FINANCIAL ANALYSIS OF SUSTAINABILITY INITIATIVES IN THE LUXURY CASHMERE SUPPLY CHAIN

by

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April 17, 2017

Masters project submitted in partial fulfillment of the

requirements for the Master of Environmental Management degree in

the Nicholas School of the Environment of

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Executive Summary

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Many corporations have embraced sustainability initiatives (SI's) as a way to both improve their bottom line and lessen their impact on the planet. The literature shows that such companies have experienced superior financial performance compared to companies that have not invested in SI's. Yet, all companies need to expand their sustainability investments to support the Paris Agreement with a goal of maintaining global warming at a maximum of 2 degrees Celsius.

Additionally, the drivers of increased financial performance for companies focused on sustainability remain unclear. The same companies that invest in sustainability are also better at long-term planning than their competitors. Furthermore, it has been difficult to separate out whether sustainability actions or sustainability marketing drives more financial success. Thus, planning and marketing may be just as key to the success of these companies as sustainability action.

To increase adoption of SI's in the corporate arena, it is important to understand what concerns sustainability investments can address for corporate actors. Traditionally, SI's have focused on reducing costs – i.e., reduced energy and water usage. However, to spread adoption, future investments on sustainability likely will need to address other, crucial corporate concerns: increasing revenue and reducing risk.

This report is the result of work with a Client (large, European, luxury goods manufacturer) to assess how SI's might reduce price volatility in the Client's cashmere supply chain. A company's biggest planetary impacts are almost always in its supply chain. Previous research illustrates that the number one concern of supply chain purchasers is "raw material price volatility." This report details a pathway showing how SI's might lead to a reduction in raw material price volatility that could lead to the direct creation of financial value for a company

Cashmere is an exceptionally volatile commodity – much more so than wool, a comparable product. A tragedy of the commons situation in Mongolia (where increased grazing pressure stresses the grassland ecosystem), plus the changing climate, has led some researchers to call the Mongolian cashmere industry not "sustainable." The Client sources all of its cashmere from Mongolia.

This report uses the Coefficient of Variation (CoV) – the standard deviation/mean – to measure price volatility, a widely used measure of price volatility in commodities. A model was built containing publicly available price information on Chinese and Mongolian cashmere. The Client put their own price data into the model and shared the general results with the author of the report.

The Client's price volatility was less than the Mongolian market as a whole, both before and after implementation of the Client's SI. The Client's price volatility was more than the Chinese market as a whole, both before and after implementation of the SI. However, no causality in the change of volatility could be attributed to SI's.

Model validation suggested that the model was accurate in determining which time periods had modeled higher or lower volatility. Fourier regression of cyclicality of purchasing as a possible driver of cashmere price illustrated that the effects of cyclicality in both the Chinese and Mongolian markets were no greater than random chance.

Future research in this area should work to establish whether this result was an aberration or part of a larger trend. Additionally, this report was not able to look at causality behind changes in volatility. Understanding causality would obviously be crucial to learning more about the role and return that SI investments can provide for corporations.

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Date

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Abstract:

Many corporations have begun to make sustainability investments, and those investments typically have relied on reducing costs, for example, though reduced energy, water, and material usage. However, an expanded focus on where sustainability can increase revenue and reduce risk will likely drive future corporate investment. The number one risk that supply chain purchasers have identified is raw material price fluctuation. Working with a large European luxury goods manufacturer, the coefficient of variation (standard deviation/mean) is used to analyze price volatility in the cashmere supply chain, both for the Client and the market as a whole. Since implementing direct purchasing, among other sustainability initiatives, the Client has reduced their raw material price volatility. However, the analysis includes no causal assessment. Future work should incorporate more data to look at the causal relationship between sustainability initiatives and reduced price volatility.

Introduction:

Corporate Sustainability Initiatives

A sustainability initiative (SI) can be defined as "a rules based partnership or collaboration among multiple supply chain stakeholders aimed at improving the social, economic, and environmental sustainability of commodity production and/or trade," (Potts et al., 2014). Corporate buyers of raw materials are often the main implementation pathway for sustainability initiatives (Potts et al., 2014). Executives help set sustainability targets or goals, but buyers implement the policies by selecting and working with suppliers who are able or who have a desire to meet those goals.

A concrete example of a sustainability initiative was demonstrated by McDonald's Corporation (McMillan, 1996). Facing a series of calls from environmentally-minded-consumers for the company to switch from plastic, non-biodegradable packaging of its food products to biodegradable paper packaging, McDonald's made the switch in 1990 (McMillan, 1996). McMillan (1996) found that this switch, which substantially improved sustainability, resulted in significant financial gain for the company.

This is not an isolated incident. Companies are increasingly embracing sustainability initiatives as a core part of their strategy (Ameer and Othman, 2012; Lubin and Krosinksy, 2013; Peylo and Schaltegger, 2014; Schramade, 2016). Many researchers have found that companies which invest in sustainability initiatives have higher financial performance than those that do not (Ameer and Othman, 2012; Van de Velde, Vermeir, and Corten, 2005). However, the driver in this financial improvement still remains uncertain (Peylo and Schaltegger, 2014).

Value-Driver Model

One aspect of the uncertainty lies in the role of sustainability improvements. Firms that incorporate sustainability often have superior overall long-term planning, which also drives higher financial results (Ameer and Othman, 2012; Peylo and Schaltegger, 2014). Thus, it is important to determine whether sustainability itself drives increases in financial performance, or if other characteristics of the company that would lead it to adopt sustainability efforts, such as long-term planning expertise, are more important for creating financial value (Ameer and Othman, 2012).

An additional point of uncertainty comes from the actual act of sustainability. How much financial value do companies generate from marketing as opposed to actually implementing sustainability initiatives (Schramade, 2016; Epstein and Buhovac, 2014)? Many companies derive significant benefits from marketing their environmentally-friendly practices, which generally requires a lower level of effort than actually implementing those same practices (Dangelico and Pontrandolfo, 2015). Furthermore, the actual methods for practical implementation of sustainability objectives often present a challenge for corporations, since sustainability is often outside a business' core area of expertise (Orlitzky et al., 2003; Epstein and Buhovac, 2014). Thus, some businesses may see sustainability efforts as high cost, low return investments, because of their lack of familiarity with the concepts of implementation – perhaps leading an organization to focus more on marketing (an area of expertise) than implementation (Orlitzky et al., 2003; Epstein and Buhovac, 2014).

While marketing successful initiatives is important, increased adoption of sustainability initiatives will rely upon showing exactly how sustainability initiatives create value for corporations (Schramade, 2016; Peylo and Schaltegger, 2014; Lubin and Krosinsky, 2013). To that end, this project uses the framework of the Value Driver Model to illustrate one way that sustainability projects may create value (Lubin and Krosinsky, 2013; Schramade, 2016).

To understand the Value Driver Model (VDM), it is helpful to consider the profit equation. Profit = Revenues – Costs. There are thus two ways to increase profits: (1) cut costs, or (2) raise revenues. Traditionally, cutting costs has been the historic pathway for companies to justify and execute sustainability efforts (Lubin and Krosinsky, 2013; Schramade, 2016). Cost cutting efforts have generally focused around issues such as reducing energy or water consumption (Lubin and Krosinsky, 2013; Schramade, 2016). While laudable, such efforts are naturally limited in scope (Lubin and Krosinsky, 2013; Schramade, 2016). Companies can only cut so much energy from their production – they will always have to use some energy and water to produce things; and future company growth will rely on increased consumption (Dauvergne and Lister, 2012).

The other way to increase profits is to raise revenue. Here, the Value Driver Model (VDM) illustrates ways that companies can pursue revenue growth opportunities – in ways that are meaningful for the firms and the environment (Lubin and Krosinsky, 2013; Schramade, 2016). The three channels of the VDM are illustrated below.

