be an attractive investment asset in the portfolio of any investor.

There are three valid reasons for the choice of Sri Lankan tea market. First, Sri Lankan tea auction is the oldest auction operating at present with 150 years of history. Sri Lankan black tea is the highest quality tea in the world and earns a premium price in the market. Second, participants in the Sri Lankan tea market face numerous risks. All the tea market participants are exposed to the price risk of tea and hence their income is uncertain. The other major uncontrollable risk they

[1] An asset class consists of assets with similar risk and return characteristics. According to Greer (1997), there are three categories of assets: capital assets, store of value assets and consumable assets. Commodities are consumable assets because their prices are determined based on the demand and supply.

face is the climate change risk. We will discuss these risks in detail under the overview of the tea market. Finally, since there are stringent regulatory controls in Sri Lanka on approving a forward contract on tea, these market participants do not have an easy access to the forward market as well. Therefore, it is interesting and worthy to study the Sri Lankan tea market as it is almost free from any derivative contract on tea.

Futures markets play an important role in the development of agriculture commodity markets. According to Atkin (1989), futures markets support establishing fair prices for commodities, create a liquid secondary market and support hedging the price risk associated with commodities. Every futures exchange attempt to introduce contracts on new commodities and/or introduce modifications for existing contracts in order to ensure the survival of the exchange. Therefore, we believe a futures contract on tea would be highly beneficial for the tea market participants.

Even before the financialization of commodity markets, Greer (1978) demonstrated that an unlevered portfolio of commodity futures is less risky than a portfolio of stocks. According to Bodie and Rosansky (1980), when an investor allocates a 40% of its portfolio to commodity futures along with stocks, he could achieve a significant decrease in portfolio risk compared to a portfolio of stocks only. Given the low correlation structure of commodities, an equally weighted portfolio of commodity futures offered the same return and Sharpe ratio as a portfolio of US equities during the period of July, 1959 through December, 2004 (Gorton and Rouwenhorst, 2006). If it is possible to introduce a futures contract on tea, it could be considered as an investment asset on tea by other investors as well. Finally, we investigate whether futures contracts on tea would be an attractive investment asset in a portfolio of non-tea market participants.

The remainder of this paper is organized as follows. In Section 2, we provide an overview of the previous related literature. Section 3 introduces the Sri Lankan tea market by explaining its historical development, tea cultivation process and production process along with tea grades. Section 4 summarizes the institutional framework of the existing tea market in Sri Lanka and the existing financing mechanism in this market. Section 5 summarizes the data and the sources of data used in the study. Section 6 presents the results and discusses the findings of this study. Finally, Section 7 summarizes and concludes the paper.

## 2. Literature Review

### *2.1. Determinants of the success of a futures contract*

There is a strand of literature examining the factors that determine the success or failure of a futures contract (Bekkerman and Tejeda, 2013; Black, 1986; Brorsen and Fofana, 2001; Carlton, 1984; Till, 2015; Webb, 2015). Accordingly, characteristics of the commodity, characteristics of the cash market and the design of a futures market determine the success of a futures contract. We discuss these factors briefly in this section and Table 1 presents a complete list of these characteristics and the respective references.

[Insert Table 1 about here]

The cash market size, volatility of cash prices, the level of activeness, degree of buyer concentration and degree of vertical integration are the salient factors in commodity cash markets that determine the suitability of a commodity for a futures contract. Larger the size of the cash market in terms of the value of production, greater the attractiveness to hedgers and speculators (Bekkerman and Tejeda, 2017; Black, 1986; Carlton, 1984; Tashjian and Weissman, 1995). These studies further conclude that there is a positive relationship between price volatility and the success

of a futures contract. A commodity with a highly volatile cash market price tends to generate a high level of price risk for the market participants and hence there is a high demand for hedging.

It is not just the size and the volatility of the cash market that matters, but the degree of activeness also contributes positively for the success of a futures contract. According to Bekkerman and Tejeda (2017), activeness of an underlying cash market represents the degree to which cash market information is available for market participants. Brorsen and Fofana (2001) define the activeness of a cash market as the number of participants and the volume of trading transactions quoted daily. Large losses arising in a large and active cash market due to high volatility in cash prices will motivate market participants to search for better risk management techniques.

Furthermore, the cash market structure also affects the successful development of a futures contract. First, Bekkerman and Tejeda (2017) and Brorsen and Fofana (2001) argue that the degree of vertical integration in the cash market requires to be low to introduce a futures contract successfully. In a market, when there are few pricing points for a commodity without adding value or changing the form of the commodity, such a market is considered to be less vertically integrated (Brorsen and Fofana, 2001). Second, the level of buyer concentration also affects the success of a futures contract (Bekkerman and Tejeda, 2017; Brorsen and Fofana, 2001). A cash market is concentrated, when a small number of buyers buys a large proportion of the production. In a buyer concentrated market, trade will likely to occur via bilateral trade agreements with buyers. Hence, the price will be determined between the negotiations of the parties to the agreement. For the success of a futures contract, it is essential that commodity prices are determined freely and competitively in the market depending on the demand and supply of each commodity (Carlton, 1984).

Additionally, the commodity itself requires to be homogenous to develop a successful futures contract. Homogeneity is required to be able to standardize the delivery of a futures contract (Atkin, 1989; Bekkerman and Tejeda, 2017; Brorsen and Fofana, 2001). A futures contract is a contract to deliver a commodity of an agreed upon quality in the future. If the commodity is not homogenous, it is difficult to establish delivery standards because a single futures contract can deliver only a single grade of a commodity.

The characteristics of the futures market that determine the success of a futures contract are availability of cross-hedging, liquidity cost of the cross-hedging, contract design, need for commercial hedging and ability to attract speculators. The cross-hedging futures contracts are the futures contracts on highly correlated commodities which can be used effectively for hedging the risk of a given commodity. If there are any already existing cross-hedging futures contracts, there won't be any necessity for a new futures contract (Black, 1986; Gray, 1966; Webb, 2015). The users of a futures contract will compare the liquidity cost of an own-hedge futures contract with that of a cross-hedge futures contract. If the cross-hedge market is more liquid and less costly compared to own-hedge market, traders will likely to use the cross-hedge product instead (Black, 1986).

In the case of introducing a new futures contract on an asset for the first time, there should be a need for hedging (Cuny, 1993; Gray, 1966; Silber, 1981; Till, 2015; Webb, 2015). High volatility in prices will generate losses for the market participants. If these losses are significant enough, market participants will search for methods to mitigate the price risk. Webb (2015) emphasizes the need of attracting speculators into the market. Speculators take the opposite position of hedgers and provide liquidity to the futures market. If the asset prices are determined

transparently and information is publicly available for all the participants, speculators will be more confident to participate in the futures market.

Moreover, Gray (1966) and Webb (2015) highlight the importance of having a good contract design that fulfill the requirements of market participants and the importance of timing when introducing a futures contract. Contract design involves the decision of determining the contract specification regarding the size, delivery date, quality of the products to be delivered, and delivery price etc. To be successful, a futures contract should be either the first contract on a commodity or a new contract design on an existing commodity which would be more attractive for the traders than the existing contracts (Cuny, 1993; Economides and Siow, 1985).

There is another argument that the design of the infrastructure in the market also affects the success of a futures contract. Ates and Wang (2005) and Tse and Zabotina (2001) find that the migration from open outcry trading to electronic trading creates a favorable environment for a futures contract due to lowered transaction costs and improved efficiency. According to Frank and Garcia (2009) and Shah and Brorsen (2011), the transition into electronic trading reduces the transaction costs in commodity futures markets. Finally, it is essential to educate the market participants and policy makers about the importance of establishing a futures market and obtain their support when introducing a new futures contract (Till, 2015; Webb, 2015).

### *2.2. Benefits of commodities in portfolio diversification*

The financialization of commodity markets during the last decade provide an evidence on the importance of commodity-based investment assets for the investors. At first, low correlation structure of commodities encouraged investors to use commodities to diversify their portfolios (Erb and Harvey, 2006; Gorton and Rouwenhorst, 2006; Kat and Oomen, 2006). However, after

10 years from their first paper, Bhardwaj, Gorton and Rouwenhorst (2015) find that correlation between commodities and stocks has now become positive during the financial crisis period whereas correlation between commodities and bonds has continued to be negative. Tang and Xiong (2012) accredit the financialization of commodity markets via index funds as the reason for this change in the correlation structure.

Previous studies find that investment in commodity futures reduces the overall risk of the portfolio (Greer, 1978; Bodie and Rosansky, 1980). Moreover, Fabozzi, Fuss and Kaiser (2008) graphically show an upward shift in the efficient frontier when commodities are included into a portfolio of U.S. and global stocks, bonds and treasury bills. However, Scherer and He (as cited in Fabozzi, Fuss and Kaiser, 2008) find that not all the commodity indices provided statistically significant diversification benefits for an investor during January 1989 to June 2006. As per their results, investment in Deutsche Bank Liquid Commodity Index (DBLCI), Deutsche Bank Liquid Commodity Index – Mean Reversion (DBLCI-MR) and Deutsche Bank Liquid Commodity Index – Optimum Yield (DBLCI-OY) delivered statistically significant diversification benefits for an investor.

Adding alternative assets into the portfolio involves an asset allocation decision among stocks, bonds and other alternative assets. According to Markowitz (1952), investors can optimize their investment decision based on the risk and return characteristics of a portfolio. The decision to add commodities into a portfolio will depend on its contribution to the overall portfolio performance but not on the standalone performance of the commodities. Theoretically, adding assets with low or negative correlation provides diversification benefits for an investor. However, a cross-correlation analysis is not sufficient to reliably test for asset classes.

Huberman and Kandel (1987) propose a regression-based test to examine whether adding alternative assets would expand the efficient frontier of an investor. Their regression method is known as 'Mean-Variance Spanning Test'. This method was widely adopted by the previous researchers in order to understand the statistical significance of introducing a new asset in to the efficient frontier of an average investor. DeSantis (1995) and Cumby and Glen (1990) examine whether US investor can benefit by international diversification. Bekaert and Urias (1996), Errunza, Hogan and Hung (1999) and DeRoon, Nijman and Werker (2001) investigate whether investors can improve their mean-variance portfolio by investing in emerging markets. Scherer and He (as cited in Fabozzi, Fuss and Kaiser, 2008) find that commodities, when invested along with US stocks and bonds, improves the risk-return trade off of a portfolio. We also adopt the Mean-Variance Spanning test in order to examine whether tea can be considered as an asset in a portfolio.

## 3. Overview of tea market in Sri Lanka

In order to familiarize readers about this largely unknown tea market of Sri Lanka, we provide an overview of the tea market by summarizing the historical evolution of the market, tea cultivation process, tea production process and tea grades adopted in Sri Lanka.

### *3.1. Historical evolution of the tea market*

According to Forrest (1967), history of Sri Lankan tea (then known as Ceylon tea) dates back to even before 1867, when the first batch of tea seeds had reached and planted at Royal Botanical Garden at Peradeniya, Sri Lanka in 1839. James Taylor was the first planter who achieved success in planting tea for commercial purposes in 1867. Later, he was acknowledged as the "Father of

Ceylon tea" for successfully marking the beginning of an era of a remarkable crop in Sri Lanka. The first lot of Sri Lankan tea shipment (of 10kg) was shipped to London for trade in 1873.

At the beginning, tea plantation sector was developed under large tea plantation companies owned by British investors and the labour was obtained from South India. After the World War II, the industry structure started changing with the increase of Ceylonese owned plantation companies. In 1967, the industry consisted of three main types of companies namely: Sterling companies, Rupee companies and individual Ceylonese ownership companies.[2]

After becoming independent on 4th February 1948, a nationalist government was elected in 1970. On 16th October 1975, this new government enforced a Land Reform Law which did limit the private ownership of lands only to fifty acres. Then in 1975, the government nationalized the Sterling and Rupee companies and acquired approximately 415,000 acres of cultivated tea land and associated assets.[3] These lands and assets were then re-distributed, under the "State Land Distribution" Program, among rural individual planters and the rest was allocated to two state corporations namely: State Plantation Corporation and Janatha (People's) Estate Development Board. This nationalization decision changed the ownership structure of the tea market from the dominant British ownership into a majority of Ceylonese tea smallholders and government owned companies.

Under this government monopoly of the tea industry, the Sri Lanka Tea Board was established in 1976 to regulate the tea market.[4] During this period, Sri Lanka started importing tea

[2] According to Forrest (1967), the ownership of approximately 600,000 acres of tea land was distributed among Sterling companies (registered in London and predominantly British capital), Rupee companies (registered in Sri Lanka with a mix of British and Ceylonese capital) and individual Ceylonese owned companies (registered in Sri Lanka and only Ceylonese capital). The remainder of the tea land was distributed among tea smallholders. Retrieved from http://www.historyofceylontea.com/ceylon-publications/other-publications/hundred-years-of-ceylon-tea-1867-1967/quick-view/index.php

[3] Details are retrieved from http://www.pureceylontea.com/index.php/independence-and-after

[4] These time line information mentioned are mostly obtained from 'The History of Ceylon Tea' web site. Retrieved from http://www.historyofceylontea.com/history-of-tea-timeline.html

for blending and re-exporting and produced/ exported the first lot of green tea. In 1983, some factories initiated using Cut, Tear and Curl (CTC) machines to manufacture black tea.[5] The CTC method of production is cost effective compared to the Orthodox method, but the quality of the tea is compromised.

