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Impact Of Imports And Exports On Employment Generation And Corporate Operations: Application Of A Bayesian Network In The Textile Sector

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Abstract:
Background*: The Brazilian textile industry, historically vital for economic development, generates approximately $51.58 billion in annual revenue, ranking fifth globally in industrial production (2.4% of the total). It plays a significant role in employment despite being dominated by small and medium-sized enterprises. However, the it currently faces, particularly in the municipality of São Bento-PB, severe threats from textile imports. Understanding the impact of these imports on production and employment is crucial to support sustainable development and effective public policy.*
Materials and Methods*: The research question focuses on the influence of imports and exports on job creation and the performance of textile companies in São Bento-PB. The objective is to implement a BN model estimating this influence. The descriptive research methodology involves a BN structure using quantitative and qualitative approaches. Data from the internet about São Bento-PB, obtained from three databases, forms the sample. The RB construction uses Netica software. The RB model comprises 6 nodes representing variables like imports, exports, employment behaviour, active companies, and average population salary*.
Results*: The RB inference yielded 500,050 distinct conditional probabilities. The node parameters, influenced by others, initially configured as follows: imports 20.0, exports 20.1, employment behaviour 20.1, active companies 19.9, and average monthly salary 20.0.*
Conclusion: *It seems that increased imports negatively impact the city's economy, leading to reduced employment and average salaries. Importantly, rising imports also challenge local businesses, hindering their competitiveness against domestic products. Conversely, simulations reveal that increased exports have a positive influence on job creation.*

Key Word*: Textile Industry; Imports; Employment; Bayesian Networks.*

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I. Introduction

The textile industry was one of the earliest productive sectors in Brazil, holding significant relevance for national economic development. The Brazilian textile sector is crucial for the country's economy, generating annual revenues of approximately $51.58 billion, resulting in thousands of jobs, even though it is largely composed of small and medium-sized enterprises (Neto et al., 2021). The country ranks fifth in the global industrial production command scale, accounting for 2.4% of the total produced, lagging only behind countries such as China, India, the United States, and Pakistan (Bezerra, 2014).

Within the regional context, transformation industries in the textile sector play a crucial role in job creation. For instance, in the city of São Bento-PB, this sector serves as the primary source of income, representing a substantial portion of employment per capita. As Miranda (2019) assures, about 80% of the available workforce in the city is allocated in the textile industry. The municipality boasts a very low unemployment rate, possibly attributed to its involvement in the entire textile production process, from cotton cultivation to the commercialization of finished products.

However, this sector's growth has become threatened by the high numbers of textile product imports, which surged in the 1990s with the increase in Brazilian commercial openness (Rios, 2018). The entire textile industry, including that of São Bento-PB, may have been impacted by the importation of sector-related products. Therefore, understanding the impact of these imports on local sector production and employment through a parametric method that reveals previously unnoticed information is necessary. Such insights would provide local managers and public administration with tangible data to aid them in decision-making.

A model capable of providing probabilistic information on the aforementioned issues, derived from previous data input, is the Bayesian Network (BN) models. These models deal with uncertainties from the environment, aiding decision-making. According to Costa (2013), BNs enable a graphical representation of probabilistic scenarios, facilitating decision-making and problem resolution.

Thus, this study focuses on the following research problem: What is the influence of imports and exports on job creation and the performance of companies in the textile sector in the municipality of São Bento-PB? To address this question, with the assistance of a parametric probabilistic model, the study aims to develop a Bayesian Network model capable of estimating the influence of imports and exports on job creation and the performance of companies in the textile sector in the municipality of São Bento, State of Paraiba, Brazil.

As a path to achieve the study's overall objective, the following specific objectives were outlined: a) gather information on imports, exports, employment behaviour, active companies, and average salary from available databases; b) standardize the collected information for a model capable of being implemented and executed in a Bayesian Network structure; c) develop the Bayesian Network incorporating all the gathered information through an application focused on BN development and analysis; and d) conduct simulations in the network, identifying the influence of imports and exports on job behaviour and the performance of textile industry companies in the municipality of São Bento-PB.

II. Theoretical Framework

Industrial production has undergone various changes over the years, adapting to market needs, where the current focus is on developing technological changes to better implement business techniques. According to Rodrigues (2019), it is the responsibility of companies to implement technological innovations and thus ensure a competitive advantage in the market. The state's role is to ensure favourable conditions for capital investment and studies in the creation of new technologies and products.

Within industrial production, the textile industry stands out, particularly in the Sertão of Paraiba, specifically in the municipality of São Bento-PB, producing and selling approximately 12 million hammocks annually. This product is the highlight of the city, making it one of the largest manufacturers of hammocks in Brazil (Miranda, 2019). The city also produces blankets, rugs, bath towels, necessary inputs for hammock production, and other textile articles.

Carneiro (2014) notes that previously, hammocks were manually woven, and artisans had complete control over what, when, and how much would be produced, considering their needs. Factories were in their backyard, and products were made for family use, with non-commercial production. Eventually, the need for new machinery arose to enable large-scale production and, thus, expand product marketing.