- Sustainability as a function of Growth

$$\frac{S}{G} = \frac{Revenue\ Growth\ from\ Sustainability\ Enhanced\ Products}{Total\ Revenue\ Growth}$$

- Sustainability as function of Productivity

$$\frac{S}{P} = \frac{Total\ Cost\ Saving + Avoidance\ from\ Sustainaiblity}{Total\ Operating\ Income}$$

- Sustainability as a function of Risk

$$\frac{S}{R} = Reductions\ in\ Exposure\ to\ Sustainability\ Related\ Risks$$

The key is to measure direct impacts of sustainability initiatives on a company's performance, in ways that companies measure their own performance (Lubin and Krosinsky, 2013; Schramade, 2016). The VDM allows firms and investment analysts to better tie sustainability initiatives to the creation of financial value, which helps spur further investment (Lubin and Krosinsky, 2013; Schramade, 2016).

This study focuses on S/R, reductions in exposure to sustainability-related risks. To that end, this study was supported by a client I partnered with a client to measure the impact of the Client's sustainability initiatives using an S/R framework. The Client is a large European luxury good manufacturer. The Client has a global supply chain, with impacts in land-use, water use, and carbon footprint. The Client has traditionally been a leader in the sustainability space and is looking to continue that leadership by better communicating the financial impact of sustainability initiatives.

Supply Chain Sustainability Initiatives & Direct Purchasing

Often, a company's biggest environmental impacts are in its supply chain (CDP, 2016). For example, carbon emissions in the supply chain can be up to four times those of a company's direct operations (CDP, 2016). Thus, the supply chain is a natural place to focus sustainability initiatives and it has been the focus of the Client's efforts. The Client's efforts had previously focused on a variety of initiatives, but one key effort involved a shift to direct purchasing of a raw material.

de Zegher and Iancu (forthcoming) outline two methods of purchasing raw materials: "commodity-based channel" and "direct-sourcing channel." de Zegher and Iancu (forthcoming) identify commodity-based channel" as one "where parties may transact through a channel that blends farmers' produce." Conversely, a channel that "allows a one-on-one interaction between farmer and processor" is a "direct-sourcing", or direct purchasing, channel (de Zegher and Iancu, forthcoming).

Direct purchasing may not seem to be a sustainability initiative, in and of itself. However, de Zegher and Iancu (forthcoming) analyzed a data from farms in Patagonia, Argentina and found that the direct-sourcing channel increased average supply chain profit 6.9%, while also realizing more positive environmental benefits, than the commodity-based channel of purchasing. de Zegher and Iancu (forthcoming) have thus established that utilizing direct purchasing, with the intent of improving environmental and social outcomes, instead of using a commodity-based channel, should count as stand-alone sustainability initiative. In fact, de Zegher and Iancu (forthcoming) found that the only way that financial value could be generated from SI's in Patagonia was under a strict set of contract criteria that could only be in place in a direct purchasing framework, and not through a commodity-based channel. The commodity-based channel represents the vast majority of commodity purchasing today (de Zegher and Iancu, forthcoming).

For the Client, direct purchasing allows them to cut out the middle man of their purchases, directly purchasing from the supplier of raw material. In addition to the advantages of reducing price and strengthening relationships with the raw material sources, it also allows the Client to have more information about the impacts of those same raw materials in their supply chain and to have some negotiation and conversation about possible sustainability initiatives with the raw materials supplier (CDP, 2016). This another example of how sustainability initiatives can contribute directly to the bottom line (CDP, 2016; de Zegher and Iancu, forthcoming).

The Client has implemented such sustainability initiatives with raw materials procurers in multiple channels of their supply chain. In this case, we focus on one channel – raw cashmere procurement. Cashmere is produced from goats, mainly grazing in China and Mongolia. The Client uses and sells cashmere in a variety of products. Due to competitive concerns, the Client was not able to disclose their specific SI's in the cashmere supply chain. Thus, all efforts to improve the environmental and supply sustainability of cashmere are here collectively referred to be the Cashmere Project. The major sustainability advantage that the Client was able to identify and discuss was direct purchasing.

To understand how sustainability projects can help create value for both the business and the cashmere purchasers of the Client, it is important to understand their main concerns. Since the framework is S/R, the topic will be approached from a risk perspective. PriceWaterhouseCoopers (PwC), a consulting firm, and the MIT Forum for Sustainable Supply Chain Innovation interviewed supply chain representatives from 209 global companies who procure raw materials from the initial raw suppliers. Over half of the respondents (53%) said the "greatest risk to which their supply chain is exposed" is "raw material price fluctuation," (PWC and the MIT Forum for Sustainable Supply Chain Innovation, 2013;

Figure 1).

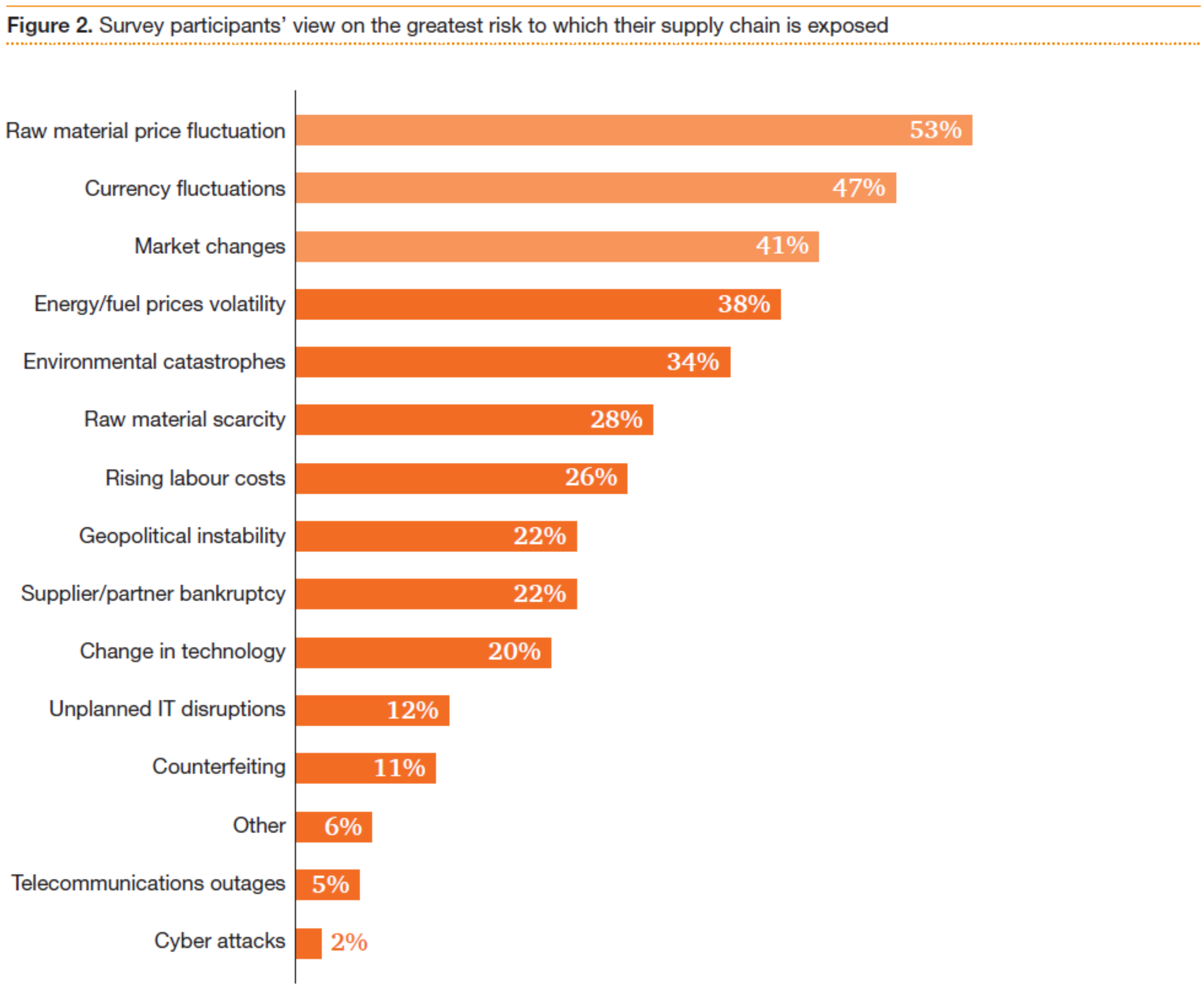


Figure 1: PWC/MIT survey of global supply chain representatives (PwC and the MIT Forum for Sustainable Supply Chain Innovation).