Despite these developments, under this government ownership, tea industry confronted with number of administrative difficulties, labour problems and financial losses. Hence, then ruling government in 1992 and 1993, decided to reverse the nationalization decision of the tea industry. However, the government retained the title to all the tea plantation lands and the management of the land was handed over to 20 private regional plantation companies under a long-term lease agreement for land. Accordingly, the tea industry in Sri Lanka now consists of these private regional plantation companies, several tea smallholders and private tea companies.

### *3.2. Tea cultivation and production process*

Tea is an agricultural crop of which both the quality and the quantity of supply are highly dependent on the agro-climatic conditions prevailing at the time of cultivating. There are three tea growing areas in Sri Lanka based on the elevation from the sea level. The high grown area has an elevation of 1200m and above; the medium grown area has an elevation between 600m to 1200m and the low grown area has an elevation from sea level up to 600m. The low altitude areas have an intensive sun light. Hence, tea bushes grow rapidly in the low grown areas and will be suitable for harvesting within about two and half years. The high growth of low grown tea sacrifices the

[5] The traditional method of tea manufacturing is the Orthodox method which is highly labour intensive and time consuming but produces high quality tea in terms of brewing and aroma. The CTC method uses machines, hence less labour intensive, and can produce tea within a lesser time than the traditional method. More details will be discussed under the Section 3.2.

quality compared to high grown teas and earns a low price in the market. Higher the altitude, higher would be the quality of the produced tea but lower the growth of the tea bushes.

There are three main important climatic factors essential to cultivate tea: soil, temperature and rainfall (Hall, 2000). Tea can be grown in a wide variety of soil, if it has a sufficient level of acidity, nitrogen and gets drained well. Any soil with an acidity level of pH values 4.6 to 6.2 would be appropriate for growing tea. When determining a suitable land for tea cultivation, it is essential to consider the depth of soil together with its contents such as gravel and rocks. A temperature level between $13^0$ to $30^0$ Celsius is required with at least four hours of daily sun light. The ideal rainfall for tea cultivation should be between 1200mm and 3000mm around the year. Concurrently, tea cultivators have a responsibility to manage and preserve the soil in their tea lands in order to avoid soil loss and soil wash that can occur as a result of heavy rainfall.

The tea cultivation process includes several steps such as clearing, preparing, planting, weeding, fertilizing, pruning and plucking. Clearing is the act of removing other trees and bushes on the land and then slopping the land as required for planting tea. It takes approximately 5 to 7 years, after being planted, for the tea bushes to become suitable for commercial exploitation and then remains productive for over 50 years. Then, tea plucking occurs at regular intervals of 4 to 10 days with approximately 50 rounds of plucking per annum. Tea plucking is a labour intensive process and requires a high level of skill, because picking the right tea bud has a direct impact on the quality of the tea produced. Sri Lanka has a unique advantage of being able to pluck tea throughout the year due to its climate conditions.

The tea production commences as soon as the tea is plucked owing to the perishability nature of fresh tea green leaves. All types of tea whether it is black tea, green tea, white tea or Oolong tea are produced from the tea buds and leaves of the same plant. However, these

differences stem from the differences in processing tea. The basic steps in the tea manufacturing process are withering, rolling, fermenting, drying, sorting and grading.

There are two methods of tea manufacturing currently adopted in Sri Lanka. Majority of the Sri Lankan tea producers still use the traditional Orthodox method. The traditional method involves processing the whole withered tea leaf into either whole leaf teas or broken leaf teas. The Orthodox manufacturing is a batch process which is highly labour intensive and relatively slow compared to CTC method. Therefore, the cost of tea production is high under Orthodox method, but it produces high quality tea with special aromatic qualities and delicate tastes. This high quality of the Sri Lankan Orthodox tea justifies earning a higher price for Sri Lankan tea in the global market compared to tea from other origins.

A small proportion of the Sri Lankan tea is produced using the modern and cost-effective CTC method. This method involves continuous processing and automated method of crushing, tearing and curling tea leaves into small granules. CTC machines can process a large quantity of tea green leaves at a relatively low cost and within a reduced time period. The CTC tea is quick to brew, dark and deep in colour but lacks the unique aroma.

### *3.3. Tea grades*

Hall (2000) states that different types of tea has different grading systems. Accordingly, green tea and Oolong tea are graded based on the quality and black tea are graded based on the size of the tea granule. There is no universally accepted standard grading system for Orthodox black tea, but there is a standard grading system for CTC tea (N. De Mel, personal communication, October 26, 2017). However, the grading system of Orthodox black tea used by other countries are reasonably similar to the grading system adopted in Sri Lanka.

In the Sri Lankan tea grading system, the 'highest' quality tea range is Flowery Orange Pekoe produced from the tip of the tea bud; the next 'fine' quality range is Orange Pekoe produced from the first small leaf; then the second leaf and rest of the leaves produce further lower quality varieties of Pekoe. The higher the number of letters to a grade, higher the quality of tea and hence higher would be the price. The Orthodox black tea grades adopted in Sri Lanka are summarized in Appendix 1.

## 4. Institutional framework of tea market in Sri Lanka

This section explains the institutional framework of the existing tea market in Sri Lanka. We discuss the role of different market participants and the role of Colombo Tea Auction (CTA). Furthermore, we identify the risks faced by each market participant and summarize the existing financing mechanism in the tea market.

### *4.1. Role of market participants*

There are four main players in the tea market in Sri Lanka: tea cultivators, tea manufacturers, tea brokers and tea buyers (N. De Mel, personal communication, January 24, 2017). Figure 1 depicts the value chain of tea market in Sri Lanka. There are three types of tea farmers namely: corporate cultivators, private tea cultivators and tea smallholders. Corporate cultivators are the large regional plantation companies engaged in both cultivation and manufacturing of tea. These large cultivators generally own tea lands of over 100 hectares. Private tea cultivators are mostly family owned companies holding tea lands over 10 acres and hire labour to work in their tea gardens. Some private tea cultivators also own tea manufacturing facilities. A tea smallholder is a tea cultivator

who owns tea lands of less than 10 acres.[6] Today, tea smallholders predominantly exist in Southern and Sabaragamuwa provinces of the country. They generally do not have their own manufacturing facilities. Tea smallholders and private tea cultivators who do not have the manufacturing facilities sell their tea green leaves to a nearby tea manufacturer either directly or via leaf dealers.

[Insert Figure 1 about here]

Leaf dealers provide an intermediary facility by buying tea green leaves from the tea cultivators and delivering them to nearby tea manufacturers. Leaf dealers are required to register and obtain an annual license under the Tea Control Act of Sri Lanka Tea Board. They can sell tea green leaves for three tea manufacturers at the same time. They buy tea green leaves at a price specified by each tea factory and obtain a fee from each factory to cover their transportation costs and a commission of 1% of the value of the tea leaves (N. De Mel, personal communication, January 24, 2017).

Tea manufacturers with tea factories process fresh tea green leaves. They process their own tea green leaves, or the leaves bought from tea smallholders or private tea cultivators. It is mandatory for tea producers to register both tea lands and tea factories at the Sri Lanka Tea Board and they are bound to manufacture tea only in those registered factories. In 2017, there were 720 registered tea factories operating in the country.[7] In practice, there is no any contractual agreement between tea factory owners and leaf dealers regarding the price to be paid for the tea green leaves or regarding the quantity of tea leaves to be supplied.

Thereafter, tea producers dispatch samples of produced tea along with the tea consignment to tea brokers on every Friday. Tea producers have the choice to select one or many tea brokers

[6] See the Tea Control Act No. 51 of 1957 of Sri Lanka for further details.

[7] These statics are obtained from the Sri Lanka Tea Board web site www.purecelyontea.com on 8th August 2017.

via whom they intend to sell their tea. This choice depends on the level of costs (storage, insurance and handling costs) charged by each broker and the percentage of the advance payment made by each broker. If any tea producer requires to change their tea broker, it is essential to submit a "No Obligation Letter" from the previous broker to ensure that he has no due payments to the previous broker (I. Dampella, personal communication, February 15, 2017).

Tea broker is responsible for distributing tea samples to respective buyers, valuing tea samples, cataloging the samples to the auction, selling tea at the auction, remitting sales proceeds to producers, packaging tea and providing warehousing.[8] There are only eight registered tea brokering companies in Sri Lanka at present. The graded and valued tea samples take approximately two weeks to be included in the tea catalogue of the auction. In brief, tea brokers handle all the activities related to the tea auction process, provide post auction services and act as intermediaries between tea producers and tea buyers. In return, they charge 1% commission on tea sales, Rs. 2 per kg[9] as storage cost until the catalogue date, insurance charges and handling charges from tea producers (N. De Mel, personal communication, January 24, 2017).

Tea buyers in the auction are two types: local buyers and export buyers. Local buyers buy approximately 10% of the produced tea from the tea auction to sell in the local market and export buyers buy the remainder for exporting either as bulk tea or under different private labels. Tea Board of Sri Lanka will verify whether export buyers meet the minimum criteria required to be an exporter of tea.[10] These criteria include the level of capital invested in the organization, availability and quality of warehousing facilities (for storing, blending and packing) and the services provided

[8] Tea brokers are regulated by the Licensing of Produce Brokers Act No 9 of 1979, Auctioneers Ordinance & By-laws and Conditions for Sale of Tea at the Auction of Sri Lanka.

[9] Based on the exchange rate prevailing at 10th July 2018 (i.e. LKR 159.286/USD), the storage cost is USD 0.01256 per kg.

[10] Export buyers are regulated under the Tea (Tax & Control of Exports) Act No 16 of 1959 of Sri Lanka.

for tea tasters. Export buyers are subject to stringent quality controls at the pre-auction, post-shipment, pre and post import points.

Finally, there are tea warehouses and tea packers providing warehousing facilities and tea packing services to the tea brokers and tea buyers. The ultimate consumers of tea are either local tea lovers in Sri Lanka or international tea lovers in rest of the world.

### *4.2. Colombo Tea Auction*

Tea is currently traded in an auction system considered to be the ideal channel for disposing tea by all tea producing countries. A public tea auction is a physical location where tea buyers and tea sellers meet to buy and sell the tea. The first tea auction in Sri Lanka was held on 30$^{th}$ July 1883 at the premises of Somerville & Company. It was a private auction which sold only five lots of tea directly by the William Somerville, the head of the Somerville & Company. These private auctions emphasized the need to establish a well-organized public auction for tea. Accordingly, on 18$^{th}$ June 1894, "The Colombo Tea Traders' Association" was formed with the objective of promoting the common interests of tea sellers and tea buyers and to uphold the good name of the Colombo Tea Auction (CTA). The ownership of the CTA is vested with the Sri Lanka Tea Board under the Sri Lanka Tea Board Law No. 14 of 1975.

This auction is the oldest and the largest (in the quantity of tea sold weekly) operational single origin tea auction in the world at present. The CTA is an English auction in which the general practice is to bid in an ascending order. Tea brokers catalogue all the tea samples received from tea producers. Then, bidding start at the lowest price and sell it to the highest bidding buyer at the end. In this auction, all the buyers have an equal opportunity to purchase tea in any quantity. Furthermore, CTA holds auctions every Tuesdays and Wednesdays (except during the Sinhala and

Hindu New Year and Christmas weeks), with the low-grown tea being sold on the first day and followed by the sale of high-grown and off-grades on the second day. Approximately, 50 auctions take place within a year. Since this auction is not yet automated, it can trade only an average of 12,500 lots per week or approximately 5 to 7 lots per minute.

The auction system establishes a free and a flawless market where prices of tea are determined transparently. Therefore, buyers and sellers can respond positively to the bids depending on their needs. This auction system does not allow the tea seller to control tea prices except by setting a minimum price to trade a lot. The sellers rarely fix a minimum price as they need to sell their tea consignment at any price due its perishability nature. However, this traditional auction system creates a burden for the tea buyers and tea brokers as they must physically present in the auction room in order to conduct the sale. Therefore, the cost of selling and time spent on selling tea via CTA is considerably high.

### *4.3. Risks faced by the market participants*

The types of risks and the degree of risks faced by each market participant in the tea value chain is different. Table 2 lists the risks faced by main participants in the tea value chain in Sri Lanka. Accordingly, weather risk is the main uncontrollable risk faced by all tea cultivators. The changing weather conditions severely affect the quality and the quantity of the produced tea and hence vary the tea prices and income that can be generated by selling the tea consignment.

[Insert Table 2 about here]

The next significant risk is the price risk. Tea cultivators and producers are largely price takers in the tea market. The price for tea is determined depending on the demand and supply of each grade of tea at the auction. Private cultivators and tea smallholders selling their tea to a third-

party tea manufacturer, do not have a great bargaining power over the price of their tea green leaves due to its perishability nature, lack of own transportation and manufacturing facilities and the monopsony power of the regional plantation company (N. De Mel, personal communication, October 26, 2017). The best choice for the tea cultivators is to sell their tea green leaves to the nearby tea processor even at a low price before the leaves get perished.

