

## **A BAYESIAN BELIEF NETWORK ANALYSIS OF FACTORS INFLUENCING THE PROPENSITY TO VIETNAMESE COFFEE EXPORT**

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**ABSTRACT:** *The purpose of this paper is to determine which particular organisational and managerial factors contribute to the propensity to export in Vietnam. For this purpose the coffee sector is chosen for investigation. A Bayesian belief network (BBN) model was developed from a set of 12 internal variables and 9 external variables to determine factors that influence export propensity in Vietnamese coffee sector using data from workshops and in-depth interviews. These were inputted into the software Netica for BBN analyses. Logistic, together with business environment, meeting customer habits, customer satisfaction, firm size, and variety of product were found to be strong influential factors explaining coffee export propensity, while the promotion had the least influence on coffee export propensity.*

**KEYWORDS:** Export Propensity, Coffee Product, International Market

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### **INTRODUCTION**

Export activity has traditionally become a core component of national importance, it affects levels of employment, foreign exchange revenues, industrial development and national prosperity; and the determinants of the export performance of enterprises are of great interest for policymakers (Lee *et al.*, 2013), export company managers (Grandinetti and Mason, 2012; Uner *et al.*, 2013) and also researchers (Combe *et al.*, 2012). This is because engagement in export operations is vital for a number of reasons, e.g. spreading business risks across different markets and ventures (Leonidou, 2011; Al-Aali *et al.*, 2013); providing a better profit base to attract and reward shareholders and employees (Vila López, 2013; Alrashidi, 2014); generating more revenue as well as funds for reinvestment and also further growth (Nguyen *et al.*, 2015).

Coffee is one of the most value traded commodities in the world (Ghoshray, 2010) in general and also Vietnam in particular. In Vietnam, coffee export is now one of the vital agricultural export products of the Vietnamese economy. It ranks second in earning export value for the nation (after oil) (Nguyen *et al.*, 2015). Vietnam's coffee export has been estimated at 1.6 million tons, a turnover of over more than \$3 billion, which makes Vietnam become one of the world leaders in exporting coffee, the second largest only after by Brazil (Ha and Shively, 2008). However, the gap between Vietnam and Brazil is still considerable in both market share and export volume. Brazil exported about 2 million tons in 2014 while Vietnam exported less than half of that (around 860,000 tons) (Nguyen *et al.*, 2015). More importantly, Brazil focuses mainly on Arabica coffee which has a high value and quality making them very competitive in the global market. On the other hand, Vietnam exports primarily Robusta coffee, which has a low value and quality – leading to low competitiveness. Vietnam exports both Arabica and Robusta coffee but it is known as the biggest Robusta coffee bean exporter in the world (with 43% of the market share) and this accounts for 90% of Vietnam's coffee (Nguyen *et al.*, 2015).

Identifying factors that have influence the export performance is an important component of export management, particularly in coffee sector. This process can be characterized by internationalisation strategies of firms which are beneficially influenced by a variety of network relationships, and in which entry into markets can each have a different web of factors (Ganotakis and Love, 2012). Numerous approaches and methodologies from various studies have been dealt in isolation by focusing mainly on single factors affecting the determinants of export performance, such as: export motivation (Wood *et al.*, 2015), export problems, firm size and performance (Wagner, 2012; LiPuma *et al.*, 2013), and management's personal characteristics, there has been a failure to test simultaneously the full set of organisational factors against the full range of export dimension (Kedia and Chhokar, 1986; Leonidou, 2011; Ganotakis and Love, 2012; Serra *et al.*, 2012; Kahiya *et al.*, 2014). Clearly, understanding the export problems has become essential for export managers. This article therefore aims to contribute to the diversified literature on the factors influencing the propensity to export by offering a comprehensive and insightful analysis of all the factors affecting the export performance of one specific commodity, namely Vietnamese coffee.