The region has good availability of local suppliers for inputs such as cotton threads, dyes, and parts and accessories for looms, characterizing the main materials for product production. The finished products were sold through market traders who travelled to other regions, distributing the municipality's production of São Bento-PB, contributing to local industrial growth (Carneiro, 2014).

Over time, technical means were gradually introduced into hammock production. Consequently, product sales expanded to other cities in the Brazilian Northeast. In the 1990s, the city consolidated mechanization in production. As a result, products reach a larger territory. Currently, the products are sold in all states of Brazil and most countries in South America, as well as being exported to some European, African, and North American countries. Thus, São Bento, in the state of Paraiba, has become popularly recognized as the world capital of hammocks (Carneiro, 2014).

As a form of incentive for local textile production, the city's public administration created an exhibition event titled "EXPO TÊXTIL." This event follows the format of a business, culture, and entrepreneurship fair, aiming to showcase articles produced in the municipality (ASCOM, 2018). The event involves the participation of local industries, suppliers of inputs, and representatives from local legislative and executive powers. According to ASCOM (2018), the event's realization provides greater development for the local industry by increasing visibility within the national and even international scene, as all promotion occurs through social media and specialized sector websites. All these actions can contribute to the expansion of the local population's income, directly contributing to increased job creation.

The Brazilian textile industry has always presented high numbers in terms of the number of people employed in the sector, owing to being one of the pioneering sectors in the country's industrial formation. To this day, the sector continues to report high numbers. According to Bezerra (2014), the Net Operating Revenue (ROL) of textile industry sales amounted to R$ 40.6 billion in 2013 alone. Concentrating most of its production in the Southeast (52.2%) and South (28.3%), the Northeast region accounts for 15.6%, being the third region with the greatest participation in the sector.

In a local context, the municipality of São Bento-PB, with the textile industry as its main source of income, presents a significant employment figure for its inhabitants in the sector. According to Miranda (2019), approximately 80% of the available workforce in the city is allocated in the textile industry. This is due to the

municipality being involved in the entire cotton production process, from planting to wholesale and retail sales of the finished product. With involvement throughout the sector's production arrangement, a large number of jobs, both direct and indirect, are generated in the region. Despite this performance, the sector has some concerns about competition from imported textile products, especially those of Chinese origin.

The international trade of goods allows for a dual analysis from a macroeconomic perspective. On the one hand, imports reveal the country's dependence on products with high technological content. On the other hand, exports demonstrate the country's pattern of commercial integration on the international stage and also indicate the level of national technological capacity in launching new products abroad (Chiarini & Silva, 2016).

Importation occurs when a country acquires a specific product or commodity from another, either for its own consumption, production, or commercialization. This activity provides a competitive advantage for entrepreneurs as it fills the gap in high technology products in the country. According to Silva et al. (2018), in the process of continuous international commercial expansion, imports have gained significant prominence, being an activity with high presence in Brazilian organizations, especially for manufactured products.

The participation of each group has not varied much in the last decade. Products with higher participation in Brazilian imports are manufactured products, accounting for over 80% of the total imported, while basic products correspond to 15% of imports, and semi-manufactured products have a percentage below 5% of the total imported (MDIC, 2019).

In the country, there is a high importation of products with high technological content, even in periods of economic crisis, this participation continues with high indices. This can be seen as a delay in the national manufacturing industry, or it can be considered that these imports fill a significant gap in the country's industries, allowing national companies to demand technology in internal production processes quickly and less expensively. Regarding Brazilian exports, for years, these were based on the export of basic products (Magalhães, 2018).

According to information from MDIC (2019), from 2009 to 2019, manufactured products showed a decrease in participation, while basic products exhibited a growing trend in the country's exports. For Magalhães (2018), one of the factors that triggered this change was the price of commodities, which showed a currency advantage for most of this period. The Brazilian commodities market quickly adapted to global changes in supply and demand, presenting a competitive balance between price and quantity. It is important to understand how the country's global commercial opening of the trade balance occurred to grasp a little about the local context of the municipality of São Bento-PB.

With the implementation of commercial opening in the country in the 1990s, companies needed to readjust, and consumers began to have access to a variety of previously unavailable products. However, the lack of competitiveness in the national industry led to the closure of many companies and consequently resulted in the reduction of jobs in various sectors such as textiles, footwear, and auto parts (Gremaud, Vasconcelos & Toneto Junior, 2018).

The lack of competitiveness in the textile industry caused the sector to be strongly affected by commercial opening. Companies that were more competitive were leaders in the sector, and the vast majority were less competitive companies that had a significant share of the national market. As Rios (2018) reports, in 1990, companies focused on the domestic market, with only 2% of production destined for the foreign market. This created a competitiveness problem, as more qualified companies perform better in foreign markets, leading to better internal competencies, surpassing competitive advantages focused solely on lower prices without quality standards (Cruz, Busso & Iacovone, 2018; Repezza, 2013).

As a form of restructuring, Brazilian textile industries began to import, in significant quantities, fibres that met international quality standards as a way to resume competitive production. In 1995, the sector began to compete directly with the international market, especially in the intermediate and final segments of the production chain. Despite this, the profits of medium and small companies decreased significantly due to the decline in the number of production units and the reduction of jobs (Rios, 2018).