Furthermore, both tea cultivators and tea manufacturers assume a significant investment risk when they decide to invest in a tea plantation and/ or in a tea factory. The cost of cultivating, processing and setting up a tea factory is considerably enormous (I. Dampella, personal communication, February 15, 2017). First, it is essential to prepare the soil and land by planting shade trees, by building drains, terraces and roads within the plantation to transport tea and purchase specialized plant and machinery required to manufacture tea. This investment decision becomes irreversible because the land prepared for tea may not be suitable for any other agricultural crops. Alongside, the plant and machinery used to manufacture tea cannot be used in any other manufacturing processes as well (I. Dampella, personal communication, February 15, 2017).

Concurrently, there is a legal risk associated with the legal right over the tea lands as well. The regional tea plantation companies have only a leasehold right to use the land for planting tea (offered by the government in 1992) over a period of 53 years (N. De Mel, personal communication, October 26, 2017). The government has not yet taken any decision regarding whether to extend this lease period or not. Therefore, these corporate cultivators are reluctant to make any further investments despite most of their plantations now require re-planting of tea plants or their factories require new machineries and equipment.

In addition, tea cultivators and tea manufacturers face a funding risk because they have to self-finance the process of growing and manufacturing tea. Corporate cultivators are mainly public listed companies and have access to both equity and debt capital sources. In contrast, private cultivators and tea smallholders are individuals or family growers and have limited access to funding sources (I. Dampella, personal communication, February 15, 2017). However, they also can borrow funds from financial institutions but at a higher interest rate than available for corporate cultivators. Due to the lack of financial resources or high cost of borrowing, tea cultivators are reluctant to remove old tea bushes and re-plant and face a limitation when modernizing their tea factories.

Furthermore, large plantation companies have an operational risk also arising due to the shortage of skilled labour. The trade unions of tea workers have a strong bargaining power and continuously demand to raise wage rate (N. De Mel, personal communication, October 26, 2017). The cost of producing tea has increased during the past decades due to this increased labour cost. If the management refuses to increase the wage rate, it will likely to ended up in a labour strike ultimately disrupting the operations and creating further losses for these companies.

In contrast, tea smallholders do not face labour strikes because they themselves work in their own tea lands by doing all the activities. Due to the limited funds available, they are unable to hire skilled labour to work in their small tea gardens (I. Dampella, personal communication, February 15, 2017). If they are not sufficiently skilled to pluck tea, this might have an impact on the quality of the plucked tea green leaves and eventually on the quality of the produced tea.

In contrast, tea buyers in the Sri Lankan tea market face a low level of threat of new entrants due to two reasons (N. De Mel, personal communication, October 26, 2017). First, tea brokers are not willing to accept bids from a new buyer due to the high risk of default. Second, new buyers

will require a great investment to set up their own tea blending or tea packing facilities, which restricts new buyers entering into the market.

Finally, it is important to note that introducing a futures contract on tea will not mitigate all these different types of risks faced by the market participants. A futures contract will only provide hedging for price risk faced by the tea market participants.

### *4.4. Existing financing mechanism*

This section provides an overview of the current financing mechanism in the Sri Lankan tea market. We provide details about the financing sources and the financing mechanism used by each market participant in the Sri Lankan tea market.

When tea producers send their tea consignment and tea samples to tea brokers, they receive an advance payment from the brokers. Tea brokers value tea samples based on the recent historical prices received for the respective grade and pay a certain percentage of that value as an advance payment. Tea producers then in turn advance the money to tea smallholders and private tea cultivators for the tea green leaves they supplied. Tea brokers take approximately 3 to 4 weeks to grade and catalogue these tea samples in the CTA (N. De Mel, personal communication, January 24, 2017).

After buying, on the next Friday immediately after the auction, tea buyers require to settle 10% of their purchase value of tea. The remaining 90% of the purchase value requires to be settled on the following Tuesday after the auction. On the $7^{th}$ day after the auction, tea broker settles all the money to the tea producer. If any buyer has not settled the payments by the due date, he is prohibited to trade in the next auction until the due amount is paid off (N. De Mel, personal

communication, January 24, 2017). Accordingly, tea producer's and tea broker's exposure to default risk is protected in this auction system.

To protect the income of tea leaf suppliers (tea smallholders and private tea cultivators who do not own a tea factory), the government has enforced a 'Reasonable Pricing Formula'[11] in 1984 (Herath and Weersink, 2009). This formula states the ratio at which the black tea price will be shared among the tea processor and the tea green leaf supplier, respectively. At present, the ratio is 32:68 allowing the tea manufacturers to receive 32% of the black tea price as the income for manufacturing tea and tea smallholders to receive 68% of the black tea price as their income for selling tea green leaves. Under this method, the price risk is shared among the tea producer and leaf supplier.

The homogeneity nature of the tea as a commodity creates a severe competition among bulk tea exporters to attract tea buyers. Tea exporters use their extended and flexible credit policy as a marketing tool to attract more tea buyers. Due to that, tea exporters must wait for a long period to collect the due amount from the tea buyers. Though this credit policy would be favorable for the buyer, it generates a harmful default risk exposure for tea exporters (N. De Mel, personal communication, January 24, 2017). As a result of this extended credit policy, the Sri Lankan tea exporters were highly affected during the recent financial crisis in 2008 when most of the international tea buyers default on their payments.

[11] As Herath and Weersink (2009) mention, the government set a guaranteed minimum price for tea green leaves for the first time in 1968. The guaranteed price for tea green leaf is calculated as the Colombo black tea price minus cost of processing tea minus tea processor's profit divided by 4.5 (i.e. the weight of tea green leaves required to produce one kilo of black tea). In this formula, the entire price risk in black tea prices is passed on to the leaf supplier. In 1978, this formula was modified to provide a guaranteed minimum price for tea leaves. In 1984, the guaranteed minimum price was replaced by the 'Reasonable Pricing Formula' (i.e. the ratio of sharing black tea price among the tea producer and leaf supplier, respectively) of 25% to 75%. In 1985, this ratio was again changed to 30% to 70% and in 1987 to 32% and 68%, respectively.

## 5. Data

This study uses average tea prices obtained from the Global Economic Monitor database of the World Bank. This is the arithmetic average tea price quoted at the main tea auctions: Mombasa, Colombo and Culcutta. We collect data on Standard & Poor 500 (S&P 500) index, Bloomberg Barclays US Corporate Total Return index, Bloomberg Barclays US Treasury Total Return index, Gold and Silver spot prices in USD from the Bloomberg. The 90-day monthly Treasury Bill rate of US is obtained from the Kenneth French website. [12]

This study collects data on the historical evolution and institutional framework of the Sri Lankan tea market mainly from the Statistical Bulletin 2011 and 2015 published by the Sri Lanka Tea Board and from the Annual Reports of the Central Bank of Sri Lanka. The details about the time line events, tea cultivation and manufacturing process are collected from the web sites of the Sri Lankan Tea Board and Dilmah Ceylon Tea Company PLC. Furthermore, we have gathered data from personal communication as well.[13]

We required to compare the tea market returns and volatilities with the returns and volatilities of 14 other agriculture commodities for which futures contracts already exist. We have selected 14 commodities included in the Bloomberg Agriculture Total Return index and the list of these commodities are presented in Appendix 2. The daily prices of these indices are collected from January 1991 (this is the earliest date on which index data is available) to October 2017 from the Bloomberg.

[12] See http://mba.tuck.dartmouth.edu/pages/faculty/ken.french/Data_Library/f-f_factors.html for further details.

[13] We have collected data via interviews and email communication with Mr Niraj De Mel (A former Chairman of the Sri Lanka Tea Board, professional tea taster with over 38 years of experience in the industry and the pioneer of The Mel's Tea Academy) and with Mr Isuru Dampella (Managing Director at New Diyagala Tea Factory, Sri Lanka).

## 6. Results

This section presents the results, analysis of the data and the discussion of the findings. First, we examine the commodity characteristics and cash market characteristics of tea to determine whether introducing a futures contract on tea would be feasible. Second, we investigate the diversification benefits of tea as an asset in a portfolio along with traditional assets.

### *6.1. Feasibility of introducing a futures contract on tea*

In the Literature Review section above, we identified a list of cash market characteristics, commodity characteristics and futures market characteristics that determine the success of a new futures contracts. This section will discuss these characteristics related to the Sri Lankan tea market to decide whether tea would be an appropriate commodity for a futures contract.

#### *6.1.1. Price volatility in the cash market*

In order to analyze the volatility of tea prices at CTA, we first graphically present the variation of the tea prices and then measure the volatility of tea prices by calculating the constant standard deviation of the monthly tea returns. We annualize these volatilities by multiplying the value by $\sqrt{12}$.

Figure 2 depicts the historical monthly average tea prices (in USD) reported at CTA from January 1991 to October 2017. The monthly mean tea price and the volatility of tea prices at CTA during this period were USD 2.29 and 0.83%, respectively. The highest price (USD 4.27/ kg) of tea was reported in March, 2017 and the lowest price (USD 1.18/ kg) was reported in April, 1994.

[Insert Figure 2 about here]

Thereafter, we compare the volatility of tea returns with the volatilities of 14 other agriculture commodities included in the Bloomberg Agriculture Total Return Index (See Appendix 2). All these commodities have pre-existing futures contracts in the market. Table 3 presents the annual volatilities of these agriculture commodity indices and tea returns. During the period from 1991 to 2017, the annual volatilities of all agriculture commodities have fluctuated every year.

[Insert Table 3 about here]

During this period, coffee (33%) and orange juice (30%) have reported the highest average standard deviation, respectively. The live cattle (13%) and feeder cattle (14%) have reported the lowest average standard deviations, respectively. In contrast, tea has an average volatility of 18% which is above the average volatilities of feeder cattle and live cattle. At present, there are successfully trading futures contracts on both feeder cattle and live cattle even when the volatilities of these commodities are comparatively lower than tea. Therefore, we conclude this high volatility of tea is sufficient to justify introducing a futures contract on tea.

### *6.1.2. Size of the cash market*

In 2016, the world tea production (black tea, green tea and all other types) reached to 5.73 million tonnes.[14] Figure 3 depicts the world tea production (in percentage) of the main tea producing countries. According to this graph, China and India have been the major tea producers in the world during last decades. Thereafter, Kenya, Sri Lanka and Japan contributes to the tea production as the third, fourth and fifth largest producers in the world, respectively. However, due to the high

[14] World tea production and consumption data are obtained from the "Current market situation and medium-term outlook report" of the 23rd Session of the Intergovernmental Group on Tea held on 17th to 20th May, 2018 at Hangzhou, The People's Republic of China. Retrieved from http://www.fao.org/economic/est/est-commodities/tea/tea-meetings/tea23/en/

level of domestic consumption of tea in China and India, these countries are not the largest tea exporting countries in the world.

[Insert Figure 3 about here]

Figure 4 shows that in 2016, Kenya, China and Sri Lanka were the three largest tea exporting countries, respectively. The export percentage of China (18.2%) is approximately closer to that of Sri Lanka (16.9%) in 2016. During the last decade, the tea production of Sri Lanka has dropped but since Sri Lanka exports majority of its tea production, the country has continued to secure its position in the tea export market.

[Insert Figure 4 about here]

In addition, we compare the world production values of coffee, orange juice and milk with the production values of tea. Figure 5 illustrates these annual export values for the period from 1991 to 2016. Accordingly, the value of the production of tea is comparatively closer to that of coffee. Hence, we can claim that the size of the world tea market and the size of the Sri Lankan tea market would also be large enough to introduce a futures contract on tea.

[Insert Figure 5 about here]

Finally, Intergovernmental Group on Tea of 2018 estimates that the world black tea production will increase by 2.2% annually from 2018 to 2027 and the world green tea production will rise by 7.5% annually from 2015/17 to 2027.[15] Therefore, the cash market of tea is expected to grow continuously in the future as well.

[15] World tea production forecasts also are obtained from the "Current market situation and medium-term outlook report" of 23rd Session of the Intergovernmental Group on Tea held on 17th to 20th May, 2018 at Hangzhou, The People's Republic of China. Retrieved from http://www.fao.org/economic/est/est-commodities/tea/tea-meetings/tea23/en/

### *6.1.3. Activeness of the cash market*

In Sri Lanka, CTA is the main mode of disposing the tea production and approximately 98% of the tea supply is sold via the auction (N. De Mel, personal communication, October 26, 2017). As mentioned above, CTA holds approximately 50 auctions per year and the tea market is active throughout the entire year. The price of tea is determined freely in the auction depending on the demand and supply of each tea grade. This auction process is transparent, and the price information is available for all the participants in the market. Furthermore, this tea auction consists of large number of buyers and sellers represented through registered tea brokers. Finally, details about the tea auction prices and tea production volumes are freely available from the Sri Lanka Tea Board. Tea export and tea import data are available in the statistics published by the Central Bank of Sri Lanka. Therefore, we can conclude that the Sri Lankan tea market is highly, liquid and a transparent market providing the information freely to the market participants and general public.