Bayesian belief networks (BBNs) is a graphical model that presents the causal relationships between the variables with their conditional probabilities (Landuyt *et al.*, 2013). It provides a useful way of dealing with complex problems because of its capability to combine the robust probabilistic methods with the lucidity of graphs that encode causal relationships between variables (Martins and Maturana, 2013). It also can be used to represent dependencies among variables, to give a concise specification of a joint probability distribution, and represents the complex interactions and causal relationships between variables in terms of their individual probability densities and their dependencies as defined by conditional probability tables (CPTs) (Ge *et al.*, 2014), the information of which can be collected from empirical data, expert (domain) knowledge or predicted from bottom-up model outputs (Duespohl *et al.*, 2012). Bayesian belief networks (BBNs) are modelling tools; it has been successfully used and in many real-world problems such as natural resource management (Gawne *et al.*, 2012; Vilizzi *et al.*, 2013), project management (Mengersen *et al.*, 2012; Khodakarami and Abdi, 2014), industrial system (Kisioglu and Topcu, 2011), ecosystem service (Landuyt *et al.*, 2014), environment management (Aguilera *et al.*, 2011; Tang *et al.*, 2016), business performance (Khodakarami and Abdi, 2014; Büyüközkan *et al.*, 2015), and medical and forensic sciences (Andersson *et al.*, 2013; Ge *et al.*, 2014; Velikova *et al.*, 2014). BBNs is therefore appropriate for a testable model that is imperially tested in order to explain which factors are associated with export propensity in Vietnamese coffee sector.

## METHODOLOGY

### Bayesian Belief Networks

A Bayesian belief network is a type of decision support system based on probability theory which implements Bayes' rule of probability (Kisioglu and Topcu, 2011). This rule shows mathematically how existing beliefs can be modified with the input of new evidence (Neil *et al.*, 2001). It not only allows decision makers to make inferences on different variables in the network based on the information about other variables in the network, but also provides a framework for graphically representing the logical relationships between variables and capturing the uncertainty in the dependency between these variables using conditional probabilities (Martins and Maturana, 2013).

It is the basis for the popular inversion formula for belief updating from evidence (B) about a hypothesis (A) using probability measurements of the prior truth of the statement updated by posterior evidence

$$P(A|B) = ( P(B|A) * P(A) ) / P(B)$$

where A is the hypothesis, B is the evidence, and  $P(x|y)$  is the conditional probability of x given y.

It is derived by the use of the joint probability definition:

$$P(x, y) = P(x|y) * P(y) = P(y|x) * P(x)$$

that is then arranged as:

$$P(x|y) = P(y|x) * P(x) / P(y)$$

where  $x = A$  and  $y = B$ .

BBNs best met our modelling needs because of the following advantages. First of all, having missing data in the data set does not make any problem for BBNs. Samples with incomplete data can be fixed by adding or integrating the probabilities over all possible values of the variable. Second, causal relationships are identified by applying a BBN. Thus, BBN makes it easier to understand the problem domain and estimate the results. Another advantage of BBN is that building a model does not consume time and need much effort. The structure of the network is developed, and then, it is easy to add new variables to the model. Finally, BBN is a combination of both a data set and users' prior knowledge; so, the model, constructed through BBN, is sufficiently dependable (Kisioglu and Topcu, 2011). Therefore, we selected a BBN model approach to consider the factors influencing the propensity to Vietnamese coffee export.

### **Data collection**

All the data, used in this study, are collected from series workshops and in-depth interview with number of experts who are representative of coffee export firms as well as specialists in coffee export (conducted in central highland of Vietnam).

The final CLDs were then converted into a BBN using NETICA™ software (Corp, 2015) by indicating states for each variables and populating conditional probability tables (CPTs). The stages are probable conditions of variable in the real world. These were initially determined using the information obtained from the survey, opinion of experts and researchers in coffee sector. Almost all notes were assigned with binary states representing the most positive and negative expect levels. The CPTs were populated using survey data. In case where survey data were not available to populate CPTs of some notes, expert opinion based on best judgement and theoretical calculation of probabilities for each state to occur were used to populate the CPTs.

A workshop with key representative of different stakeholders in coffee supply chain was conducted in the central highland of Vietnam to review the BBNs structure. In this workshop, all the participants were together to examine the graphical structure, names of the notes and states, and CPTs of the variables of BBNs. After finalizing the structure of the BBNs and examining the probabilities, the participants were then asked to discuss and fill in the condition

probability tables (CPTs) of selected nodes in the model that could not be populated with the survey data but for which they had expertise.