Raw material price fluctuations are important for a variety of reasons. One key reason is planning. The Client's raw materials purchasers have to acquire cashmere a long time, often months, before a customer buys a product off the shelf. Forecasting customer demand is in and of itself a challenging process, which only gets worse the longer the supply chain is – a phenomenon known as the bullwhip effect. By reducing the length of the supply chain (from Client -> middle man - > cashmere to Client -> cashmere), it should reduce the amount of time it takes the cashmere to reach the Client, which should reduce the bullwhip effect.

Reduced Price Volatility and Creation of Financial Value

However, since lead time cannot be reduced to zero, some level of forecasting will always be required. Even if a customer only wanted to buy raw cashmere off the shelf, the amount of cashmere required would vary depending on the time of year, customer demand, and many other variables. Price of cashmere could very well be a key driver of demand, but even if it isn't, the price of cashmere is a key input to the cashmere forecast purchasing model. The more stability there is around price, the more likely the forecast is to be accurate.

The tie between the accuracy of the forecast and the creation of financial value can be thought of in terms of false positives (overage cost) and false negatives (underage cost) in the forecasting models. Overage cost is the cost of having too much inventory on hand. More specifically, it is the cost of ordering one more unit of product than you would have, had you perfectly known the demand. Overage cost can be summarized by the following formula (Salvage Value is what it is possible to sell the overstocked item for),

$$Cost\ of\ Product - Salvage\ Value\ =\ Overage\ Cost$$

Conversely, underage cost is the cost of not having enough inventory on hand. More specifically, it is the cost of ordering one less unit of product than you would have, had you perfectly known the demand. Underage cost can be summarized by the following formula,

$$Price\ of\ the\ Product - Cost\ of\ the\ Product = Underage\ Cost$$

The value proceeding from reducing raw material price volatility is that forecasts are improved, leading to more accurate orders, fewer missed sales, and less overstock.

The recent study from PwC and the MIT Forum for Sustainable Supply Chain Innovation corroborates this logic. The 209 responding companies found that long-term supply chain planning (for instance, those planning processes required to implement sustainability projects, as discussed at the beginning of the introduction) had the following advantages, as opposed to a short-term focus for supply chain planning (PwC and the MIT Forum for Sustainable Supply Chain Innovation, 2013; Figure 2):

The findings validate *five key principles* that companies can learn from to better manage today's risk challenges to their supply chains and prepare for future opportunities.

Supply Chain Risk Management

1. Supply chain disruptions have significant impact on company business and financial performance.
2. Companies with mature supply chain and risk management capabilities are more resilient to supply chain disruptions. They are impacted less and they recover faster than companies with immature capabilities.
3. Mature companies that invest in supply chain flexibility are more resilient to disruptions than mature companies that don't.
4. Mature companies investing in risk segmentation are more resilient to disruptions than mature companies that do not invest in risk segmentation.
5. Companies with mature capabilities in supply chain and risk management do better along all surveyed dimensions of operational and financial performance than immature companies.

Figure 2: Principles for managing risk in supply chains (PwC and the MIT Forum for Sustainable Supply Chain Innovation, 2013).

Based on the results of this study, it appears that improving supply chain forecasting is critical to the business process – it represents real opportunities to generate financial value and improve business operations. Improving the supply chain is also a critical focus of all current SI's.

Possible Drawbacks of Direct Purchasing – Smaller Supply

In 2013, Rhett Godfrey started the Chetna Coalition. The mission of the Coalition is to help "small and marginal farmers towards improving their livelihood options and making farming a sustainable and profitable occupation," (Godfrey, 2017). Essentially, Chetna organizes multiple different purchasing organizations together to secure a long-term supply of organic cotton for the participating organizations (Godfrey, 2017). This approach gives organic cotton farmers a sure demand commitment. Organic cotton purchasers receive a relatively sure source of supply. Since their founding, Chetna has grown their sales of organic cotton from 300 to 1500 metric tons (Godfrey, 2017).

Anecdotally, Godfrey (2017) noted that initially reduced price volatility had been one of many benefit that the purchasers had received. The reduced price volatility had helped both the purchaser's and the grower's planning efforts and was a big part of the reason why Chetna's organic cotton sales had grown so much (Godfrey, 2017). However, political events had conspired to undermine the price stability that Chetna had seen (Godfrey, 2017). In the fall of 2016, India removed its highest denomination rupee notes (500 and 1,000) as part of an effort to curb corruption. This demonetization changed the previously agreed to cotton prices (and prices for pretty much all other commodities; Godfrey, 2017).

Godfrey (2017) observed, "If you had asked me before the demonetization – did going organic/advance purchasing have a positive effect on price stability? The answer was undoubtedly yes. However, the demonetization effort has totally ruined that effect." Godfrey felt that there were too many factors in price to say that advance purchasing agreements would singlehandedly drive long-term price stability (Godfrey, 2017). Godfrey (2017) also pointed out that "when you switch from a commodity to an organic version of that commodity, you are also moving from the whole world commodity supply to a smaller version of that supply. The smaller source of supply [organic] is inherently more risky because there is just less of than the global supply. It is just more susceptible to pests, weather, etc."

Cashmere

Cashmere is produced from the hair of goats. Goats are shorn, and then the cashmere is taken to population centers for processing. Cashmere is a key component of the luxury goods market, probably accounting for €4 billion of the total €60 billion world market (Yu et al., 2014; Bain and Company, 2015). 85% of the world's supply of cashmere comes from China and Mongolia (Yu et al., 2014). Mongolia produces approximately 33% of the world's cashmere supply annually (Yu et al., 2014; Schmitz, 2016). The Client sources cashmere exclusively from Mongolia.

In Mongolia, an estimated 44 million goats forage the ground in the cashmere industry (Mongolia Newswire, 2015; Lkhagvadorj et al., 2013). Cashmere sales in Mongolia have accounted for 70% of cash income in the livestock husbandry industry since 1990 (Lkhagvadorj et al., 2013). Global demand for cashmere has grown significantly in the 1990's and 2000's (Berger et al., 2013; Yu et al., 2014).

The rise of global demand and the important contribution of cash to herders has meant a sharp increase in the number of goats on the land across Central Asia (Berger et al., 2013; Yu et al., 2014). Berger et al. (2013) now estimate that across Mongolia, India, and China, native ungulate biomass represents less than five percent of the domestic species biomass – a result of domestic goats replacing native fauna. This increased domestic grazing pressure exerts more stress on the ecosystem, which in addition to reducing wild animal populations, also puts the cashmere industry itself at greater risk of population crashes and subsequent price swings (Berger et al., 2013; Lkhagvadorj et al., 2013; Yu et al., 2014).