In light of all the aforementioned issues, it is necessary to use a parametric model that can confront information from different data sources, connecting the behaviour of imports and exports with employment behaviour. A model capable of presenting solutions based on a probabilistic understanding is the models developed by Bayesian Networks (Jing et al., 2018), which will be presented below:

Bayes Theorem

The Bayes' Theorem, also known as Bayes' Law or Bayes' Rule, was defined through a suitable equation capable of making probabilistic estimates of the occurrence of an event based on conditional prior information relevant to the studied event (Tommasi, Ferrara & Saggino, 2018). The initial appearance of Bayesian theory was in the publication of the journal by Reverend Thomas Bayes between the 1750s and 1760s. Bayes' empirical technique was combined with the classical technique of Robbins' research in the 1980s and 1990s. From this point onwards, Bayesian Networks (BNs) are employed in research and studies on artificial intelligence (AI), with the

aim of refining probabilistic reasoning. The Bayesian model has become one of the most widely used methods for reasoning under uncertainty in various fields of knowledge (Jing et al., 2018).

With the continuous deepening of the Bayesian model and the improvement of its level of implementation, the method began to be simulated through graphical illustrations, employing probabilistic knowledge, sometimes surpassing rule-based models based on evaluations and computational problems. BNs are frequently used in academic environments. Their main attributes stem from a tangible theoretical foundation, a flexible learning structure, and an application pattern with a diversified reasoning capacity (Jing et al., 2018).

Initially, various concepts and theorems were introduced within the scope of the function. Understanding the method, it is observed that the prior probability alludes to the posterior probability, based on judgment from previous experience. In the posterior probability, events occur according to the possibility driven by the occurrence of one of the events. Conditional probability originates from the event of a specific episode "A," conditioned on the event of a specific episode "B," explained by the probability P(A | B) (Jing et al., 2018).

$$P(A|B) = \frac{P(A \cap B)}{P(B)} \tag{1}$$

Besides considering conditional probability, one must account for the occurrence of a possible event from a complete set of episodes, weighing the emergence of a positive probability. This will include episodes B1, B2, B3, and so forth. P(B) is established for any episode that occurs in "A" (Jing et al., 2018).

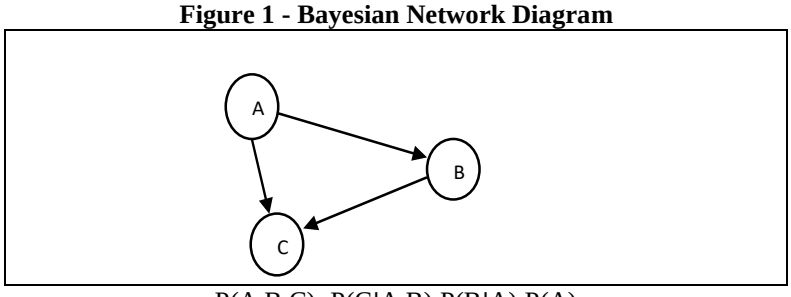
$$P(B) = \sum_{i=1}^{n} P(A_i) P(B|A_i) \tag{2}$$

From the understanding of the Bayes' rule and its development, it is possible to comprehend how these elements connect in a Bayesian probabilistic network model.

Bayesian networks are automated reasoning structures based on the laws of Bayes' probability theory, proving to be a significant tool for implementations in the field of AI. BNs can accommodate estimates that assist in the decision-making process amid uncertainties in the environment (Rappel et al., 2019).

BNs are composed of acyclic graphs characterized by conditional probabilities. The acyclic graphs are directed among their pairs, providing conditional dependence within a set of variables. The parametrization occurs through a conditional probability distribution. Every node in the graph (represented by a circle) must be parameterized by P(node | Pa(node)), where Pa(node) denotes the parent node in the graph. The following illustration presents a simplified BN (Jing et al., 2018).

Figure 1 - Bayesian Network Diagram



$P(A,B,C)=P(C|A,B)\cdot P(B|A)\cdot P(A)$

Source: Adapted from Jing et al. (2018, p. 2)

The organizational framework of a Bayesian Network (BN) is displayed in two stages; the first stage generates the network topology, while the second validates the network parameters (Jing et al., 2018). BNs exhibit a composition of conditional probabilistic arrangements. These arrangements are fed by insights provided by experts, which can be based on technical standards and/or the experiences of these professionals, as well as information from external data sources. BNs employ induction algorithms that are sufficiently accurate in estimating the probability of outcomes. BNs are developed using computational tools that accommodate the construction and execution of networks, facilitating the modelling of uncertainties inherent in the problem being addressed (Noyes et al., 2018).

Among the various computational tools for solving BNs, Netica from Norsys Software Corp offers numerous features, proving to be user-friendly and versatile, working with both BNs and influence diagrams. Netica provides an intuitive operational environment, easy to work with in BNs. After creating a model within the software, the knowledge and structure developed can be transferred to other BNs built on the same platform (Norsys Software Corp, 2019).