Finally, the BBNs model was used to carry out simulation test and scenario analyse to identify highly important factors influencing to the competitive advantages in whole coffee supply chain. Interventions in the complexity of coffee supply chain then were implemented so that relatively small actions can have large impact of whole coffee chain to enhance the competitive advantages of Vietnamese coffee product.

### **Sensitivity analysis**

A sensitivity analysis was undertaken on each BBN using Netica software. Sensitivity analysis is used to determine the relative influence of a single variable (node) or array of nodes on another variable in the network and is an important process in model testing, understanding the influential pathways through the developed BBNs (Leakey and Simons, 1997), results of sensitivity analysis are expressions of entropy reduction. In the context of this study, identifying important determinants of coffee export.

Entropy reduction is interpreted as the amount of entropy or uncertainty at an output node or variable, which is expected to be eliminated if the true value of another variable is known. In symbolic form, entropy is expressed as  $I = \sum_q \sum_f P(q,f) \log[P(q,f)/P(f)]$ , where  $q$  is the state of the query variable  $Q$ ,  $f$  is the state of the findings variable  $F$ , and the summation is over all states  $q$  and  $f$  of the variables  $Q$  and  $F$ . The higher the entropy reduction value, the greater is the influence of a particular factor on the factor under investigation.

## **RESULTS AND DISCUSSION**

The BBN model was constructed based on knowledge of Vietnamese coffee experts and prior analysis. The completed model is shown in Fig.1 and the beliefs are shown for each node in the form of the belief bars. These represent the initial beliefs (presented as probabilities) about the determinants of coffee export activity in Vietnam as evidenced by the data used. The general sensitivity analysis results of this model are presented in Table 4 and the nodes are ranked in according to the degree of influence of their findings on the outcomes of the coffee export activity node calculated as a measure of mutual information or variance reduction (expressed as a percentage).

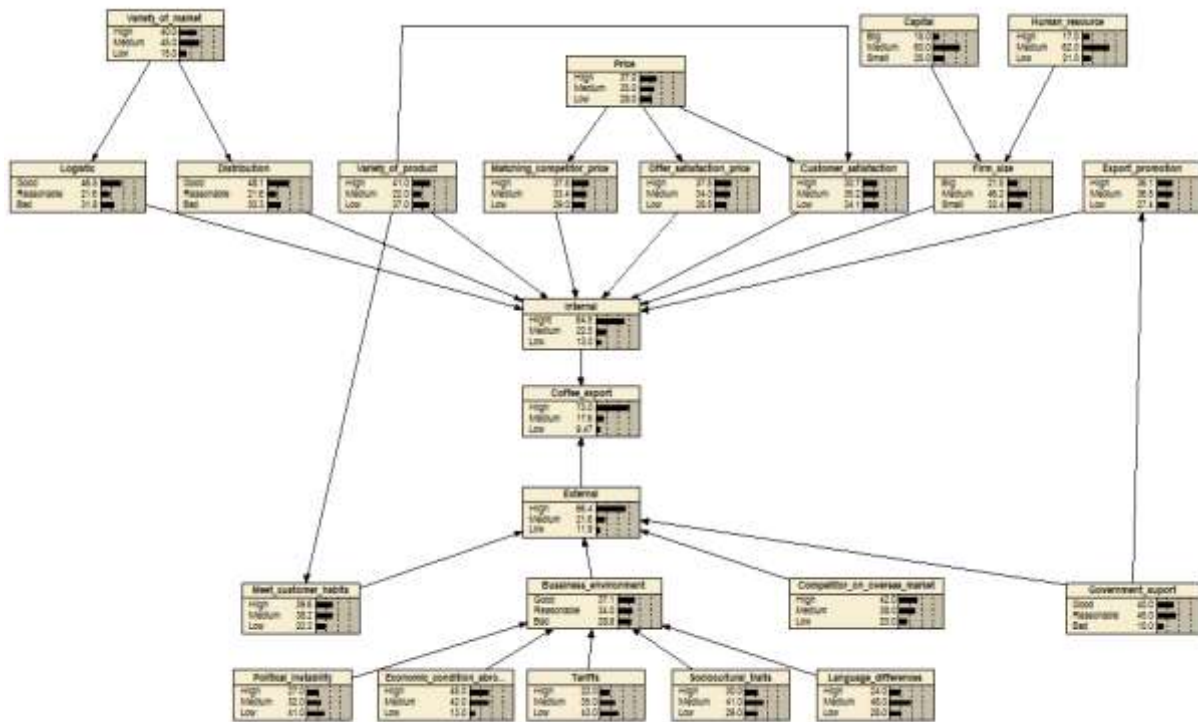
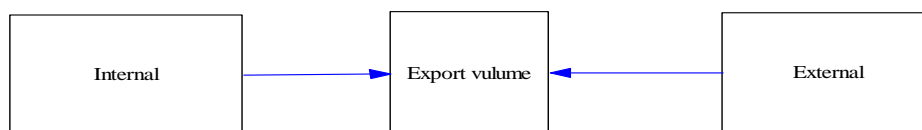