Climate change is already having an impact on Mongolian herders – the mean annual temperature in herding areas of the country has increased by over 2°C over the last 70 years (Dagvadorj et al., 2009). Impacts include, but are not limited to, an increase in frequency and length of heat waves, corresponding to drought in summer and temporary rangeland degradation (Sternberg et al., 2011). Another impact is a changing precipitation pattern, increasing frequency of heavy rainfall, which is less suitable for the rangeland vegetation than steady rain (Nandintsetseg et al., 2007). Where increased summer drought has been observed, reduced tree growth and inhibited forest regeneration has also been observed (Dulamsuren et al., 2010a, b). Cashmere goat herder perception of all these changes is important, because it contributes to their own decision-making on how they use the rangeland and it affects their assessment of their own long-term economic situation (Fernández-Giménez, 1993). Combining the factors of explosive growth of cashmere goat herds (Figure 3) and changing climate, Lkhagavadorj et al. (2013) concluded that current patterns of land-use and cashmere production in Mongolia were not sustainable."

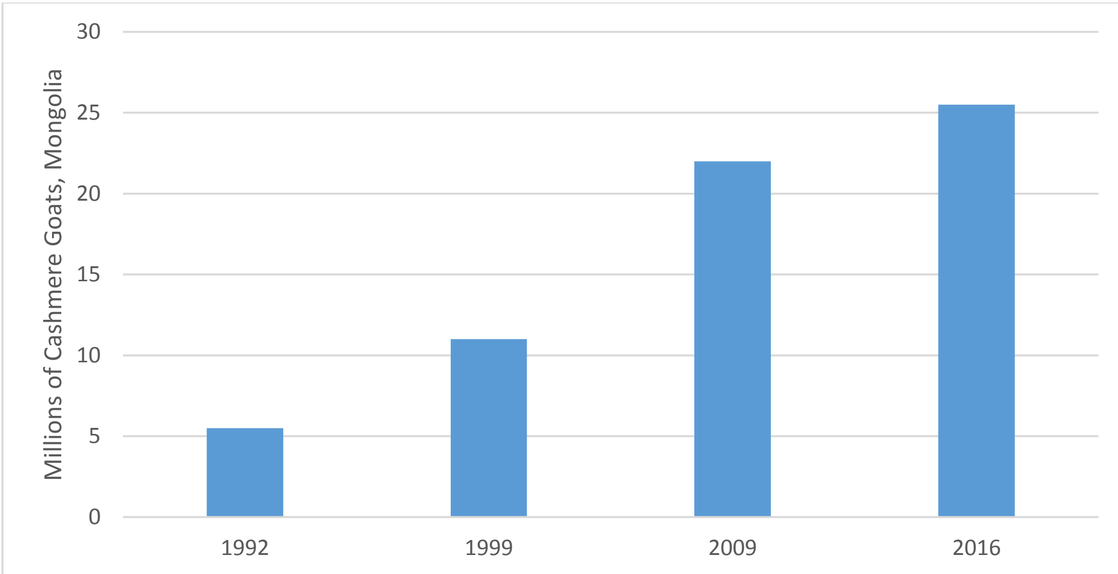


Figure 3: Growth of cashmere goats in Mongolia representatives (Hurd, 2013; Mongolian Statistical Service, 2017).

Cashmere typically has higher price volatility than other comparable raw materials (Figure 4; Yu et al., 2014). Several factors contribute to this volatility. First, as Westinghuysen (2005) describes, cashmere production (the hair on the goat itself) is highly unpredictable. For example, particularly fierce winters in 2009 and 2010 in Mongolia decimated goat populations, driving up the price (Yu et al., 2014). Secondly, demand drives a large amount of fluctuation – the global economic downturn in 2008-2009 severely depressed prices because of reduced demand (Mattis, 2009). Thirdly, China imports about 50% of Mongolian cashmere production, meaning that the industry is highly responsive to changes in Chinese demand (Yu et al., 2014). Fourthly, and more recently, the growth in goat population has contributed to an overgrazing problem that leads to large swings in the number of goats the rangeland ecosystem can support (Berger et al., 2013; Lkhagvadorj et al., 2013; Yu et al., 2014). As an example of price volatility in the cashmere market, Chinese cashmere prices demonstrate extremely high volatility compared to wool prices in the same market over the last 5 years (Figure below; Emerging Textiles, 2016).

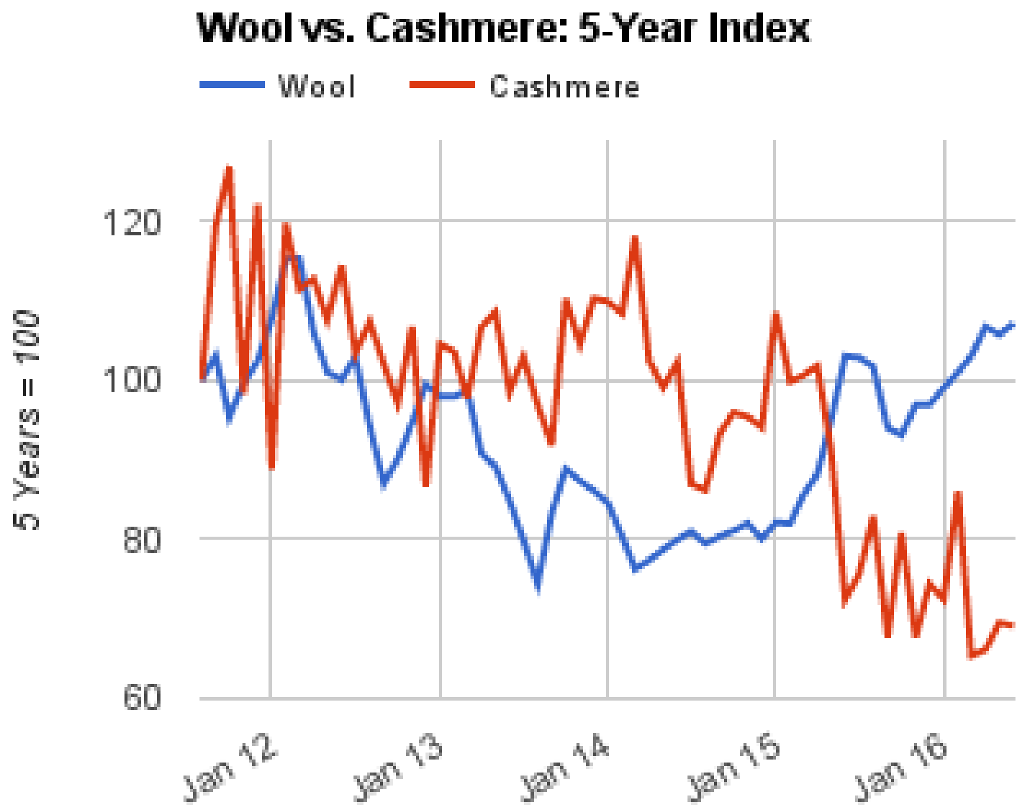


Figure 4: The price of a standard weight of cashmere and wool relative to January, 2012 = $100.

Consequently, there are both economic and ecological reasons for the Client to implement sustainability initiatives in its cashmere supply chain. There are many ways to measure the improvements of such sustainability initiatives – from decreased amount of total forage area to acres of restored grassland or increased percentage of native ungulates in total biomass. These are all important aspects to understand when it comes to evaluating the health of the ecosystem, but ultimately, measuring those pieces of data would require a lot of time and input from the Client, in an area in which it may not have business expertise. Furthermore, measuring ecosystem values has limited immediate relevance to the financial performance of the company upon which management is measured.