Adjustments to variables that are not relevant to the BN can be promptly extracted without altering the overall relationships. Probabilistic samples can be explored through simple operations involving the addition of causal influences, removal, or reconnection of network links. Other operations can be performed with mouse clicks, making the application suitable for the preparation, maintenance, and use of BNs (Norsys Software Corp, 2019). The development of the method, as well as the results analysis stage, will illustrate the tool's functionality more effectively.

III. Material And Methods

From the perspective of the research nature, it aligns with applied research, as it aims to identify a problem and find satisfactory solutions, intending to bring direct and immediate improvements to the environment. According to Michel (2015), applied research aims to transform the social environment, seeking to modify knowledge and improve the quality of life with new discoveries. Regarding the study's objectives, these align with a descriptive research model, as the direct participants in the study cannot interfere with the results; they should only analyse, interpret, record, and classify the obtained data (Andrade, 2018).

The structuring and modelling of the Bayesian Network (BN) will employ two approaches. The quantitative approach, called the learning criterion, will be derived from conditional probabilistic calculations in the existing relationship between the nodes that will compose the network; this approach will operate in the network simulations. The qualitative approach, termed structural knowledge, will consist of constructing and structuring the BN itself, configured from the interconnections of the network nodes within the graph configuration. The quantitative approach uses cause-and-effect relationships from the initial parameters obtained in the qualitative approach. These parameters will be sourced from secondary data (Efe; Kurt; Efe, 2018; Lee; Park; Shin, 2009).

The research sample relied on information available on the Internet about the municipality of São Bento, in the state of Paraiba, from the federal government's databases. To address the study's objective, five distinct variables were selected that proved capable of meeting the demands of this research. To obtain these five variables, the research relied on three databases.

The first variable relates to the number of active companies in the municipality, while the second variable is dedicated to surveying the average monthly salary of the population; both are available in the historical series of the Central Companies Registry of IBGE (2019). The third and fourth variables refer, respectively, to the number of imports and exports, year by year, in the study period. This information was collected from the MDIC database (2019). The fifth and final variable is the employment behaviour in the manufacturing industries in the municipality, which, according to Miranda (2019), the local textile industry accounts for approximately 80% of the workforce in the city. Information about employment balance, given by the subtraction of hires from layoffs, is available on the CAGED online page (2019).

Overall, some limitations were encountered in the data collection process. The IBGE (2019) databases provided information about the municipality, the study's scope, only for the period from 2006 to 2017. CAGED (2019) presents, in its historical series, information about the same municipality, for the period from 2000 to 2019. The Ministry of Industry, Foreign Trade and Services (MDIC, 2019) provides information about the city of São Bento/PB covering the interval between 2008 and 2018. To standardize and compare the data across databases, the decision was made to use the interval from 2008 to 2017, a significant time frame for analysis (10 years), allowing for a comprehensive yearly comparison across all databases.

Due to the distinct nature of the data obtained from different sources, standardization was necessary for the BN modelling. Using Microsoft Excel, a spreadsheet was constructed that presents the five variables with data for the period from 2008 to 2017. Adopting the five variables as elements (groups) within the spreadsheet, based on the calculation of PGRB (calculations performed in Excel), it was possible to obtain standardized values for each of the groupings.

$$PG_{RB} = \frac{EG_{RB}}{TG_{RB}} \tag{3}$$

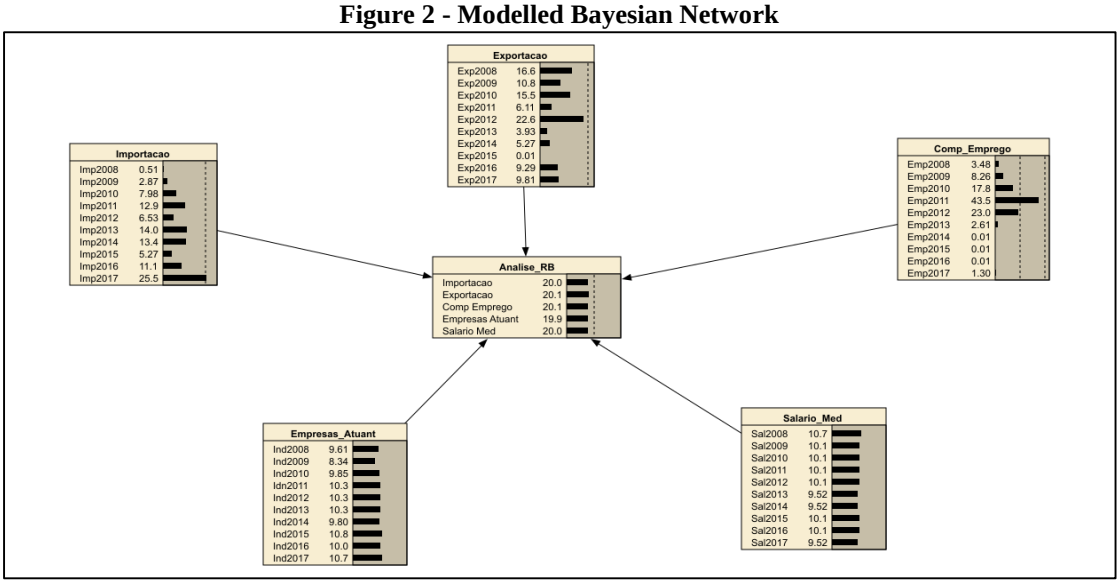
Enhancing the understanding of the calculation, PG_{RB} represents the standardization carried out on each of the variables that will comprise the group (node) of the Bayesian Network (BN). EG_{RB} corresponds to the non-standardized element (before treatment) belonging to a specific variable in the study. TG_{RB} is the total sum of non-standardized elements of a specific variable. The purpose of the calculation is to proportionally standardize each item within the variable so that the sum of all elements in the variable will be 1.