Figure 1: BBN model of coffee export in Vietnam

**Analysis of factors by group**

Over recent years Vietnam has encountered a large number of factors affecting directly the coffee export propensity that can be classified in two main categories: **internal**, which consists of barriers associated with organisational resources/capabilities and company approaches to export and **external**, which includes the factors stemming from the home and host environment within which the firm operates



A sensitivity analysis of two group factors affecting directly the Vietnamese coffee export reveals that the internal factor has higher influence on propensity to export than external factor with 9.61%, and 3.03% respectively (see Table 1).

**Table 1: Sensitivity analysis of Coffee export to a finding at Internal and External node**

Node	Mutual Info	Entropy reduction (%)
Internal	0.1294	9.61
External	0.0408	3.03

### Internal factors

Sensitivity analysis the key factors in the internal factor group (see table 2) revealed that logistic, customer satisfaction and firm size are highly important factors that impact to Vietnamese coffee export activity, while other distribution and export promotion have the least impact.

**Table 2: Sensitivity analysis for influencing factor on internal factor of Coffee export**

Node	Mutual Info	Entropy reduction (%)
Logistic	0.007565	0.594
Customer satisfaction	0.002519	0.198
Firm size	0.002053	0.161
Matching competitor price	0.001478	0.116
Offer satisfaction price	0.001435	0.113
Variety of product	0.001205	0.095
Distribution	0.000836	0.066
Export promotion	0.000275	0.022

### External factors

Finding from the sensitivity analysis of external factors discovered that (see table 3) the key factors influencing on Vietnamese coffee export activity are business environment and customer habits.

**Table 3: Sensitivity analysis for influencing factor on External factor of Coffee export**

Node	Mutual Info	Entropy reduction (%)
Business environment	0.010220	0.827
Meet customer habits	0.005699	0.461
Government support	0.005535	0.448
Competitor on overseas market	0.004836	0.391

### Analysis of factors in general

The model generally manifests the complexity of the interactions between internal and external factors that can influence export activity.

A sensitivity analysis of the factors affecting the Vietnamese coffee export in general reveals that the logistic system is the most significant factor causing the largest entropy reduction in the Vietnamese coffee export activity (see Table 4). The business environment also shows a strong conclusive influence on Vietnamese coffee export with 3.89%, followed by the factors of meet customer habit, customer satisfaction, firm size, and variety of product with 3.45%, 2.97%, 2.60%, and 2.59% respectively. Government support, competitor on overseas markets,



matching competitor price, offer satisfaction price, and distribution each result in less than 2% entropy reduction with export promotion having the least influence with a value of 0.50%.

**Table 4: Sensitivity analysis of Coffee export to a finding at another node**

<b>Node</b>	<b>Mutual Info</b>	<b>Entropy reduction (%)</b>
Logistic	0.00116	8.56
Business environment	0.00052	3.89
Meeting customer habits	0.00046	3.45
Customer satisfaction	0.00040	2.97
Firm size	0.00035	2.60
Variety of product	0.00035	2.59
Government support	0.00027	1.97
Competitor on oversea markets	0.00026	1.95
Matching competitor price	0.00023	1.73
Offer satisfaction price	0.00023	1.68
Distribution	0.00015	1.14
Export promotion	0.00007	0.50

Logistic, which is one of the internal factors, is the most influence factor on Vietnamese coffee export activity (Table 4). This can be explained that logistic is necessary for most coffee product because coffee production and consumption are not usually synchronized. It is accumulated whenever coffee production exceeds consumption and then is drawn down whenever coffee consumption is greater than production through inventories. In addition, logistic is also critical in securing a constant flow of coffee products to the host market, in achieving timely delivery, and in maintaining coffee quality at high levels. Therefore, the propensity for export of coffee enterprises is focusing to the markets where their warehouses and foreign channels of distribution are available.