### *6.1.4. Product homogeneity*

This study measures the product homogeneity by the effectiveness of the grading system following Brorsen and Fofana (2001). A commodity should be effectively graded to represent the variation in prices and this grading system should be commonly accepted and adopted by all the participants in the market. There is no universally accepted single grading system for Orthodox black tea, whereas there is a standard grading system for CTC black tea (N. De Mel, personal communication, October 26, 2017). The countries like Sri Lanka and India producing Orthodox black tea, use a tea grading system which is fairly similar. As mentioned in Appendix 1, the grading nomenclature of Orthodox black tea creates grades based on the leaf size. Mainly there are two grades: whole leaf grade or broken leaf grade and a variety of sub grades under each category.

The tea grading system in Sri Lanka is well established as well as prevalent among the tea buyers. However, these substantial sub-grades create a significant market segmentation. The larger the number of market segments, it effectively reduces the size and activity of each sub-grade and hence lower the likelihood of a successful single futures contract on tea. If the quality of the produced tea is not exactly the promised grade to deliver, the futures price can be varied. This segmentation may overcome by designing a futures contract with a premium or discount system based on the variation of the tea grades.

### *6.1.5. Underlying market structure*

For a futures contract to be successful, cash market requires to be less vertically integrated and less buyer concentrated. According to Brorsen and Fofana (2001), the degree of vertical integration depends on the number of pricing points of a commodity. In the tea market, first, tea smallholders and private tea cultivators sell tea green leaves to the tea manufacturer. When tea is produced, it is sold either in the auction or directly via private contracts. The income of the tea manufacturers and tea cultivators depend on the tea prices earned in the auction. All the local buyers and export buyers can directly buy tea from the auction. Tea price is determined in the CTA and hence, the auction is the only pricing point for tea. Therefore, we conclude that tea market is highly vertically integrated.

We consider the concentration of buyers in the market as the percentage of the commodity handled by the largest players in the market (Brorsen and Fofana, 2001). In the global tea market, tea buyers are highly concentrated and hence have a high bargaining power (Thushara, 2015). There are only four major multinational companies that account for approximately 80% of

international tea trade (Ganewatta and Edwards, 2002). Therefore, there could be a possibility that buyers might influence the prices in the auction via bidding process.

### *6.1.6. Availability of cross-hedging*

It is necessary to identify the cross-correlations between the asset under consideration and other closely related assets to determine whether cross-hedging will be effective. We measure the correlation between coffee prices and tea prices. We obtained world average tea prices, tea prices at Colombo Tea Auction, world average coffee Arabica prices and coffee Robusta prices from the Global Economic Monitor Commodities database.[16] In addition, we collect the Composite Coffee Price Index[17] data published by the International Coffee Organization. The data consists of monthly prices for the period from January 1991 to October 2017.

Table 4 shows the cross-correlations between tea and coffee time series data. Panel A uses data obtained from the Global Economic Monitor database and Panel B uses coffee price data obtained from the International Coffee Organization. According to the results in Panel A, world average tea price is positively correlated with world average Arabica coffee prices (0.10) and with world average Robusta coffee prices (0.07). The Colombo tea prices are positively correlated with coffee Arabica prices (0.06) and slightly negatively correlated with coffee Robusta prices (-0.01). Furthermore, in Panel B, both world average tea prices and Colombo tea prices show a low positive correlation (less than 0.01) with the Composite Coffee Price Index.

[Insert Table 4 about here]

[16] The world average tea and coffee prices are the nominal prices in USD per kg.

[17] Composite Coffee Price Index calculated by the International Coffee Organization is the weighted average composite price of Brazilian natural Arabica coffee prices (31%), Colombian mild Arabica coffee prices (12%), other mild Arabica coffee prices (23%) and coffee Robusta prices (34%). The coffee prices are collected from USA, France and Germany spot markets. The weighting of each group is reviewed every two years.

Theoretically, negative cross-correlation values will provide a better hedging for tea. According to our findings, futures contracts on coffee Arabica or coffee Robusta will not provide an effective cross-hedging opportunity for tea market participants due to their positive and low correlation values with tea.

### *6.1.7. Need for hedging*

According to Webb (2015) and Till (2015), one of the major factors that determine the success of a futures contract is the need for hedging. A futures contract is a mechanism to hedge the price risk. In the Sri Lankan tea market, tea producers and exporters have to undergo a strict approval process to enter into a forward contract. Therefore, the use of forward contracts to mitigate the price risk is not practically adopted in the Sri Lankan tea market. Furthermore, the global tea market is also free from futures contracts on tea.

Theoretically, a necessity of a futures market arises due to the limitations in the forward market. The unavailability of forward contracts indeed emphasizes the economic need of introducing an exchange traded futures contract on tea. A futures contract on tea will provide an effective hedging mechanism for the tea market participants to mitigate their price risk. Due to the large number of tea producers and tea exporters involved in this market, if introduced, we can expect a futures contract on tea to achieve a considerable level of trading volume.

### *6.1.8. Interest of speculators*

A successful futures contract requires to fulfill the need for hedging as well as should be able to attract speculators (Till, 2015; Webb, 2015). There are three aspects to attract speculators: there must be a community of risk takers, there must be a level playing field for speculators and

speculators must have the ability to manage the price risk by taking the other side of the hedger's position (Till, 2015).

Tea buyers in this market would be willing to participate in a futures market as speculators. They would be willing to take the other side of the price risk faced by the tea producers. However, if the tea prices at CTA is high, tea buyers have the ability to buy tea from another market at a comparatively lower price than the prices at CTA. Hence, this substitution effect of tea (arising due to the homogeneity nature of the tea) might reduce the necessity of entering into a futures contract by tea buyers.

Finally, we do not identify a readily available community of risk takers for the tea market other than the market participants at present. If we can provide empirical evidence on the diversification benefit of tea as an investment asset in a portfolio of an average investor, this market would attract the interest of general investors as well. The diversification benefits of tea will be discussed later.

#### *6.1.9. Public order flow*

According to Till (2015) and Webb (2015), it is essential to have a free public order flow to establish a successful futures contract. As mentioned above, tea prices and other tea market related statistics are freely available for both tea market participants and other general investors.

Furthermore, it is essential to have government support to introduce a futures contract on tea. First, government requires to understand the national interest as well as the potential interest of global tea market participants and investors on a futures contract of tea, if introduced. Thereafter, government has a vital role to create confidence among the existing tea market

participants to use futures contract on tea, to establish a regulator to the futures exchange, to maintain a healthy level of competition and to safeguard the assets of the market participants.

At present, Sri Lanka does not have a futures market on equities as well. Therefore, investors and the general public in Sri Lanka do not have any experience of a futures contract yet. The lack of this financial literacy would hinder the growth of a futures contract on tea. As a staring step, it is essential to educate the community regarding the benefits of a futures contract and how to use this futures contract to mitigate the price risk.

#### *6.1.10. Trading platform*

Finally, the CTA is not an automated trading platform at present. The auction is held for two consecutive days to sell all the tea lots catalogued in that week. Since the auction process is not computerized, buyers or their agents must physically present in the auction floor to do a trade. There is a substantial resistant in the tea market to change from the existing auction structure due to the fear of losing power and fear of losing job opportunities.

Previous empirical evidence suggests that the automation of an auction process may reduce the transaction costs in a commodity market (Frank and Garcia, 2009; Shah and Brorsen, 2011). If the regulators of the tea market can convince the tea market participants about the benefit of automating the auction process, this will create a favorable environment to introduce a new futures contract on tea and will be able to open that futures market for any investor in the world to invest in.

Finally, in Table 5 we summarize the degree to which Sri Lankan tea market meets these success criteria of a futures contract. Sri Lankan tea market has a sufficient level of price volatility, a considerable cash market size in terms of the trades, number of participants and the production

value of tea and highly active with continuous trading throughout the year. Tea prices are freely determined in the market and the price information is publicly available for free. The tea producers have an unfulfilled need for hedging the price risk they face in the tea auction. There is a need for a own-hedge futures contract on tea as cross-hedging using coffee would not be effective. These characteristics of the tea market favors the successful introduction of a futures contract on tea.

[Insert Table 5 about here]

In contrast, there are several factors that might delay the successful introduction of a futures contract on tea. The major concern is the less homogeneity of tea as there are number of different tea grades and there is no universally accepted tea grading system. The government and the tea market regulators have a large responsibility to provide the required support.

### *6.2. Diversification benefits of tea*

#### *6.2.1. Methodology*

Diversification benefits can be achieved only when we combine assets with negative correlation structure. The ultimate objective is to create an optimal portfolio of assets that will optimize the risk-return expectations of an investor. In this analysis, first we calculate the annualized mean return and standard deviation of the tea and 14 other agriculture commodities (mentioned in Appendix 1). In addition, we calculate the Sharpe ratios and correlations of tea with these other agriculture commodities. Second, we calculate the correlation of tea returns with the returns of S&P 500 index, Bloomberg Barclays US Corporate Bond index, Bloomberg Barclays US Treasury Bond index, Gold and Silver spot price indices (quoted in USD).[18]

[18] Standard and Poor's 500 (S&P 500) index is the total return index of the 500 largest market capitalization companies in US. Bloomberg Barclays US Corporate Bond index measures the investment grade, fixed-rate, taxable corporate bond market. It includes USD-denominated securities publicly issued by US and non-US industrial, utility and financial issuers. Bloomberg Barclays US Treasury Bond index measures USD-denominated, fixed rate nominal debt issued by the US Treasury. This index excludes

Third, we develop the efficient frontier under three scenarios and compare the performance of the portfolios. Case 1 includes only stocks, corporate bonds and treasury bonds. Case 2 includes a portfolio consisting of stocks, corporate bonds, treasury bonds and precious metals (gold and silver). Case 3 adds tea along with all the above-mentioned assets. According to Black (1972), given any two envelope portfolios, we can develop the efficient frontier of all portfolios because the efficient frontier includes all the convex combinations of these two envelope portfolios. We calculate investment proportions of the global minimum variance portfolio (GMVP) and the market portfolio.[19] We derive the GMVP using the following formula.

$$X_{GMVP} = \frac{1_{row}S^{-1}}{1_{row}S^{-1}1_{row}^{T}}, \quad (1)$$

where $X_{GMVP}$ is the matrix of the weights in GMVP, $1_{row}$and $1_{row}^{T}$ is a row vector including the value 1 only and the transpose of that row vector. Finally, $S^{-1}$ is the inverse of the sample variance-covariance matrix.

The investment proportions of the market portfolio are calculated using the following formula.

$$X_{Market} = \frac{S^{-1}\{E(r)-c\}}{\sum[S^{-1}\{E(r)-c\}]}, \quad (2)$$

where $X_{Market}$ is the matrix of the proportions in the market portfolio, $S^{-1}$ is the inverse of the sample variance-covariance matrix, $E(r)$ is the expected return of the portfolio and $c$ stands for the risk-free rate of return. Then, we calculate a series of portfolio returns and standard deviations

Treasury Bills but includes Treasury Bonds with a maturity period ranging from more than one year up to 10+ years. Gold and Silver prices are quoted in USD in US market.

[19] GMVP is the portfolio with the lowest possible minimum variance for a given level of return. Market portfolio is an efficient portfolio which consists of all the risky assets.

assuming different combinations of GMVP and market portfolio under three scenarios to graphically present the efficient frontier under each scenario.

Furthermore, Markowitz (1952) suggests that investors can optimize their investment decision based on the risk and return of the portfolio only. Later, other researchers developed various portfolio optimization models based on mean-variance criteria.[20] DeMiguel, Garlappi and Uppal (2009) compare the efficiency of 14 portfolio optimization strategies with the naïve diversification strategy (equal weights). They find none of these 14 strategies consistently performed better than the naïve strategy. Therefore, we also created an equally weighted portfolio under each case and compared its performance with the GMVP and tangent portfolio.

Finally, we test whether an average investor can enhance the set of efficient portfolios by adding tea as an asset. We test this statistically by using the Mean-Variance Spanning test which was first introduced by Huberman and Kandel (1987). We consider a US investor to represent an average investor because US has both well developed and liquid equity and bond markets and previous researchers also adopts a US investor to represent an average investor (Bekaert and Urias, 1996; Cumby and Glen, 1990; DeRoon et al., 2001; DeSantis, 1995; Errunza et al., 1999). We regress the excess return of tea on the excess returns of other traditional assets that we add into the portfolio as follows.

$$\left(R_i - R_f\right) = \alpha + \sum_{j=1}^{J} \beta_j \left(R_j - R_f\right) + \varepsilon \qquad (3)$$

where $R_i$ is the return on tea, $R_f$ is the risk-free rate (90 days Treasury Bill rate), $R_j$ is the return on other assets (return on S&P 500 index, return on Bloomberg Barclays US Corporate Bond index, return on Bloomberg Barclays US Treasury Bond index, return on gold and silver) and $\varepsilon$ is

[20] See Kolm, Tutuncu and Fabozzi (2014), Loistl (2015), Markowitz (2014), Rubinstein (2002) and Steinbach (2001) for more details on these different models of mean-variance-optimization, limitations in these models and the approaches developed to encounter these limitations.

the error term. Every $\beta_j$ coefficient is interpreted as weights of traditional assets that can be used to replicate the return of tea. We test the null hypothesis $H0: \alpha = 0$. If the constant term ($\alpha$) is statistically significant and not equals to zero, there is a significant portion of the tea return unexplained by the traditional assets. Then, we can consider tea as a separate asset in the portfolio.