With the standardized data, the construction of the BN requires the use of software, and in this study, Netica from Norsys will be employed. This is a widely-used Bayesian network construction software globally, designed to be easily understood and reliable, exhibiting satisfactory performance in its internal calculations. Facilitating decision-making in business, engineering, or even medicine, the software is employed by numerous companies and government agencies worldwide (Norsys Software Corp, 2019).

IV. Result

The Bayesian Network (BN) modelled featured 6 nodes, accommodating the five variables of the study, namely: importation, exportation, employment behaviour, active companies, and average population salary. With the inputted data, the BN allowed the inference of 500,050 distinct total conditional probabilities. The illustration of the modelled BN can be observed in Figure 2. In the image, one can perceive the standardized values already affected by the initial calculations of the BN, arising from the connections generated in the structure. The node created for the BN calculation, named Analysis, comprises the other five nodes (nodes of the study variables). The parameters of the node, influenced by the others without initial triggers, exhibited the following configuration: importation 20.0, exportation 20.1, employment behaviour 20.1, active companies 19.9, and average monthly salary of 20.0.

Figure 2 - Modelled Bayesian Network



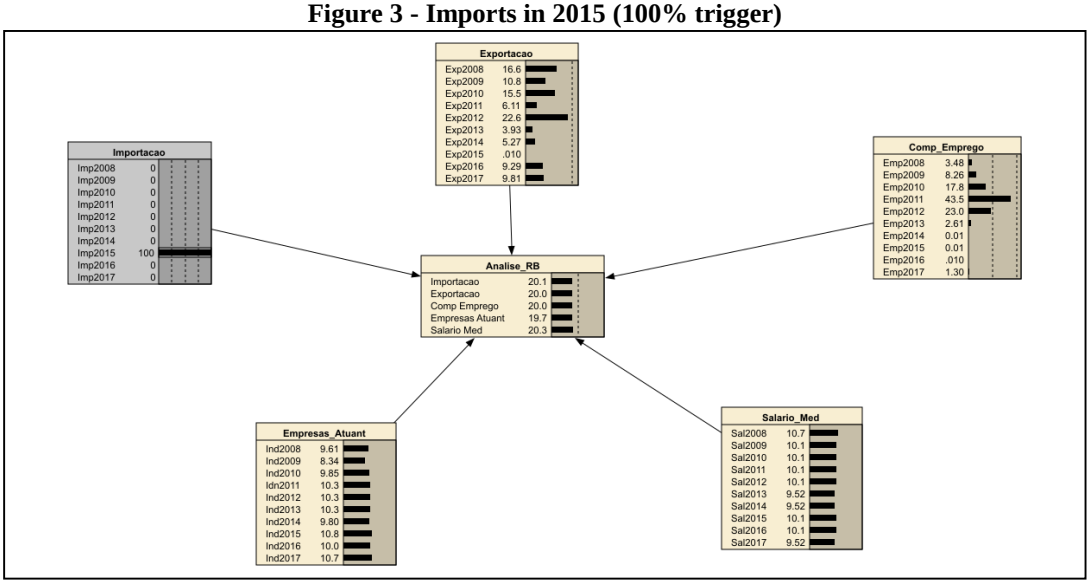
The Bayesian Network has a structure of an acyclic graph; the nodes simulate the input and output variables of the study, relating to each other and revealing the structural understanding obtained from the standardized information in the databases. These nodes are connected by arcs (connections). It is observed that in the Analysis node (using probability theory), the BN distributes probabilities among the parameters (in this case, the variables) so that the total is approximately 100%. This same logic is replicated in the other five nodes.

Due to the possibility of 500,050 inferences of distinct total conditional probabilities and the space available for the article's development, it will not be possible to observe and consequently analyse all probabilities. Therefore, the study aims to simulate a trigger in each of the five nodes representing the study variables. The choice for the period concerning each node will be made deliberately.

For the simulation stage, triggers were performed on the five nodes corresponding to the study variables; these nodes feed the node corresponding to the analyses. The trigger logic represents a possible certainty of the occurrence of the parameter (100% trigger of the item in the network). The first simulation was carried out by activating the node (variable) of imports in the year 2015 at 100%, seeking to understand the influence of imports in the chosen year on the other variables, as shown in Figure 3.

As observed below, with a higher incidence of imports in the year 2015, the average salary would increase to 20.3, while the export variable would decrease to 20.0 following the trigger. The employment behaviour would show a reduction, settling at 20.0, and the number of active companies would decrease to 19.7. Thus, it is noteworthy that with the increase in imports, employability in the sector would be negatively affected, as observed in the employment behaviour in the industries, as well as in the total number of active companies. According to Rios (2018), direct competition with the international market erodes the profits of medium and small national companies, causing a decline in the number of production units and, consequently, a reduction in employment.