However, using the VDM framework presented earlier (S/R – do sustainability initiative decrease risk in the supply chain?), we can measure the sustainability initiatives, with their laudable ecosystem goals, on whether or not they also accomplish business goals and encourage adoption.

This approach leads to the following potential outcomes

1. Sustainability initiatives – here called the Cashmere Project– have no effect on the price volatility of the prices the Client pays for cashmere, neither creating nor destroying immediate financial value for the Client (Null hypothesis).

2. Cashmere price volatility decreases after the implementation of sustainability initiatives, creating immediate positive financial value for the Client (Alternative hypothesis).

Methods:

Data

The original agreement between the Client and the author had functioned on an understanding that there would be sufficient and relevant data to perform some data analysis, similar to that proposed in the introduction. However, the necessary data was both harder to procure and to share than the Client and the author had originally realized when it was first agreed that they would work together. Thus, the agreement was amended. The author would build the model into which the Client could input their data. The Client would report on the generic results of the data analysis in the model, such as "since sustainability initiatives were implemented, price volatility decreased (or increased)."

The Client has monthly data on the price paid for cashmere (usually in euros/kg). The Client also has a record of the date when they began to implement their sustainability initiatives. They will input this data into the model, and the model will then indicate whether their sustainability initiatives reduced price volatility.

To achieve the analysis, client data can be compared to monthly data from October, 2012 to July, 2016 for the general market price of raw cashmere in China (US$/kg) (Emerging Textiles, 2016). For this data set, the average price was $130.93, with a standard deviation of $8.58. The general market price of raw cashmere in Mongolia during the same period averaged $130.17, with a standard deviation of $32.68 (Mongolian Statistical Information Service, 2017; Figure 5). Data on Chinese market price was downloaded from the Emerging Textiles website (2016) and was analyzed in its original form (it was provided in US$/kg). Data on Mongolian market price was downloaded from Mongolian Statistical Information Service (2017). Mongolian data was geographically segregated at a provincial level; consequently, to maintain consistency with the Chinese data, the Mongolian price for each month was averaged across all provinces. The Mongolian data was also originally provided in Mongolian *tughrik*, the Mongolian currency, so the data was normalized to match the exchange rate with the US Dollar at each relevant time interval. The current exchange rate is $1 to 2470 *tughriks*.

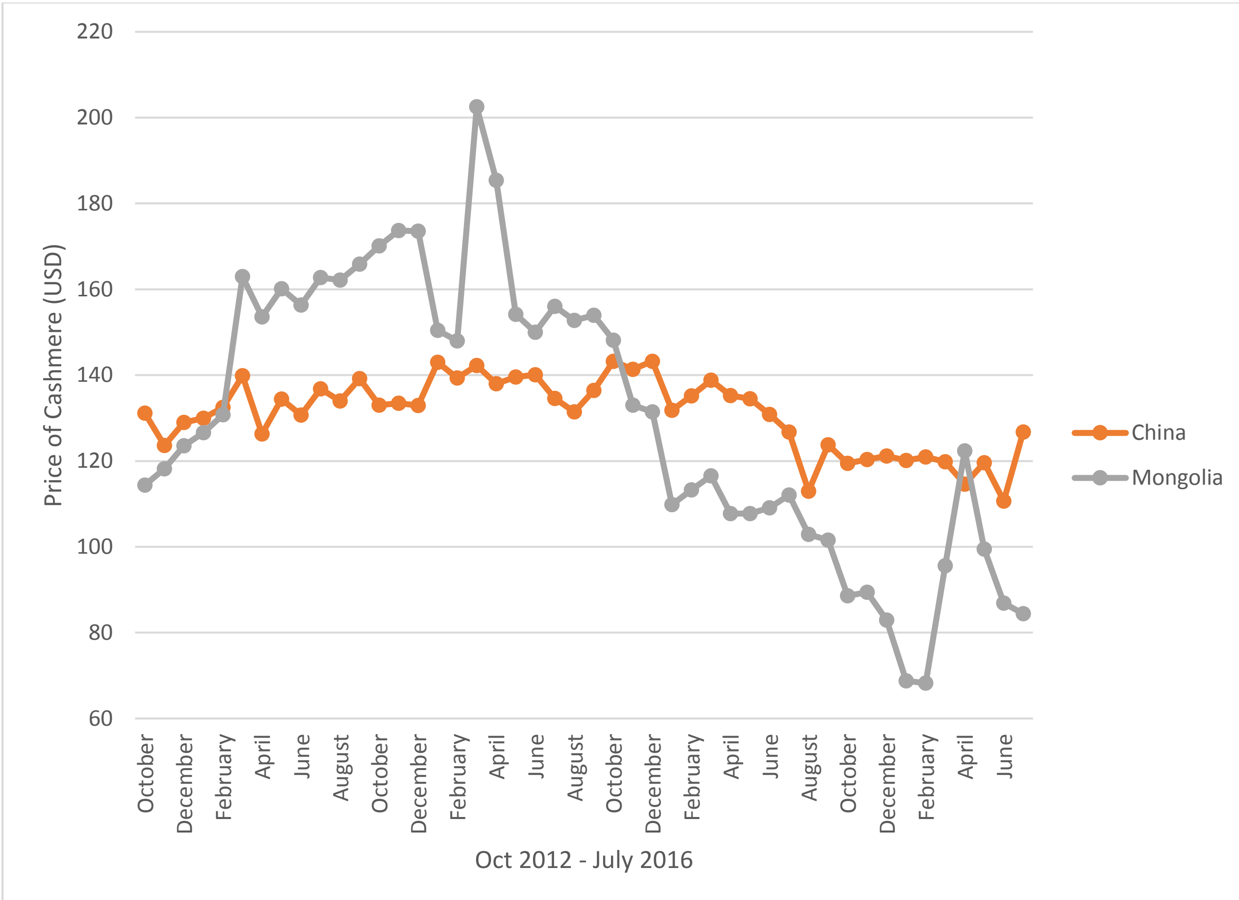


Figure 5: Price of cashmere (USD/kg) on the Chinese market, October, 2012 – July, 2016 (Emerging Textiles, 2016; Mongolian Statistical Information Service, 2017).

To further understand price volatility in the Mongolian cashmere market, price data for raw Mongolian cashmere leather was also downloaded from Mongolian Statistical Information Service (2017). Cashmere leather comes from the same source as cashmere wool – goats. However, since the processing of cashmere leather relies on dead goats (leather being a product of the animals' skin), comparing cashmere leather volatility to cashmere wool volatility allows this study to compare the most similar animal products, with different sourcing methods, that are available at the Mongolian Statistical Information Service. Since we do not know the Client's market share in cashmere, it is possible to understand better the impacts (if any) of the sustainability initiatives in the context of the broader animal products industry. The Mongolian cashmere leather data was treated the same way as the Mongolian cashmere wool data – prices averaged across provinces, then normalized to match the exchange rate with the US Dollar at each relevant time interval. From October, 2012 to October, 2016, cashmere leather sold for an average of $8.97 per kg, with a standard deviation of $5.14. The coefficient of variation (discussed in further detail later) is thus 57.3%, making leather prices more volatile than wool prices, with a coefficient of variation of 25.10% (Figure 6).