### *6.2.2. Results*

First, we present the descriptive statistics of the agriculture commodities in Table 6. During the period from January, 1991 to October, 2017, a majority of these commodities earned a negative mean return. Soymeal and soybean report the highest mean returns of 7.30% and 5.50%, respectively and tea reports a mean return of 1.93%. The lowest mean returns of -7.70% and -7.21% are reported for wheat and lean hogs, respectively. Coffee and orange juice have the highest volatility of returns of 35.84% and 31.02%, respectively. Tea reports the third lowest volatility of return of 16.81%. However, it is noteworthy that feeder cattle (14.44%) and live cattle (13.86%) which have lower volatilities than tea have successfully trading futures contracts in the market.

The Sharpe ratio of a commodity explains the level of excess return (commodity return – risk-free return) per unit of risk. Most of these agriculture commodities including tea has a negative Sharpe ratio because of negative excess return which is not meaningful to interpret. The results reveal that tea has a positive correlation with all other agriculture commodities except with lean hogs. Therefore, adding tea into a portfolio along with these agriculture commodities would not convey any diversification benefits for an investor.

[Insert Table 6 about here]

Subsequently, Table 7 summarizes the descriptive statistics and correlation statistics of tea, stocks, corporate bonds, treasury bonds, treasury bills, gold and silver for the period from January,

1991 to October, 2017. A US investor represents an average investor in our study. We include gold and silver into the portfolio as precious metals are now considered to provide a hedge against stocks and bonds.[21]

[Insert Table 7 about here]

Compared to these traditional assets and precious metals, tea has the lowest return (1.96%) and the second highest volatility (16.78%) which is below the highest volatility of silver (30.03%). Due to its lower mean return than the average risk-free return, tea reports a negative Sharpe ratio (-0.0375), whereas all the other assets report a positive Sharpe ratio. However, tea has a low positive correlation (less than 0.10 approximately) with all the assets except with government securities. Our results show that tea is negatively correlated with treasury bonds (-0.1032) and treasury bills (-0.0183). Hence, tea acts as a hedge against the government securities in this case.

Thereafter, we graphically present the efficient frontiers in Figure 6. This graph does not depict a significant change in the risk and return of the portfolios available for a low risk averse investor (i.e. the portfolios located at the upper end of the frontiers). In contrast, there is a significant shift in the GMVP of each case. The risk and return of the GMVP under case 2 (including gold and silver) is slightly lower than the risk and return of the GMVP under case 1 (including traditional assets only). By adding tea in case 3, we could create a GMVP which has a significantly lower risk compared to both the previous cases (but with a lower return as well). This graphical representation shows a shift in the efficient frontier from the lower end including the GMVP.

[Insert Figure 6 about here]

[21] Gold act as a hedge and a safe haven for stock in US, UK and German (Baur and Lucey, 2010), in major European markets and US (Baur and McDermott, 2010), in EMU, Indonesia, Russia and Turkey (Beckmann, Berger and Czudaj, 2015).

In Table 8, we provide the risk-return characteristics of the GMVP, tangent portfolio and for an equally weighted portfolio under each case. According to the results, the GMVP invests more than 90% in Treasury bonds, approximately 12% in stocks and include a short selling position of less than 13% in corporate bonds. Under both Case 2 and 3, GMVP invests 3% and 2% in precious metals, respectively. Under Case 3, GMVP invests 7% on tea along with other assets. Adding tea has reduced the risk of the GMVP compared to both Case 1 and 2. The GMVP portfolio under Case 3 report a mean return of 5.31% and a standard deviation of 0.0405%. The coefficient of variation (CV)[22] is lowest (0.76%) for GMVP under Case 3 when we add tea into the portfolio. Therefore, we can conclude that tea would provide diversification benefit for the portfolio of a high-risk averse investor. However, the economic significance of this benefit is questionable as the reduction in the risk is numerically low.

[Insert Table 8 about here]

As per our results, the tangent portfolio invests 11% in stocks, approximately 40% in corporate bonds and approximately 50% in Treasury bonds. Furthermore, the tangent portfolio invests only 2% in silver and holds a short selling position of 3% in gold. The tangent portfolio takes a short selling position in tea by short selling only 1% of the value. In contrast to the GMVP, adding precious metals and then tea into the tangent portfolio will increase the risk of that portfolio instead of reducing the risk. The CV is highest (0.87%) when we add tea into the tangent portfolio. Accordingly, there is no diversification benefit by adding tea into the tangent portfolio. Hence, we can conclude that for a low risk averse investor investing in the tangent portfolio, tea will not provide any diversification benefits.

[22] Coefficient of variation (CV) is the ratio of standard deviation for the mean. It shows the risk per unit of return. Theoretically, lower the CV is better.

For the equally weighted portfolio, adding gold and silver increases both the portfolio returns and risk significantly. In Case 3, the equally weighted portfolio with tea reports a mean return of 5.22% and a risk of 0.21%. Adding tea reduces the CV of the equally weighted portfolio compared to Case 2. Therefore, we conclude that tea would provide diversification benefit for an average investor who simply follows a naïve strategy as well.

Finally, we present the findings of the mean-variance spanning test in Table 9. This test examines whether tea can be considered as a separate asset in a portfolio. According to our findings, corporate bonds are positively related with the excess return on tea whereas Treasury bonds are negatively related with the excess return on tea. In contrast, stocks, gold or silver do not show any significant relationship with the excess return on tea. Furthermore, we find that the constant term of all these regressions is not significant and hence, we conclude that it is not statistically significant to consider tea as a separate asset in the portfolio of an average investor.

## 7. Conclusion

This study investigates a fascinating question why tea has not yet developed into an investable commodity in the financial markets. First, we provide an overview about this mostly unknown and less researched tea market. In this regard, we explore the Sri Lankan tea market and summarize its historical evolution and the current scenario. Since there is no derivative product to mitigate the price risk faced by the tea market participants in Sri Lanka, this study evaluates the viability of introducing a futures contract on tea. Finally, we study whether a futures contract on tea can attract the interest of investors by providing diversification into their portfolios.

Accordingly, we find that introducing a futures contract on tea is not an impossible task, but it is challenging given the existing structure of the tea market. The existing cash market of tea

and the risks faced by tea market participants favorably support the need for a futures contract tea. Therefore, a futures contract on tea would be highly beneficial for the tea market participants.

However, there is a major role to be played by the policy makers to create the required infrastructure for a futures market. First, tea market regulators all over the world should agree for a common grading system for tea. Second, policy makers in Sri Lanka should create a supportive regulatory environment for establishing a futures contract. Third, tea market regulators specifically require understanding the utmost importance of moving forward with the tea auction by automating the auction process. An automated auction will provide easy access to the international tea buyers and hence will be able to globalize this market easily. Finally, the government, tea market regulators and even the academics in Sri Lanka have a responsibility to enhance the financial literacy of the tea market participants and other investors by improving the awareness of the uses of a futures contract.

Finally, we identified adding tea would shift the mean-variance efficient frontier from the GMVP point. The results reveal that tea would diversify the risk involved in the GMVP and an equally weighted portfolio. In contrary, the Mean-Variance Spanning test suggests that tea does not act as a statistically significant asset in a portfolio. Therefore, attracting investors to financialize a futures market on tea might not be sensible.

Further research is required to decide the suitable grading system and to decide the optimal contract design for a futures contract on tea. We believe our empirical results and the qualitative knowledge gathered would essentially pave the way for a futures contract on tea by linking this separated commodity market and financial market. To end, the findings of this study leave a doubt about the argument that commodity markets were financialized during the last decades due to its contribution to the portfolio performance of an investor.

## References


Ates, A. & Wang, G. H. K. (2005). Information transmission in electronic vs. open outcry trading systems: An analysis of U.S. equity index futures markets. *The Journal of Futures Markets*, 14, 391-419.

Atkin, M. (1989). *Agricultural commodity markets. A guide to futures trading*. London, England: Routledge Press.

Basak, S. & Pavlova, A. (2016). A model of financialization of commodities. *The Journal of Finance,* 71(4), 1511-1556.

Baur, D. G. & Lucey, B. M. (2010). Is gold a hedge or a safe haven? An analysis of stocks, bonds and gold. *The Financial Review*, 45, 2017-229.

Baur, D. G. & McDermott, T. K. (2010). Is gold a safe haven? International evidence. *Journal of Banking and Finance*, 34, 1886-1898.

Beckmann, J., Berger, T. & Czudaj, R. (2015). Does gold act as a hedge or safe haven for stocks? A smooth transition approach. *Economic Modelling*, 48, 16-24.

Bekaert, G. & Urias, M.S. (1996). Diversification, integration, and emerging market closed-end funds. *Journal of Finance,* 51, 835–870.

Bekkerman, A. & Tejeda, H. A. (2013). *Revisiting the determinants of futures contracts: The curious case of distillers' dried grains*. Available at SSRN 2274912.

Bekkerman, A. & Tejeda, H. A. (2017). Revising the determinants of futures contracts success: the role of market participants. *Agricultural Economics*, 48, 175-185.

Bergfjord, O. J. (2007). Is there a future for salmon futures? An analysis of the prospects of a potential futures market for salmon. *Aquaculture Economics & Management*, 11(2), 113–132.

Bhardwaj, G., Gorton, G. & Rouwenhorst, G. (2015). *Facts and fantasies about commodity futures ten years later*. Retrieved from https://papers.ssrn.com/sol3/papers.cfm?abstract_id=2610772

Black, F. (1972). Capital market equilibrium with restricted borrowing. *The Journal of Business*, 45(3), 444-455.

Black, G. D. (1986). *Success and failure of futures contracts: theory and empirical evidence*. Monograph 1986-1 Salomon Brothers Center for the Study of Financial Institutions, New York.

Bodie, Z. & Rosansky, V. (1980). Risk and return in commodity futures. *Financial Analysts Journal*, 36(3), 27-39.

Brorsen, B. W. & Fofana, N. F. (2001). Success and failure of agricultural futures contracts. *Journal of Agribusiness*, 19(2), 129–146.

Carlton, D. W. (1984). Futures markets: Their purpose, their history, their growth, their successes and failures. *The Journal of Futures Markets*, 4(3), 237-271.

Cumby, R.E. & Glen, J.D. (1990). Evaluating the performance of international mutual funds. *Journal of Finance*, 45, 497–521.

Cuny, C. J. (1993). The role of liquidity in futures market innovations. *Review of Financial Studies*, 6(1), 57–78.

DeMiguel, V., Garlappi, L., & Uppal, R. (2009). Optimal versus naive diversification: How inefficient is the 1/N portfolio strategy? *Review of Financial Studies*, 22, 1915–1953.

DeRoon, F.A., Nijman, Th.E. & Werker, B.J.M. (2001). Testing for mean-variance spanning with short sales constraints and transaction costs: the case of emerging markets. *Journal of Finance*, 56, 723–744.

DeSantis, G. (1995). *Volatility bounds for Stochastic Discount Factors: Tests and Implications from International Financial Markets*, Working Paper, University of Southern California.

Domanski, D. & Heath, A. (2007). Financial investors and commodity markets. *Bank for International Settlements Quarterly Review*, 53-67.

Economides, N. & Siow, A. (1985). *Liquidity and the success of futures markets*. Working Paper No. CSFM-118, Center for the Study of Futures Markets, Columbia Business School.

Erb, C. B. & Harvey, C. R. (2006). The strategic and tactical value of commodity futures. *Financial Analysts Journal*, 62, 69–97.

Errunza, V., Hogan, K. & Hung, M.W. (1999). Have the gains from international diversification disappeared? *Journal of Finance*, 54, 2075–2107.

Fabozzi, F.J., Füss, R. & Kaiser, D.G. (2008). *The Handbook of Commodity Investing*. Hoboken, NJ, USA: John Wiley & Sons, Inc.

Forrest, D. M. (1967). *A hundred years of Ceylon tea 1867-1967*. Retrieved from http://www.historyofceylontea.com/ceylon-publications/other-publications/hundred-years-of-ceylon-tea-1867-1967/quick-view/index.php

Frank, J. & Garcia, P. (2009). *Bid-ask spreads, volume, and volatility: Evidence*. Paper presented at Agricultural and Applied Economics Association annual meeting 26-28 July 2009.

Ganewatte, G. & Edwards, G. W. (2002). *The Sri Lanka tea industry: Economic issues and government policy*. Paper presented at 44th Annual Conference of Australian Agricultural and

Resources Economics Society, Sydney, Australia. Retrieved from https://ageconsearch.umn.edu/record/123648/

Gorton, G. & Rouwenhorst, K. G. (2006). Facts and fantasies about commodity futures. *Financial Analysts Journal*, 62(2), 47-68.

Gray, R. W. (1966). Why does futures trading succeed or fail: An analysis of selected commodities? *In Futures Trading Seminar*, III, Madison, WI: Mimir, 115–137.