Business environment is the second most influential factor determining the Vietnamese coffee export. This factor is influenced by economic conditions abroad, political instability in foreign markets, tariffs, sociocultural traits, language differences, and country rules and regulations. Some oversea business environments are plagued by political instability caused by economic (low per-capita income, inflationary trends), societal (religious fundamentalism, ethnic tension, high degree of corruption), and political (authoritarian regime, conflict with neighbours, military control) factors. Such instability can jeopardize seriously the coffee exporter's operations abroad in a number of ways, such as the closing/suspending of activities, or the prohibition of repatriation of earnings. Business environment usually is a subject to rapid changes and is very difficult to predict and control. Therefore, Vietnamese coffee export enterprises tend to export their coffee product to the oversea markets where good economics condition and political stability have, such as; Japan, Belgium, Germany, and USA.

Meeting customer habits has a moderate impact upon coffee export propensity in Vietnam. It is possibly true to say that coffee consumers cannot only receive what coffee company produces and delivers, but they also can directly and indirectly influence the operations and outcomes of coffee enterprise. However, customers living in different countries with different income levels and habits have clear differences in coffee product preferences, price acceptance levels, and methods for making a cup of coffee. Therefore, coffee exporters' products should

be meet requirements of customer habits in different markets especially the quality of coffee export products.

Another aspect that was evaluated was customer satisfaction. The satisfaction has potential influence on consumer behavioural intentions and customer with a product or service (McColl-Kennedy, 2015); it has also been the subject of much attention in the literature (Shiau and Luo, 2012; Yoon *et al.*, 2013). It is described as “an evaluation of an emotion”, suggesting that satisfaction reflects the degree to which a consumer believes that the possession and/or use of a service evokes positive feelings (Hunt *et al.*, 2012). In the case of Vietnamese coffee, customer satisfaction is the most efficient and, at the same time, least expensive source of market communication, as a satisfied consumer will tell others of his satisfaction and recommend the Vietnamese coffee product to potential customers in the international markets.

Firm size is also a key determinant of export propensity for Vietnamese coffee enterprises. Most researchers agree that larger coffee export companies have greater export propensity than smaller ones because the larger enterprises have better resources (such as human, market information or financial resources), can be overcome such initial cost barriers as gathering coffee market information or uncertainty of a foreign coffee market (Leonidou, 2011; Kahiya *et al.*, 2014), and can produce cheaper coffee products for international markets (Serra *et al.*, 2012) while smaller firms perceive more coffee export barriers than larger firms. It is likely that many small coffee firms view international business as a risky investment for allocating their limited resources. Thus, larger coffee firms will have a higher export propensity (i.e., be more likely to export) than will smaller firms in the coffee industry.

Variety of product is the sixth most influential factor determining the Vietnamese coffee export. It is possibly true to say that coffee products in Vietnam are generally less variety than in the other largest export coffee countries, at least until recently. In Vietnam, the enterprises which have better product variety may have greater driver and ambition to generate greater export propensity. Given this environment the role of product within Vietnamese coffee enterprises is seen to play a significant role. The extent to which this will be maintained in the future depends upon its success of breaking down resistance to change. Since coffee product is a factor influencing export propensity, it is recommended that in production stage. Vietnamese coffee companies can compete successfully in niche export markets if they change the way in which coffee is produced via improving production technologies to increase the variety and quality of the product, and developing new products for specific foreign markets, meeting export quality standards and packaging, adapting export product design/styles.

The influence of government support is also notable. The Vietnamese government has the role in supporting the businesses and boost coffee exports in each market, settlement of disputes, warning of the risks, helps businesses peace of mind when doing business in the local markets. In addition, Vietnamese government can also stimulate export activity by providing relevant information of international coffee markets, or it can legislate attractive tax incentives programs. Therefore, this factor should at least be considered as potentially important for firms in the export propensity in different international environments.