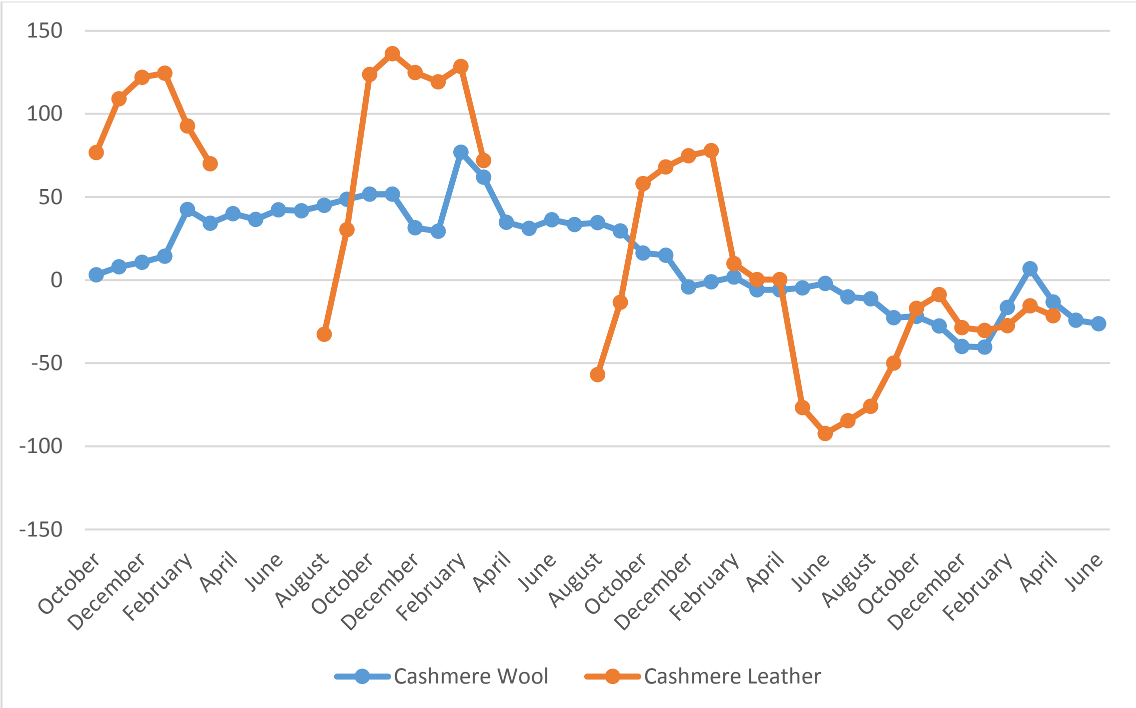


Figure 6: The price of a standard weight of raw cashmere and cashmere leather relative to April, 2012 = $0.

For model validation, two datasets were randomly generated. Both datasets consisted of 30 randomly generated numbers in R (R Development Core Team, 2017). The first dataset had a mean of 130, with a standard deviation of 40. The second 30 numbers also had a mean of 130, with a standard deviation of 20. The two randomly generated datasets represent similar means to both the Mongolian and Chinese cashmere, while having very different standard deviations and can therefore be used to test the veracity of the model. When the model was implemented with validation data, September, 2014, was chosen as the date of the implementation of the SI, to allow for a similar number of data points before and after the implementation of the SI. The modeled SI can be thought of as direct purchasing, since more specific data was not available from the Client.

Analyses – Event Study

Event study is one of the key statistical tools of the financial world (Kothari and Warner, 2007). It allows statisticians to compare the impact of one (or a series of) events on the financial value of a firm. Usually it is employed to assess changes in a company's stock price, but in this study, the framework of event study is applied to the Client's raw materials purchase prices.

Event study typically compares how a firm's stock price changed as a result of a certain piece of news, compared to the stock market as a whole for that particular day. For instance, if a firm announced it was laying off many employees, and its stock price dropped 3%, but the stock market (as valued by the S and P 500 index) climbed 1% that day, one could say the total abnormal return on the news was -4%, because of the market's overall 1% rise.

The overall goal, then, of event study is to compare a “normal” return on investment (the S and P 500 index) to an “unexpected” return (the firm’s layoffs). The basic formula for event study has not changed significantly since its initial proposal in Fama et al., 1969 (Kothari and Warner, 2007). The basic formula is

$$Unexpected\ return = Observed\ return - Predicted\ return$$

Since event study measures the impact of one event, in this scenario, the event would be the implementation of a sustainability initiative, such as direct purchasing. First, the Client would pinpoint a certain time when their direct purchasing from supplier program started. From that time point, we could use event study methodology to study how volatility changed for both the Client and the wider market as whole.

There are two normal outcomes in this case, and thus two possible analyses. The first analysis uses the before-sustainability-initiative as the predicted return. The second uses the average monthly cashmere price data for Mongolia and China as the predicted return. In both cases, the after-sustainability-initiative data is the observed return. However, the Client was asked a total six questions, which should help give a better idea of the nature of return on sustainability investment:

1. Price Volatility since Sustainability Initiative;
2. Price Volatility compared to Mongolian Market, after Initiative;
3. Price Volatility compared to Mongolian Market, before Initiative;
4. Price Volatility compared to Mongolian Market, whole time period;
5. Price Volatility compared to Chinese Market, after Initiative;
6. Price Volatility compared to Chinese Market, before Initiative.

Question 1 gets at the most basic question of this event study – has internal price volatility decreased since its implementation? Questions 2-4 compare trends in the larger Mongolian marketplace, to understand if price volatility in the wider marketplace was trending in the same or opposite direction as that of the Client. Questions 5 and 6 seeks to address the internal price volatility compared to the largest cashmere market in the world.

Short horizon event studies are generally the most well accepted, whereas long term event studies begin to suffer from some problems, including other outside factors influencing price movements (Kothari and Warner, 2007). However, by their very definition, sustainability initiatives are supposed to deliver long-term results. Thus, in this instance, it is reasonable to compare whatever risk reduction there was over the entire term for which the Client had data.

Analyses – Coefficient of Variation

The model was based on the concept of Coefficient of Variation (CoV). Coefficient of Variation is a relatively straightforward analysis; it is the standard deviation of a data set divided by the mean of the data set. Coefficient of Variation is one of the most widely-used and well-respected methods to calculate price volatility in commodity markets (Moledina et al. 2004; European Commission, 2009; Matthews, 2010; Huchet-Bourdon, 2011; Bellemare et al., 2013). Weber et al. (2004) highlight how CoV represents an appropriate measure of risk to return.

Coefficient of Variation is typically used to measure historic price volatility (Huchet-Bourdon, 2011). Another way that commodity price volatility is measured is implied volatility from future pricing of the commodity (e.g. Pindyck, 2001; UNCTAD, WFP 2011). Futures are a contract that requires the contract holder to buy or sell a certain amount of a commodity at a certain price at some point in the future (often between 3 months – 1 year). Future prices illustrate implied volatility, or what market participants expect future volatility to be. Volatility in future prices is measured as a percentage of the deviation in the futures price (six months ahead) from underlying expected value (similar to how CoV is measured, using standard deviation in a percentage manner). Futures are often used in many US commodity markets. However, there are no future markets for cashmere, so this is not a viable option for this study.

Coefficient of Variation does suffer from some autocorrelation issues (Albright, 2017). In this instance, autocorrelation is when the price of cashmere yesterday heavily influences the price of cashmere today. Autocorrelation is an important aspect of this pricing study in a real-world situation. In a study titled, “Has food price volatility risen” included in the “Workshop on Methods to analyze price volatility” Gilbert and Morgan (2010) outline the situation:

> *“Economic series typically exhibit trends. Any measure of the volatility of price levels therefore requires the series to be detrended since otherwise trend movements will be included in the volatility measures. Because trends are rarely linear and deterministic (Kim et al, 2003; Kellard and Wohar, 2006), detrending requires a trend model which implies a judgemental trade-off between attribution of variability to the trend itself and to variation about the trend. The volatility measure can therefore depend on the choice of trend model in an undesirable manner. In looking at price volatility, economists often circumvent these issues by measuring volatility as the standard deviation of price returns, i.e. the standard deviation of changes in logarithmic prices.”*

In building the model for the Client, the goal was to keep the analyses as easy to understand as possible. Model parsimony was also important, since the Client would be operating the spreadsheet model independently. In addition to checking the internal success of any sustainability initiative, external success was also analyzed by comparing the internal after-initiative price volatility with the after-initiative price volatility in the Mongolian and Chinese cashmere markets.