Greer, R.J. (1978). Conservative commodities: A key inflation hedge. *Journal of Portfolio Management (Summer),* 26-29.

Greer, R.J. (1997). What is an asset class, anyway? *Journal of Portfolio Management*, 23(2), 86-91.

Hall, N. (2000). *The tea industry*. Cambridge, England: Woodhead Publishing.

Herath, D. & Weersink, A. (2009). From plantations to smallholder production: The role of policy in the reorganization of the Sri Lankan tea sector. *World Development*, 37(11), 1759-1772.

Huberman, G. & Kandel, S. (1987). Mean-variance spanning. *Journal of Finance*, 42, 873-888.

Johnston, E. T. & McConnell, J. J. (1989). Requiem for a market: An analysis of the rise and fall of a financial futures contract. *Review of Financial Studies*, 2(1), 1–23.

Kat, H.M. & Oomen, R.C.A. (2006). *What every investor should know about commodities. Part I: Univariate return analysis* (Alternative Investment Research Centre Working Paper Series Working Paper #0029). London: Alternative Investment Research Centre.

Kolm, P. N., Tütüncü, R. & Fabozzi, F. J. (2014). 60 Years of portfolio optimization: Practical challenges and current trends. *European Journal of Operational Research*, 234, 356-371.

Loistl, O. (2015). Does mean-variance portfolio management deserve expected utility's approximative affirmation? *European Journal of Operational Research*, 247, 676-681.

Markowitz, H. M. (1952). Portfolio selection. *The Journal of Finance*, 7 (1), 77–91.

Markowitz, H. M. (2014). Mean-variance approximations to expected utility. *European Journal of Operational Research*, 234, 346–355.

Pirrong, C. (1996). Market liquidity and depth on computerized and open out- cry trading systems: A comparison of DTB and LIFFE Bund contracts. *Journal of Futures Markets*, 16, 519—544.

Rubinstein, M. (2002). Markowitz's ''portfolio selection'': A fifty-year retrospective. *Journal of Finance*, 57, 1041–1045.

Shah, S. & Brorsen, B. W. (2011). Electronic vs open outcry: Side-by-side trading of KCBT wheat futures. *Journal of Agricultural and Resource Economics*, 36(1), 48-62.

Silber, W. L. (1981). Innovation, competition and new contract design in futures markets. *The Journal of Futures Markets*, 1(2), 123-155.

Steinbach, M. C. (2001). Markowitz revisited: Mean–variance models in financial portfolio analysis. *SIAM Review*, 43, 31–85.

Tang, K. & Xiong, W. (2012). Index investment and the financialization of commodities. *Financial Analysts Journal*, 68(6), 54-74.

Tashjian, E. & Weissman, M. (1995). Advantages to competing with yourself: Why an exchange might design futures contracts with correlated payoffs. *Journal of Financial Intermediation*, 4, 133-157.

Thushara, S. C. (2015, May). *Sri Lankan tea industry: Prospects and challenges*. Paper presented at the Second Middle East Conference on Global Business, Economics, Finance and Banking, Dubai, UAE. Retrieved from https://www.researchgate.net/publication/280917771_Sri_Lankan_Tea_Industry_Prospects_and_Challenges

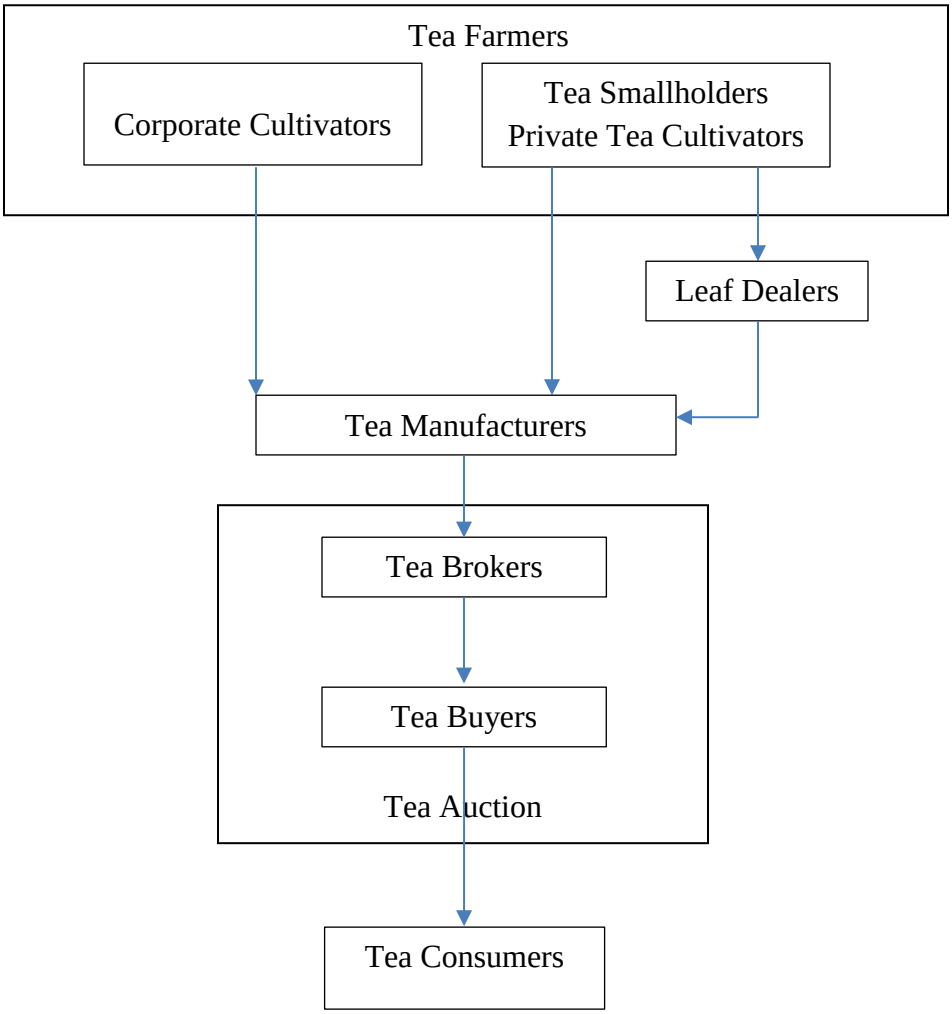
Till, H. F. (2015). *Why some commodity (and financial) futures contracts succeed and others fail: A survey of relevant research*. Available at SSRN2573894.

Tse, Y. & Zabotina, T. (2001). Transaction costs and market quality: Open-outcry vs electronic trading. *Journal of Futures Markets*, 21, 713-735.

Webb, R. (2015). *What drives success in futures markets*. Keynote speech, 2015 Derivative Markets Conference.

Zaremba, A. (2015). *The financialization of commodity markets: Investing during times of transition*. New York: United States, Palgrave Macmillan.

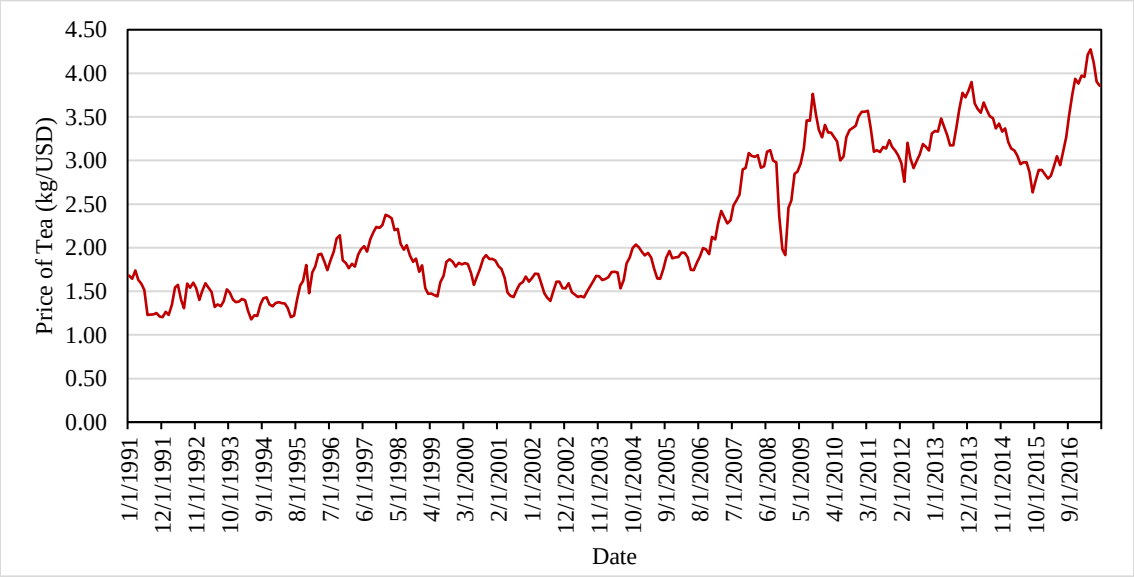
Figure 1
Value chain of the tea market in Sri Lanka




Source: Authors' Note

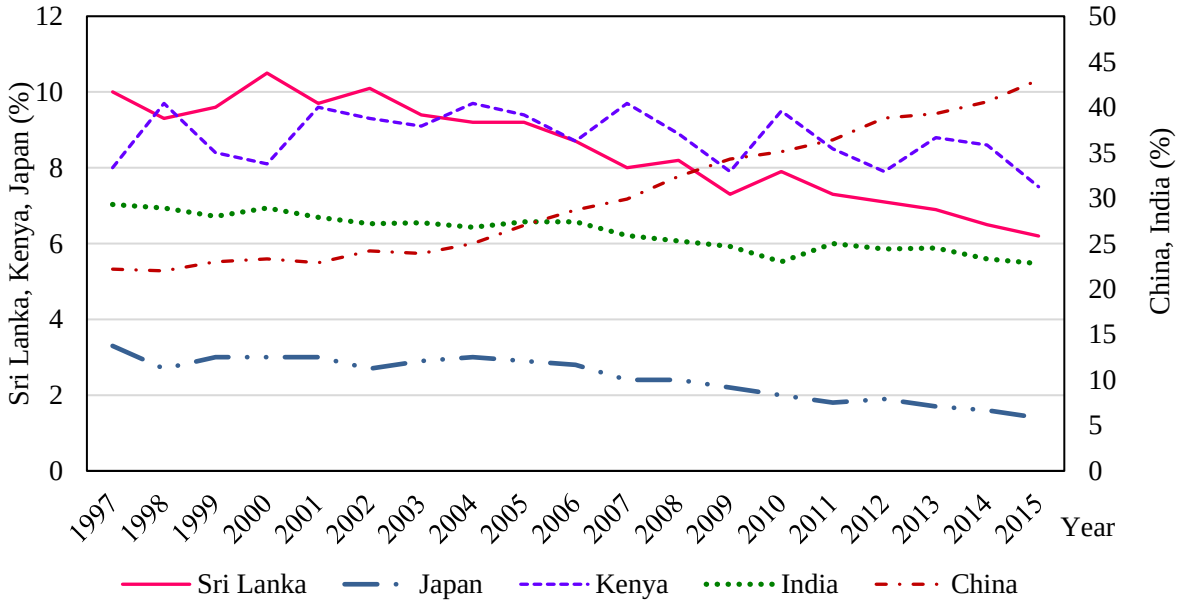
Note: This figure depicts the value chain of tea market in Sri Lanka. There are two types of tea farmers: corporate cultivators and private cultivators/ tea smallholders. Corporate cultivators have their own tea manufacturing facilities whereas only some private tea cultivators have their own tea factories. Private tea cultivators and tea smallholders without tea manufacturing facilities either sell their tea green leaves directly or via leaf dealers to the nearby tea factory. Thereafter, produced tea is sold in the tea auction which via tea brokers representing both buyers and tea manufacturers. There are two types of tea buyers: export buyers (who buy tea for export purposes) and local buyers (who buy tea to sell in the local market). Finally, well-packed and labelled packet of tea reaches to the tea lovers for final consumption.