Figure 3 - Imports in 2015 (100% trigger)



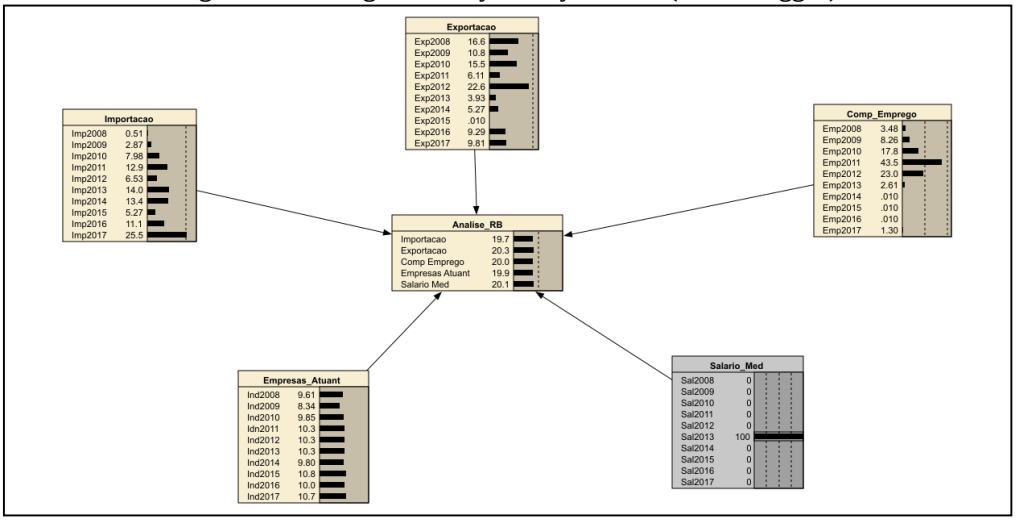
Based on previous information, the probability of the BN will be automatically adjusted, transforming into a powerful theoretical inference of probabilities. The most influential property of the BN is that the probability acquired at each step is reflected by science and mathematics. In other words, if there is sufficient prior knowledge about the addressed problem, it is possible to obtain a statistical sense based on this information, from satisfactory inferences derived from the BN (Jing et al., 2018).

As observed above, Bayes' theorem estimates the posterior probability of the incidence of an event, based on prior knowledge (in the case of simulations, it is the knowledge acquired from the databases), and the knowledge of the results of the specificity and sensitivity of the simulation. Based on these resources, it is admissible to estimate probabilistic inferences about the intended problem. The Bayesian probabilistic approach is, relatively, simple to handle and understand, even by individuals with little knowledge in statistics and mathematics (Tommasi, Ferrara & Saggin, 2018).

Using user-friendly software, it is possible to demonstrate the utility of applying a BN to a set of data, whether primary or secondary. A prerogative of the BN approach for a certain dataset is that the complex calculations involving a BN are now readily accessible through robust computational applications and platforms and, to some extent, manageable in terms of handling (Noyes et al., 2018).

In the second simulation, the parameter of Monthly Average Salary in 2013 was triggered (100% trigger). Observing the behaviour, year by year, of the Monthly Average Salary node in the BN matrix, it was noted that after a stabilization for four consecutive years (2009, 2010, 2011, and 2012) at 10.1, there was a decline in 2013, which was the chosen period for this specific option. The variable was triggered to analyse the changes that could occur with a potential increase in the average salary in this year. The effects can be observed in the figure below.

Figure 4 - Average Monthly Salary in 2013 (100% trigger)



In the event of a salary increase in 2013, the number of active companies would remain stable (19.9), exports would rise to 20.3, while imports would decrease to 19.7, and employment behaviour would decrease to 20.0. This could occur because industries might offer lower salaries due to the competitive market from abroad, leading companies to reduce production costs to compete with the prices of imported products. Rios (2018) reports that the immediate result of this change was the significant growth in imports from Asia, bringing synthetic fibre fabrics to the Brazilian market at a value 50% lower than domestically produced equivalents.