The model has two inputs: date of sustainability initiative and monthly price data from the client. The model separates the data into two different sets: before initiative and after initiative. The model calculates a separate mean and standard deviation for each of the 2 different sets of data (the before set and the after set, or the Mongolian market price from the time that the after set began). It then calculates the CoV, or the standard deviation divided by the mean, for each of the 2 different data sets.

$$\frac{Standard\ Deviation}{Mean}$$

It is perhaps helpful to illustrate the CoV with an example. If the dataset has a mean of 2, and standard deviation of 1, then the CoV is

$$\frac{1}{2}$$

If the dataset has a mean of 4, and a standard deviation of 2, then the CoV is

$$\frac{2}{4}$$

In this case, obviously, the CoV is the same, even though the underlying numbers are different. It is worth mentioning that one of the reasons CoV is so popular in commodity price volatility studies is because it allows for apples to apples comparisons (Huchet-Bourdon, 2011). Since the standard deviations are divided by the means of the sample sets, it allows for direct comparison between two otherwise different datasets (e.g. volatility in one time period vs volatility in a separate time period; Huchet-Bourdon, 2011).

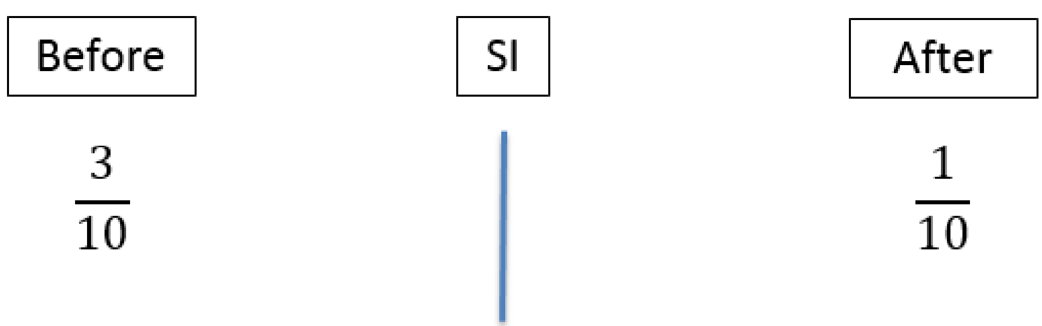
Lower CoV means lower variation. If the mean of the data is 10, and the standard deviation is 1, then CoV is

$$\frac{1}{10}$$

If the mean of the data is still 10, but the standard deviation is 3, then the CoV is

$$\frac{3}{10}$$

So, if for example, the Client had an initial price volatility of 3/10, then implemented their SI, and following the SI had a volatility of 1/10, then it would be possible to say that their volatility decreased. The model then assesses the percent change between .3 and .1 to illlustrate about the degree of change.



Analyses - Cyclicality

A concern for any commodity is cyclical variation in price. In this instance, it is especially important to test for cyclicality to make sure that any differences in price volatility represent an accurate apples-to-apples to apples comparison, and not general variation in pricing. To test for cyclicality in pricing, the Fourier regression technique was used, as it is one of the most well-regarded ways to measure cyclicality (Fulford, 2014).

Fourier regression is described the equation below. Essentially, one turns the data being regressed into a sinusoidal function. To do this, month number was divided by 12 or 6, creating a repeating cycle of months that could be compared against each other. Variation was tested at annual and semi-annual cycles. For both cycles, the cosine (month cycle), sine (month cycle), cosine (2*month cycle), and sine (2*month cycle) were tested as independent variables in a multiple regression analysis, with price as the dependent variable.

$$f(x) = a_0 + \sum_{j=1}^{N} \left(a_j \cos(2\pi t \div 12) + b_j \sin(2\pi t \div 12) \right),$$

where, a_o is the intercept, where t is the month number in the calendar year where the jth point is measured (12 represents in the number of months in the year), α_i and b_j are the coefficients to be estimated, and N is the number of pairs of terms in the truncate Fourier series.

Results:

A test of the dummy data (Figure 7) generated for model validation indicates that the model was successful at determining differences between two unique datasets (Table 1). Recall that "the first (randomly generated) dataset had a mean of 130, with a standard deviation of 40. The second (randomly generated) 30 numbers also had a mean of 130, with a standard deviation of 20." The model has successfully indicated that price volatility dropped in the dummy situation (Table 1).

Table 1. Model validation results.

Model Validation Data		
	Before Simulated SI	After Simulated SI
Mean	$131.56	$126.85
Standard Deviation	$40.39	$16.23
Count	30	25
Coeffiecent of Variation	30.70%	12.79%
Change in CoV		**-58.33%**

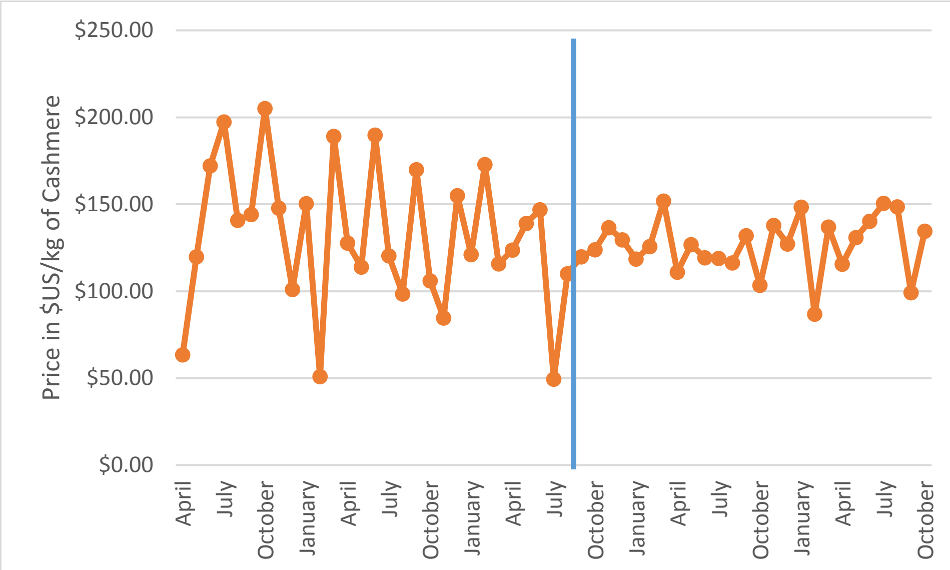


Figure 7: Simulated price of cashmere (USD/kg) for the Client, April, 2012 – October, 2016 (simulated, randomly generated data). The blue line represents the start of the simulated sustainability initiative.

The Client ran the model with their own purchasing data, and found that price volatility had decreased when compared to volatility before the SI (Table 2). Similarly, the Client had lower volatility than the Mongolian market as a whole, but also lower volatility than the Mongolian market both before and after the implementation of the SI (Table 2). The Client had higher volatility than the Chinese market in both cases (Table 2).