Figure 2
Historical tea prices at Colombo Tea Auction



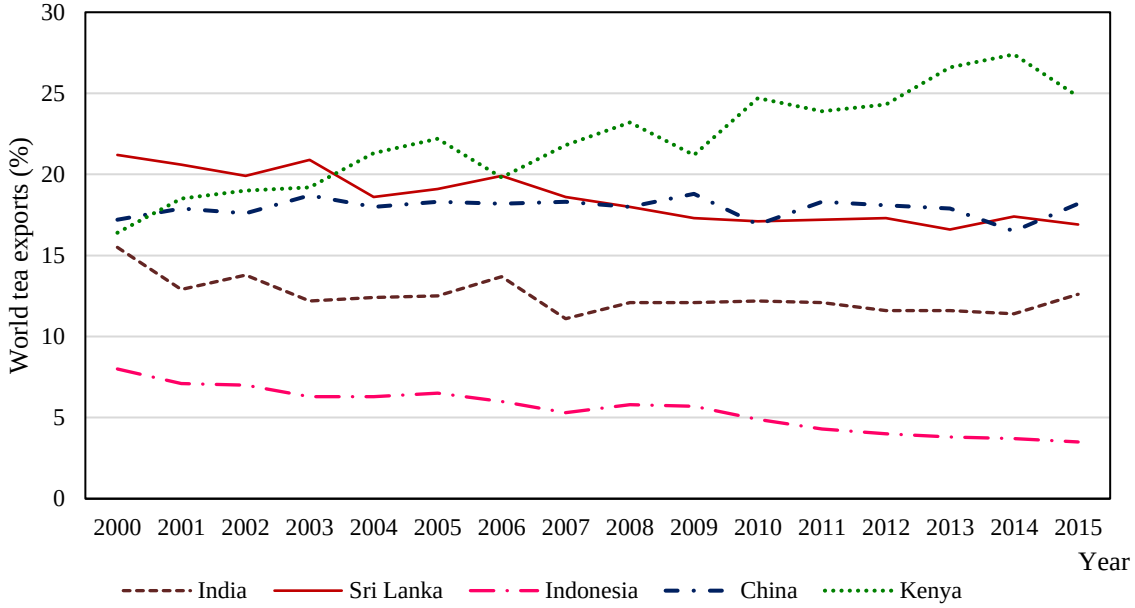

Source: Global Economic Monitor Database, World Bank

Figure 3
World tea production (in percentage)



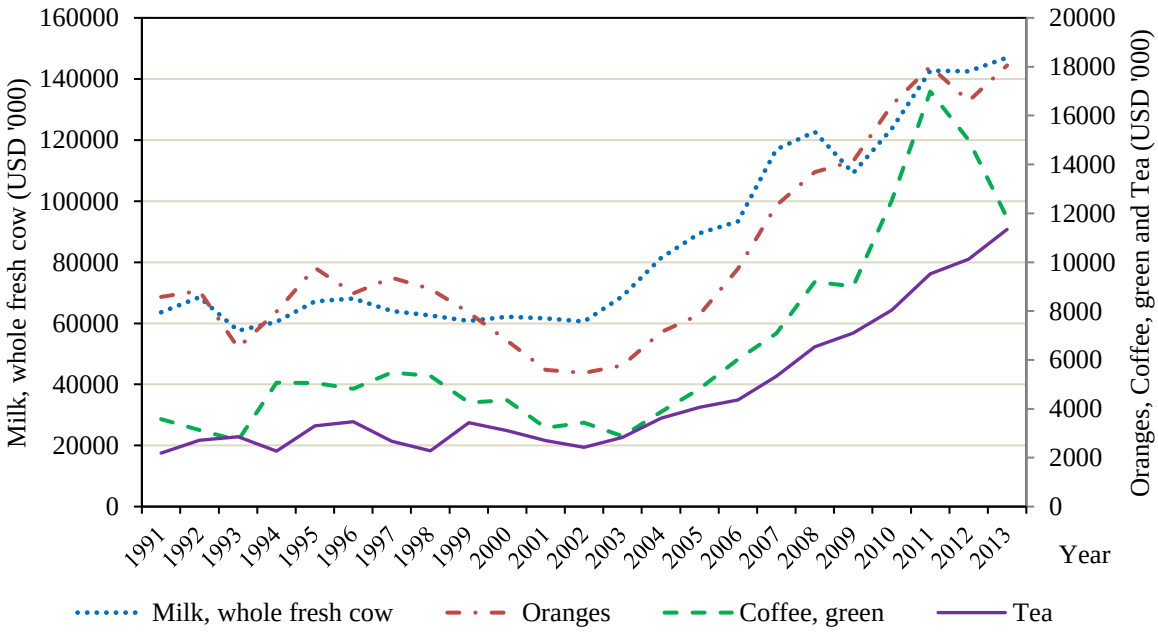

Source: Statistical Bulletin 2015, Sri Lanka Tea Board

Figure 4
World tea export (in percentage)



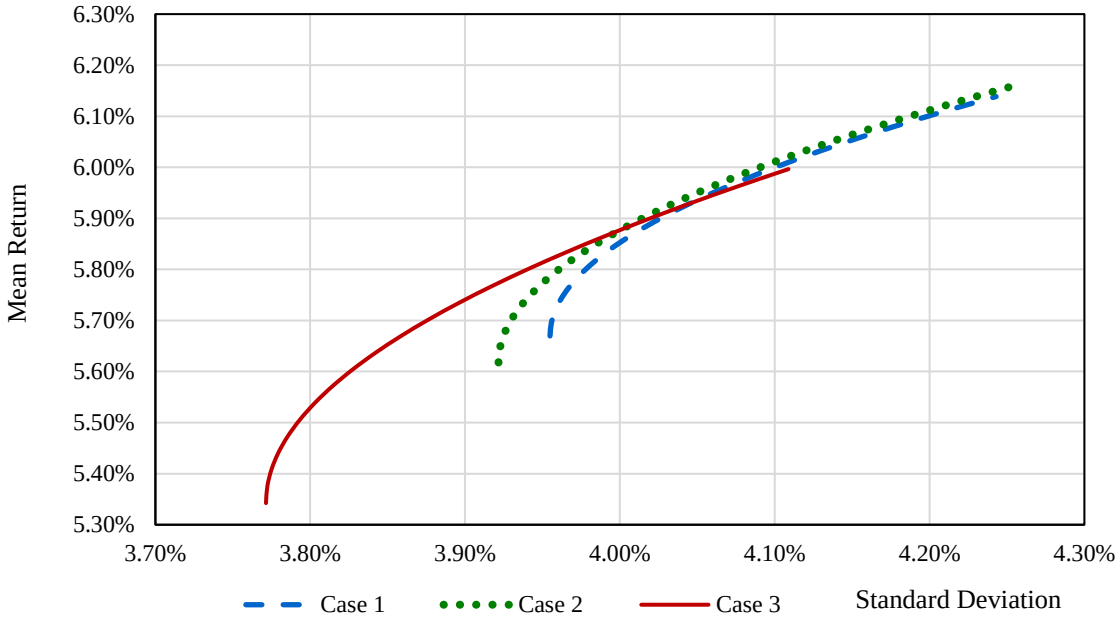

Source: Statistical Bulletin 2015, Sri Lanka Tea Board

Figure 5
World production values of coffee, orange juice, milk and tea




Source: Food and Agriculture Organization Database

Figure 6
Efficient frontier under three scenarios




Note: Case 1 includes a portfolio of stocks, corporate bonds and treasury bonds. Case 2 includes a portfolio of stocks, corporate bonds, treasury bonds, gold and silver. Case 3 includes a portfolio of stocks, corporate bonds, treasury bonds, gold, silver and tea. This graph shows the efficient frontiers of these three portfolios. The X axis depicts the standard deviation of the portfolios and the Y axis shows the portfolio returns.

Table 1
List of factors determining the success of a futures contract and references

| Category | Characteristic | Literature |
|---|---|---|
| Cash | Volatility of cash prices | Bekkerman and Tejeda (2017); Black (1986); Tashjian and Weissman (1995); Webb (2015) |
| Cash | Size of the cash market | Black (1986); Bekkerman and Tejeda (2017); Carlton (1984); Tashjian and Weissman (1995) |
| Cash | Activeness of the cash market | Bekkerman and Tejeda (2017); Brorsen and Fofana (2001) |
| Cash | Degree of vertical integration in the cash market | Bekkerman and Tejeda (2017); Brorsen and Fofana (2001) |
| Cash | Degree of buyer concentration | Bekkerman and Tejeda (2017); Brorsen and Fofana (2001) |
| Commodity | Homogeneity of the commodity | Atkin (1989); Bekkerman and Tejeda (2017); Brorsen and Fofana (2001) |
| Futures | Availability of cross-hedging | Bekkerman and Tejeda (2017); Black (1986); Webb (2015) |
| Futures | Liquidity cost of cross-hedging | Black (1986); Webb (2015) |
| Futures | Public order flow | Bergford (2007); Webb (2015) |
| Futures | First mover advantage and timing | Cuny (1993); Economides and Siow (1985); Webb (2015) |
| Futures | Availability of an electronic trading platform | Ates and Wang (2005); Frank and Garcia (2009); Pirrong (1996); Shah and Brorsen (2011); Tse and Zabotina (2001) |
| Futures | Good contract design | Gray (1966); Johnston and McConnell (1989); Webb (2015) |
| Futures | Ability to attract speculators | Gray (1966); Till (2015); Webb (2015) |
| Futures | Need for hedging | Cuny (1993); Gray (1966); Johnston and McConnell (1989); Silber (1981); Till (2015); Webb (2015) |
| Futures | Public policy support for the futures market | Till (2015) |

Table 2
Risks in the tea value chain of Sri Lanka

| Participant | Risks Faced |
|---|---|
| Corporate and Private Cultivators | • Changing weather conditions<br>• Uncertainty about the prices<br>• Perishability nature of the tea<br>• Uncertainty about the lease on land<br>• Lack of skilled labour<br>• Lack of financial resources<br>• Rising cost of production due to increasing wage rate<br>• High cost to exit |
| Tea Smallholders | • Changing weather conditions<br>• No guaranteed price for tea green leaves<br>• Lack of financial resources<br>• Perishability nature of the tea<br>• High cost to exit |
| Tea Manufacturers | • Price risk<br>• High cost to exit<br>• Lack of skilled labour<br>• Rising cost of production due to increasing wage rate |
| Tea Exporters | • Default risk on a tea consignment sold<br>• Extending the credit policy to attract exporters further enhances the default risk |

Source: Authors' Notes

Table 3
Annual volatilities of agriculture commodities

| Year | **Tea** | **Rank of Tea** | Soybean Oil | Cocoa | Corn | Cotton | Feeder Cattle | Coffee | Kansas Wheat | Live Cattle | Lean Hogs | Orange Juice | Sugar | Soymeal | Soybean | Wheat |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1991 | **22%** | **3** | 20% | 27% | 21% | 21% | 9% | 18% | 14% | 10% | 17% | 40% | 27% | 16% | 17% | 17% |
| 1992 | **33%** | **1** | 17% | 22% | 18% | 23% | 10% | 32% | 20% | 8% | 12% | 24% | 20% | 9% | 14% | 20% |
| 1993 | **21%** | **5** | 18% | 19% | 13% | 16% | 7% | 42% | 17% | 7% | 22% | 49% | 34% | 16% | 14% | 17% |
| 1994 | **19%** | **5** | 19% | 34% | 17% | 24% | 12% | 58% | 17% | 15% | 27% | 27% | 17% | 12% | 15% | 16% |
| 1995 | **32%** | **2** | 11% | 18% | 10% | 26% | 13% | 40% | 25% | 14% | 14% | 21% | 19% | 12% | 9% | 21% |
| 1996 | **26%** | **6** | 15% | 7% | 29% | 13% | 14% | 46% | 31% | 16% | 23% | 27% | 17% | 20% | 19% | 30% |
| 1997 | **12%** | **10** | 17% | 28% | 24% | 9% | 11% | 63% | 34% | 9% | 11% | 26% | 13% | 30% | 26% | 31% |
| 1998 | **15%** | **10** | 19% | 13% | 23% | 20% | 16% | 33% | 20% | 15% | 32% | 40% | 25% | 25% | 20% | 22% |
| 1999 | **24%** | **7** | 29% | 34% | 14% | 14% | 9% | 49% | 20% | 7% | 39% | 40% | 45% | 17% | 20% | 23% |
| 2000 | **16%** | **10** | 23% | 19% | 25% | 31% | 6% | 21% | 16% | 9% | 22% | 20% | 38% | 25% | 22% | 17% |
| 2001 | **16%** | **9** | 30% | 45% | 20% | 36% | 10% | 18% | 17% | 14% | 15% | 21% | 36% | 22% | 21% | 20% |
| 2002 | **17%** | **10** | 21% | 29% | 15% | 25% | 12% | 39% | 31% | 11% | 45% | 20% | 35% | 11% | 12% | 26% |
| 2003 | **12%** | **10** | 25% | 51% | 25% | 30% | 21% | 30% | 21% | 30% | 24% | 15% | 32% | 33% | 29% | 25% |
| 2004 | **19%** | **8** | 43% | 34% | 33% | 38% | 16% | 46% | 15% | 14% | 18% | 34% | 12% | 35% | 39% | 18% |
| 2005 | **16%** | **11** | 25% | 21% | 23% | 27% | 11% | 26% | 19% | 11% | 18% | 26% | 21% | 31% | 29% | 24% |
| 2006 | **16%** | **8** | 21% | 16% | 27% | 13% | 15% | 21% | 21% | 18% | 23% | 21% | 38% | 20% | 20% | 19% |
| 2007 | **16%** | **11** | 12% | 25% | 30% | 23% | 13% | 20% | 36% | 10% | 27% | 33% | 23% | 28% | 18% | 37% |
| 2008 | **28%** | **11** | 57% | 50% | 47% | 41% | 16% | 41% | 43% | 16% | 32% | 33% | 42% | 46% | 49% | 42% |
| 2009 | **30%** | **6** | 22% | 30% | 33% | 26% | 9% | 29% | 34% | 9% | 26% | 39% | 36% | 27% | 25% | 38% |
| 2010 | **13%** | **12** | 27% | 24% | 36% | 37% | 15% | 28% | 40% | 8% | 19% | 19% | 63% | 24% | 26% | 45% |
| 2011 | **11%** | **12** | 20% | 42% | 38% | 39% | 19% | 38% | 44% | 17% | 23% | 30% | 34% | 30% | 27% | 44% |
| 2012 | **21%** | **9** | 19% | 24% | 39% | 28% | 16% | 20% | 24% | 11% | 17% | 47% | 27% | 33% | 30% | 25% |
| 2013 | **12%** | **10** | 15% | 17% | 15% | 23% | 10% | 11% | 21% | 5% | 16% | 30% | 13% | 22% | 19% | 17% |
| 2014 | **10%** | **15** | 23% | 17% | 33% | 24% | 13% | 46% | 31% | 12% | 28% | 19% | 18% | 34% | 26% | 36% |
| 2015 | **13%** | **13** | 22% | 23% | 25% | 17% | 24% | 20% | 35% | 19% | 27% | 38% | 31% | 24% | 22% | 40% |
| 2016 | **13%** | **13** | 18% | 25% | 24% | 25% | 21% | 29% | 16% | 17% | 41% | 37% | 31% | 35% | 24% | 19% |
| 2017 | **13%** | **10** | 15% | 30% | 10% | 13% | 19% | 22% | 31% | 19% | 23% | 28% | 24% | 19% | 16% | 30% |

Note: This table summarizes annual volatilities of agriculture commodities measured by the standard deviation. Tea prices reported at the Colombo Tea Auction are obtained from the Global Economic Monitor database of World Bank and the prices of all other agriculture commodities are obtained from the Bloomberg. The data covers the period from January, 1991 to October, 2017.