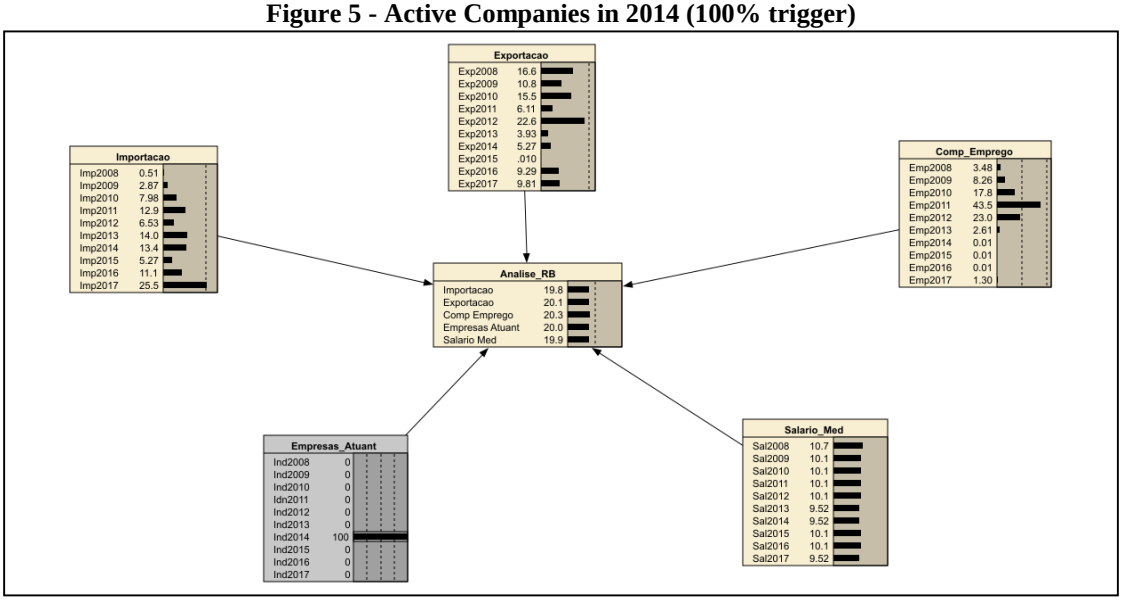
The Bayesian approach is an alternative assimilation procedure that allows for the computation of uncertainty modelling based on statistics of phenomena in an experiment. The results of RB inferences are obtained from probabilistic density calculations based on the parameters of interest. The results of simulations (as observed in the illustration above) are scientifically known as the posterior distribution in Bayesian nomenclature (Rappel et al., 2019).

An RB can compute the conditional probability of various parameters existing in the network (in the case of the simulations above, for any period existing in the network nodes). This promotes the assessment of probability variation through the occurrence of any of the parameters that can be simulated (Lee; Park; Shin, 2009).

With the use of RB, events in the researched environment can interact with each other. In other words, the probability of one event occurring can decrease or increase the probability of another event occurring (as observed in the simulation above). Based on these probabilities, managers can analyse event linkages, update probabilities, and mitigate uncertainties using RB (Efe; Kurt; Efe, 2018).

In the third simulation, the parameter of Active Companies in the year 2014 was triggered (100%), seeking to identify how the market would respond to a change in the year 2014, after three years of stabilization (2011, 2012, and 2013) of active companies in the sector, which were observed in the RB matrix. The results presented can be observed below.

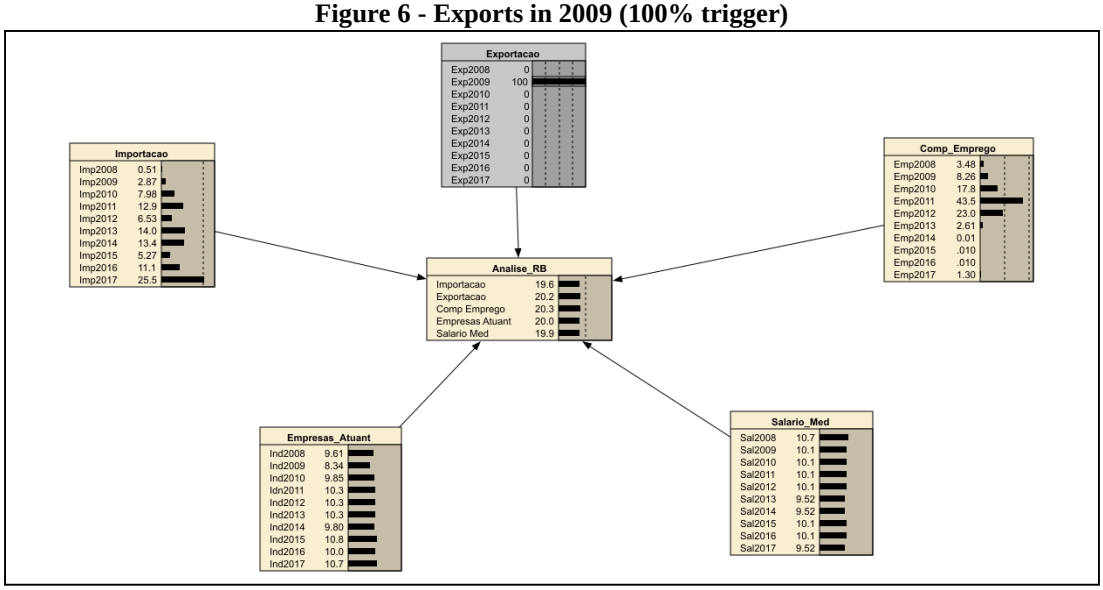
Figure 5 - Active Companies in 2014 (100% trigger)



With a potential increase in active companies in the year 2014, employment behaviour would rise to 20.3, imports would decrease to 19.8, exports would fall to 20.1, and the average salary would decline to 19.9. There is a positive trend in employability but a negative trend in imports, exports, and average salary. The rise in active companies, eventually impacting employment behaviour, may be due to the high demand for labour in the local manufacturing industry. According to Miranda (2019), the municipality of São Bento, PB, produces and sells approximately 12 million hammocks per year, making it one of the largest manufacturers of the product in Brazil.