Table 2: Client outcomes

Question	**Result**
1. Price Volatility since Sustainability Initiative	Decreased
2. Price Volatility compared to Mongolian Market, after Initiative	Lower Volatility
3. Price Volatility compared to Mongolian Market, before Initiative	Lower Volatility
4. Price Volatility compared to Mongolian Market, whole time period	Lower Volatility
5. Price Volatility compared to Chinese Market, after Initiative	Higher Volatility
6. Price Volatility compared to Chinese Market, before Initiative	Higher Volatility

Cyclicality has essentially no effect on price variation in the cashmere wool market (Tables 3-6). As measured by r-square, 6-month cyclicality explained 1.6% of the variation in Chinese prices, and 4.4% in Mongolian prices (Tables 3-4). 12 month cyclicality explained 1.8% of the variation in Chinese prices, and 5.1% in Mongolian prices (Tables 5-6).

Discussion:

Using CoV, the most commonly accepted way to analyze price risk in commodity markets (Moledina et al. 2004; European Commission, 2009; Matthews, 2010; Huchet-Bourdon, 2011; Bellemare et al., 2013), it was found that the Client has decreased their overall price volatility, relative to the overall market, after implementing their sustainability initiative. The Client's volatility was less than the Mongolian volatility in all cases and more than the Chinese volatility in all cases.

However, the CoV analysis does not allow us to draw any conclusions about causality. In order to establish causality, more variables would have to be incorporated into a more detailed analysis of the data. Some information that would be useful for futures analyses includes, but is not limited to:

- Client's market share of Mongolian cashmere
- X-variables to help isolate any effects of purchasing power and monopoly effects
    - Quantity of raw material purchased
    - Number of suppliers for each raw material
    - Quantity purchased from each individual supplier (as opposed to an average)
    - Purchase methodology (open bid, reverse auction, etc.)
    - Number of intermediaries – (i.e. direct supplier to Kering, or wholesaler)

Furthermore, the degree of decreased volatility would obviously also be helpful information for both future studies and to help spread adoption of SI's (i.e. if the difference is sufficiently large for other business departments to justify investment, or even if it is not). Future work could also look at historical drivers of price volatility in the cashmere supply chain (or other supply chains) and use information about the correlation between those variables to analyze what might drive change in more current volatility.

While the only information available about the Client's sustainability initiatives is an increase in the use of direct purchasing, de Zegher and Iancu (forthcoming) concluded that, in Patagonia, Argentina, the direct-sourcing channel increased average supply chain profit 6.9% over the commodity-based channel of purchasing, while also realizing more positive environmental benefits. Unfortunately, the Client's supply chain profit margins were not available, so it is not possible to make a direct comparison between the results of this study and the results to be published by de Zegher and Iancu. However, it is possible to say that the results fit the general pattern that de Zegher and Iancu (forthcoming) observed.

In this case, Godfrey (2017)'s issue of a smaller supply source eventually increasing price volatility has not yet occurred. In fact, what is similar thus far is that the price volatility has decreased, similar to what happened at the beginning of Godfrey's (2017) work. However, it is of course impossible to say much about the degree and scale of volatility change, when the only information available is more generic – whether or not volatility increased or decreased. Having more information about the degree of change would, again, be very useful. Given the high price volatility of cashmere (Yu et al., 2014), volatility should be measured going forward as well, since it will be likely to change. In this way, the effects of the sustainability initiative can continue to be monitored, just as the environmental effects would also be monitored in a more traditionally measured sustainability initiative. This would allow for both further information about the project (that may or may not justify further investment from other departments) and it would also allow for comparison to Godfrey's timeline, of initial decreased volatility, which converted to increased volatility after a few years.

Raw material price fluctuation is the most important issue about which procurement officers are concerned (PWC and the MIT Forum for Sustainable Supply Chain Innovation, 2013). To increase the adoption of sustainability initiatives at companies, it is important to frame the benefits of such initiatives in a way that corporations can easily compare sustainability investments to non-sustainability investments – i.e. the creation of financial value (Schramade, 2016; Peylo and Schaltegger, 2014; Lubin and Krosinsky, 2013). The study has attempted to outline one possible framework for how sustainability initiatives might create financial value: by decreasing price risk in the supply chain. It is impossible to determine how much changes in price volatility were driven by sustainability initiatives, due to data issues. However, this study suggests that these general patterns would benefit from more research, with more data, to determine more causality.

Tables:

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.210572
R Square	0.044341
Adjusted R Square	-0.04889
Standard Error	33.46763
Observations	46

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	4	2130.756	532.6891	0.47558	0.753382
Residual	41	45923.37	1120.082		
Total	45	48054.13			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	-159.304	371.7744	-0.4285	0.670532	-910.118	591.5093	-910.118	591.5093
X Variable 1	158.2099	254.2303	0.622309	0.537184	-355.219	671.6384	-355.219	671.6384
X Variable 2	376.0406	468.8836	0.801991	0.427182	-570.889	1322.97	-570.889	1322.97
X Variable 3	83.13625	97.86601	0.849491	0.400542	-114.508	280.7807	-114.508	280.7807
X Variable 4	-83.2091	137.7735	-0.60396	0.5492	-361.448	195.0301	-361.448	195.0301

Table 3. Fourier regression of 6 month seasonality in Mongolian cashmere prices.

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.22628
R Square	0.051203
Adjusted R Square	-0.04136
Standard Error	33.34726
Observations	46

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	4	2460.508	615.1271	0.553152	0.697807
Residual	41	45593.62	1112.04		
Total	45	48054.13			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	130.4365	4.934315	26.43457	2.24E-27	120.4714	140.4015	120.4714	140.4015
X Variable 1	-4.92584	6.84674	-0.71944	0.475949	-18.7531	8.901428	-18.7531	8.901428
X Variable 2	-1.96446	7.103625	-0.27654	0.78352	-16.3105	12.3816	-16.3105	12.3816
X Variable 3	-7.18633	7.016964	-1.02414	0.311775	-21.3574	6.984712	-21.3574	6.984712
X Variable 4	-5.17972	6.925575	-0.74791	0.458782	-19.1662	8.806759	-19.1662	8.806759

Table 4. Fourier regression of 12 month seasonality in Mongolian cashmere prices.

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.127859
R Square	0.016348
Adjusted R Square	-0.07962

Standard Error	8.917682
Observations	46

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	4	54.18888	13.54722	0.170352	0.952303
Residual	41	3260.527	79.52505		
Total	45	3314.716			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	79.29653	99.06187	0.800475	0.42805	-120.763	279.356	-120.763	279.356
X Variable 1	33.1276	67.74143	0.48903	0.627426	-103.679	169.9342	-103.679	169.9342
X Variable 2	66.84558	124.9373	0.535033	0.595517	-185.47	319.1616	-185.47	319.1616
X Variable 3	15.40531	26.07707	0.590761	0.557923	-37.2584	68.06904	-37.2584	68.06904
X Variable 4	-19.2594	36.7107	-0.52463	0.602669	-93.3981	54.8794	-93.3981	54.8794

Table 5. Fourier regression of 6 month seasonality in Chinese cashmere prices.

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.13439
R Square	0.018061
Adjusted R Square	-0.07774
Standard Error	8.909915
Observations	46

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*

Regression	4	59.86594	14.96649	0.188527	0.943047
Residual	41	3254.85	79.38658		
Total	45	3314.716			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	130.9187	1.318379	99.30277	1.75E-50	128.2562	133.5812	128.2562	133.5812
X Variable 1	0.913978	1.829352	0.499618	0.620015	-2.78047	4.608429	-2.78047	4.608429
X Variable 2	0.871571	1.897988	0.459208	0.64851	-2.96149	4.704636	-2.96149	4.704636
X Variable 3	-0.96009	1.874834	-0.51209	0.611335	-4.74639	2.826217	-4.74639	2.826217
X Variable 4	-0.06604	1.850416	-0.03569	0.971702	-3.80303	3.670946	-3.80303	3.670946

Table 6. Fourier regression of 12 month seasonality in Chinese cashmere prices.

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