Table 4
Cross correlations between tea and coffee prices

| Panel A | Coffee Arabica | Coffee Robusta | World Average Tea | Tea (Colombo) |
|---|---|---|---|---|
| Coffee Arabica | 1 | | | |
| Coffee Robusta | 0.7142 | 1 | | |
| World Average Tea | 0.0997 | 0.0683 | 1 | |
| Tea (Colombo) | 0.0589 | -0.0082 | 0.3941 | 1 |

| Panel B | World Average Tea | Tea (Colombo) | Coffee Composite |
|---|---|---|---|
| World Average Tea | 1 | | |
| Tea (Colombo) | 0.3941 | 1 | |
| Coffee Composite | 0.0879 | 0.0491 | 1 |

Note: This table summarizes the cross-correlations between world average tea prices, tea prices at the Colombo Tea Auction, coffee Arabica prices, coffee Robusta prices and composite coffee prices. The Panel A includes price data obtained from the Global Economic Monitor Database and the Panel B obtained Composite Coffee price index data collected from the International Coffee Organization. The data covers the period from January, 1991 to October, 2017.

Table 5
Determinants of the success of a futures contract

| Success criteria | Quality of the tea market |
|---|---|
| Cash price volatility | Sufficient |
| Cash market size | High |
| Cash market activeness | High |
| Product Homogeneity | Need to standardize |
| Vertical integration | High - Not supportive |
| Buyer concentration | High - Not supportive |
| Availability of cross-hedging | Poor |
| Need for hedging | High |
| Interest of speculators | Poor |
| Public order flow | High |
| Trading platform | Need to automate |

Note: This table summarizes the quality of the Sri Lankan tea market in meeting the success criteria of a futures contract.

Source: Discussion in this paper

Table 6
Descriptive statistics and correlations among agriculture commodities

| Variable | Observations | Mean | Standard Deviation | Sharpe Ratio | Correlation with Tea |
|---|---|---|---|---|---|
| Tea | 322 | 1.93% | 16.81% | -0.0391 | 1.0000 |
| Cocoa | 322 | -2.72% | 28.58% | -0.1857 | 0.1013 |
| Coffee | 322 | -5.25% | 35.84% | -0.2187 | 0.1085 |
| Corn | 322 | -6.39% | 26.12% | -0.3436 | 0.0184 |
| Cotton | 322 | -2.92% | 26.28% | -0.2097 | 0.1105 |
| Feeder Cattle | 322 | 1.89% | 14.44% | -0.0480 | 0.1015 |
| Kansas Wheat | 322 | -4.88% | 27.05% | -0.2760 | 0.0786 |
| Lean Hogs | 322 | -7.21% | 25.12% | -0.3901 | -0.0227 |
| Live Cattle | 322 | 1.58% | 13.86% | -0.0728 | 0.0704 |
| Orange Juice | 322 | -5.10% | 31.02% | -0.2478 | 0.0631 |
| Soybean | 322 | 5.50% | 23.73% | 0.1226 | 0.0975 |
| Soybean Oil | 322 | -0.57% | 24.08% | -0.1310 | 0.0941 |
| Soymeal | 322 | 7.30% | 25.70% | 0.1833 | 0.0880 |
| Sugar | 322 | 2.40% | 30.61% | -0.0062 | 0.0974 |
| Wheat | 322 | -7.70% | 27.96% | -0.3678 | 0.0760 |

Note: This table summarizes the mean return, standard deviation, Sharpe ratios of commodities along with their correlation values with tea. The descriptive statistics are calculated based on monthly returns from January 1991 to October 2017. The mean returns and standard deviations are annualized. Sharpe ratio is the ratio of excess return to standard deviation. The risk-free rate is 90-day US Treasury Bill rate.

Table 7
Descriptive statistics and correlations between traditional assets and alternative assets

| Variable | Observations | Mean | Standard Deviation | Sharpe Ratio | Correlation with Tea |
|---|---|---|---|---|---|
| Tea | 323 | 1.96% | 16.78% | -0.0375 | 1.0000 |
| S&P 500 | 323 | 7.84% | 14.20% | 0.3698 | 0.0793 |
| Corporate Bonds | 323 | 6.43% | 5.34% | 0.7197 | 0.0564 |
| Treasury Bonds | 323 | 5.38% | 4.35% | 0.6405 | -0.1032 |
| Gold | 323 | 5.36% | 15.97% | 0.1736 | 0.0502 |
| Silver | 323 | 7.23% | 30.03% | 0.1545 | 0.0802 |
| Treasury Bills | 323 | 2.59% | 0.64% | 0.0000 | -0.0183 |

Note: This table summarizes the mean return, standard deviation, Sharpe ratios and correlation values with tea. The descriptive statistics are calculated based on monthly returns from January 1991 to October 2017. The monthly mean returns and standard deviations are annualized. Sharpe ratio is the ratio of excess return to standard deviation. S&P 500 index represents the equity investment. Bloomberg Barclays US Corporate Bond index and Bloomberg Barclays US Treasury Bonds Index represent bonds. Gold and silver price indices in USD are obtained from the Bloomberg. The risk-free rate is 90-day US Treasury Bill rate.

Table 8
Portfolio Performance under Different Scenarios

| Asset | Case 1 | | | Case 2 | | | Case 3 | | |
|---|---|---|---|---|---|---|---|---|---|
| | GMVP | Tangent Portfolio | Equally Weighted | GMVP | Tangent Portfolio | Equally Weighted | GMVP | Tangent Portfolio | Equally Weighted |
| S&P 500 | 12% | 11% | 34% | 12% | 11% | 20% | 11% | 11% | 17% |
| Corporate Bonds | -5% | 37% | 33% | -8% | 37% | 20% | -12% | 39% | 17% |
| Treasury Bonds | 92% | 52% | 33% | 93% | 54% | 20% | 93% | 53% | 17% |
| Gold | - | - | - | 1% | -3% | 20% | 1% | -3% | 17% |
| Silver | - | - | - | 2% | 2% | 20% | 1% | 2% | 17% |
| Tea | - | - | - | - | - | - | 7% | -1% | 17% |
| Mean Return | 5.6698% | 6.1385% | 2.5515% | 5.6178% | 6.1615% | 5.8734% | 5.3091% | 6.2279% | 5.2163% |
| Standard Deviation | 0.0452% | 0.0520% | 0.0967% | 0.0444% | 0.0523% | 0.2499% | 0.0405% | 0.0541% | 0.2072% |
| Coefficient of Variation | 0.7963% | 0.8466% | 3.7900% | 0.7903% | 0.8489% | 4.2550% | 0.7638% | 0.8692% | 3.9714% |

Note: Note: This table summarizes the investment proportions, annualized mean returns, annualized standard deviations and coefficient of variations of the Global Minimum Variance Portfolio (GMVP), Tangent Portfolio and an equally weighted portfolio under three cases. Case 1 includes a portfolio of stocks, corporate bonds and treasury bonds. Case 2 includes a portfolio of stocks, corporate bonds, treasury bonds, gold and silver. Case 3 includes a portfolio of stocks, corporate bonds, treasury bonds, gold, silver and tea.

Table 9
Mean – Variance Spanning Test Results

| | Model 1 | | Model 2 | | Model 3 | | Model 4 | | Model 5 | |
|---|---|---|---|---|---|---|---|---|---|---|
| | β | SE | β | SE | β | SE | β | SE | β | SE |
| S&P 500 | 0.0946 | 0.0818 | 0.0814 | 0.0812 | -0.0415 | 0.0823 | -0.0404 | 0.0814 | -0.0442 | 0.0826 |
| Corporate Bonds | - | - | 0.1415 | 0.2098 | 0.8696* | 0.3007 | 0.8472* | 0.2860 | 0.8458* | 0.2891 |
| Treasury Bonds | - | - | - | - | -1.1648* | 0.3941 | -1.1708* | 0.3899 | -1.1531* | 0.3987 |
| Gold | - | - | - | - | - | - | 0.0520 | 0.0607 | 0.0313 | 0.1025 |
| Silver | - | - | - | - | - | - | - | - | 0.0142 | 0.0509 |
| Constant | -0.0009 | 0.0028 | -0.0013 | 0.0028 | -0.0004 | 0.0028 | -0.0005 | 0.0028 | -0.0005 | 0.0028 |

Note: This table summarizes the results of the Mean-Variance Spanning test. The dependent variable of all five regression models is the excess return on tea. The table presents the coefficient of each independent variable and its standard deviation (SE) under each model in the columns. The data covers the period from January, 1991 to October, 2017. *, ** and *** indicate the significance at 1%, 5% and 10% level, respectively.

## Appendix 1

Grades of Orthodox black tea

| Type of the Leaf | Grade Name | Nomenclature |
|---|---|---|
| Whole leaf grades | SFTGFOP | Special Finest Tippy Golden Flowery Orange Pekoe |
| | FTGFOP | Finest Tippy Golden Flowery Orange Pekoe |
| | TGFOP | Tippy Golden Flowery Orange Pekoe |
| | GFOP | Golden Flowery Orange Pekoe |
| | FOP | Flowery Orange Pekoe |
| | OPA | Orange Pekoe A |
| | OP1 | Orange Pekoe One |
| | OP | Orange Pekoe |
| | FP | Flowery Pekoe |
| | P | Pekoe |
| | PS | Pekoe Souchong |
| | S | Souchong |
| Broken leaf grades | TGFBOP | Tippy Golden Flowery Broken Orange Pekoe |
| | GFBOP | Golden Flowery Broken Orange Pekoe |
| | GBOP | Golden Broken Orange Pekoe |
| | FBOP | Flowery Broken Orange Pekoe |
| | BOP1 | Broken Orange Pekoe One |
| | BOP1A | Broken Orange Pekoe One A |
| | BOP | Broken Orange Pekoe |
| | BP1 | Broken Pekoe One |
| | BP | Broken Pekoe |
| | BPS | Broken Pekoe Souchong |
| Fannings | BOPF | Broken Orange Pekoe Fannings |
| | GOF | Golden Orange Fannings |
| | OF | Orange Fannings |
| | PF1 | Pekoe Fannings One |
| | PF | Pekoe Fannings |
| Dust | PD | Pekoe Dust |
| | D1 | Dust One |
| | D | Dust |

Source: Hall, N. (2000). *The Tea Industry*. Cambridge, England: Woodhead Publishing Limited.

**Appendix 2**

List of commodities included in the Bloomberg Agriculture Total Return Index

| Bloomberg Ticker | Index Name |
|---|---|
| BCOMBOTR | Bloomberg Soybean Oil Subindex Total Return |
| BCOMCCTR | Bloomberg Cocoa Subindex Total Return |
| BCOMCNTR | Bloomberg Corn Subindex Total Return |
| BCOMCTTR | Bloomberg Cotton Subindex Total Return |
| BCOMFC | Bloomberg Feeder Cattle Subindex |
| BCOMKCTR | Bloomberg Coffee Subindex Total Return |
| BCOMKW | Bloomberg Kansas Wheat Subindex |
| BCOMLCTR | Bloomberg Live Cattle Subindex Total Return |
| BCOMLHTR | Bloomberg Lean Hogs Subindex Total Return |
| BCOMOJ | Bloomberg Orange Juice Subindex |
| BCOMSBTR | Bloomberg Sugar Subindex Total Return |
| BCOMSM | Bloomberg Soymeal Subindex |
| BCOMSYTR | Bloomberg Soybean Subindex Total Return |
| BCOMWHTR | Bloomberg Wheat Subindex Total Return |

Source: Bloomberg Database