Competitor on oversea markets has a moderate impact upon coffee export propensity in Vietnam. It is one of the severe problems faced by coffee export firms because competitors in different markets with different strategies and customers have clear differences in coffee products, price offer levels, distribution systems, and methods for making a cup of coffee. Vietnamese coffee export enterprises want to survive and develop to win against competitors



they should focus not only in terms of pricing, quality, credibility, but also to adopt niche markets as the most viable strategy to compete abroad. Therefore, the Vietnamese coffee exporters must always know to build themselves a strong brand, also reasonable on prices, increase the quality of coffee product. It is a great success for coffee export.

Matching competitor price is a moderate influential factor determining the export propensity of Vietnamese coffee. Several studies investigating trends over the past century have found that competitor price correlated well with export propensity (Filipe Lages and Montgomery, 2004). Through coffee exports, Vietnam have joined in the competition on price in the international market. This competition requires Vietnamese coffee enterprises to reorganize production, formed the structure of production has always adapted to the market. Coffee production should be meet the market demand via reduced coffee export price.

Offer satisfaction price is also an influential factor determining the export propensity of Vietnamese coffee. The coffee export price influences on the importer's buying decision process because price has the capability of attracting or repelling coffee product, especially since price functions as an indicator of coffee quality. If the price is high, customers are likely to expect high coffee quality, or it can induce a sense of being "ripped off." Likewise, if the price is low, customers may question the ability of coffee exporters to provide high quality of coffee products. Moreover, due to the competitiveness of the coffee industry, customers are able to establish reference prices. Therefore, the coffee price offering for the export needs to be in accord with what the customer expects to pay.

In this study, distribution was the factor which was less sensitive to coffee export propensity than other factors above. However, it is considered to be one of the major challenges facing coffee exporters in Vietnam. This obstacle can be explained by (1) complex foreign distribution channels because the distribution channel is different not only between the home and host countries, but also between overseas markets; (2) accessing coffee export distribution channels are difficult due to the fact that some channels of distribution are already occupied by other coffee competitors; and (3) obtaining reliable coffee foreign representatives. It is very hard to find foreign representatives who would meet the structural (financial strength, facilities), operational (product assortment, logistical arrangements, coffee warehouse facilities), and behavioural (market reputation, relationships with government cooperative attitude) requirements of the exporter. Therefore, to increase the distribution ability, Vietnamese coffee export companies should: (1) address the complexity in foreign distribution channels by adjusting their distribution; (2) find ways to bypass the difficulty in accessing export distribution channels by seeking the assistance of international coffee export management companies which already have established distribution systems or have set up direct coffee distribution channels to consumers; (3) obtain reliable foreign representation by attracting both traditional and new representation through offering higher profit rates.

The promotion is not a very strong factors in this study, it had the least influence on coffee export propensity. This can be explained that almost all the Vietnamese coffee export enterprises have limited promotional resources and low levels of competition. Coffee marketing efforts must therefore be judiciously targeted and professionally developed. The most efficient approaches focus on relationship building, such as exporter and roaster visits and trade shows, rather than on non-targeted advertising. Some useful promotional strategies such as E-Trade and business development, internal consumption campaigns, and market information systems should be applied in the coffee trade.

## CONCLUSION

In this analysis, we have demonstrated a novel approach to analyse coffee export propensity. A BBN model was developed in the assessment framework for the ranking and selection of the factors influencing on the coffee export propensity (i.e, internal and external). Sensitivity analysis was used to identify key parameters or key management interventions that need to be determined accurately and from a monitoring and adaptive management perspective. Logistic, together with business environment, meeting customer habits, customer satisfaction, firm size, and variety of product were the most influential factors explaining coffee export propensity of Vietnam. Of particular importance is that the BBN approach provides the means of combining and reasoning about data from different sources and scales. Despite the inherent limitations and errors, the model was highly accurate and has enabled the complex coffee export strategy to be conceptualized and integrated in order to identify key factors specific to international markets of the Vietnamese coffee product. As to future research, the BBN can still be developed further into a dynamic model that takes into account temporal variations in Vietnamese coffee competitors and environmental policies in oversea markets, which could be useful in dynamic export risk assessment.

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