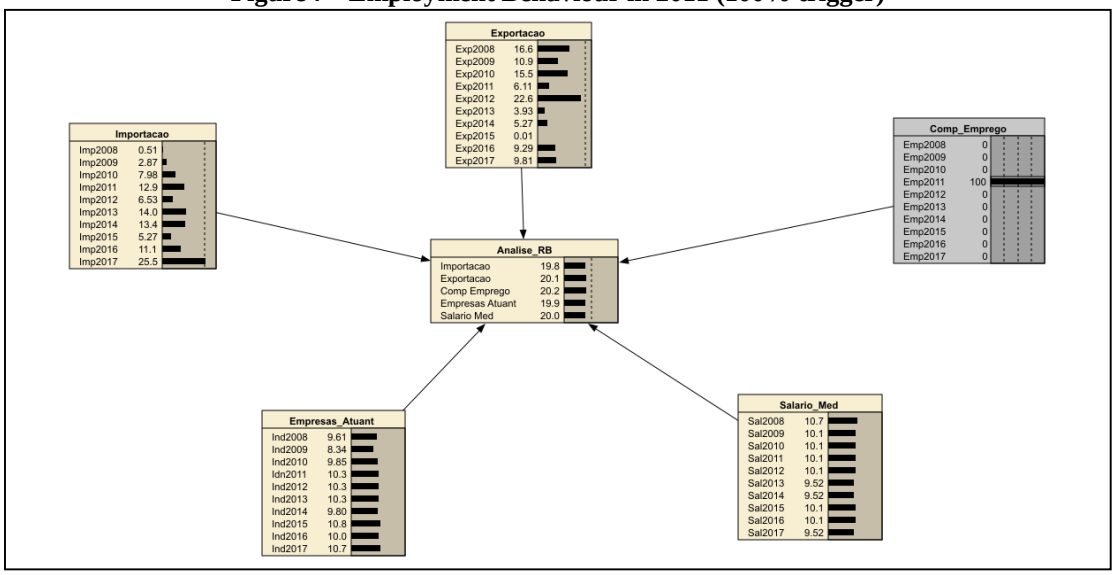
In the next simulation, the export variable for the year 2009 was triggered (100% trigger). The choice of this period is due to a decrease in exports followed by an increase in imports during the same period, as observed in the RB matrix. As seen in Figure 6, employment behaviour would experience a gain, reaching 20.3, while active companies would also show an increase (20.0). However, imports would decrease to 19.6, and the average salary would decrease to 19.9. Thus, it can be said that when exports increase, there is greater employability in the city but with a reduced average salary. According to Silva et al. (2018), the implications of intense economic globalization, with the increasing insertion of new enterprises and products, have modified the performance of companies in the market, intensifying competition among them. The availability of new technologies has led to a greater diversification of companies' portfolios, consequently reducing operational costs to achieve greater competitiveness in the market.

Figure 6 - Exports in 2009 (100% trigger)



The fifth and final simulation sought to understand employment behaviour in the year 2011 (100% trigger). The goal was to comprehend how the market would react to increased employability in the manufacturing industries, even after the variable had high values in the RB matrix (43.5). In response, the obtained data is illustrated below.

Figure 7 - Employment Behaviour in 2011 (100% trigger)



As observed above, exports, active companies, and average salary would remain stable when compared to the RB matrix. However, imports would decrease to 19.8. It is evident that increased employability in the industry would negatively impact imports. As articulated by Gremaud, Vasconcelos, and Toneto Junior (2018), a realignment of national companies and the implementation of commercial openness in the country would provide a greater variety of products available to consumers, containing the consumption drive for foreign products.

As seen in the simulations, the RB allowed, through the parameterization and implementation of study variables, an understanding of the impact of imports on the generation and behaviour of jobs in the textile industry of São Bento-PB. This enables better decision-making for both industrial sector managers and public officials in the municipality. Based on the historical analysis of the variables, year by year, they can plan protective or promotional measures for the local industry. According to Rappel et al. (2019), RBs support managers in the decision-making process amid potential uncertainties that may impact the environment.

V. Conclusion

The study aimed to implement a model of uncertain knowledge representation through the application of Bayesian Networks, identifying the influence of imports and exports on job creation and the performance of companies in the textile sector in the municipality of São Bento-PB. Through the Netica software, after standardizing the researched data, the BN was created, and through simulations, the understanding of the impact of imports on the local economy was achieved. The achievement of this objective was possible by fulfilling four other specific objectives.

The first specific objective was to gather information about imports, exports, employment behaviour, active companies, and average salary from available databases. Through searches in the IBGE (2019), MDIC (2019), and CAGED (2019) databases, data related to the municipality of São Bento-PB were found. The second specific objective aimed to standardize the collected information for a model capable of being implemented and executed in a BN structure. This was achieved by standardizing the information collected in the databases using a spreadsheet.

The third objective was to develop the BN, encompassing all the information gathered through an application focused on the development and analysis of Bayesian Networks, achieved through the Netica software, which was used to construct the network. The results for the variables in the RB analysis node were as follows: import 20.0, export 20.1, employment behaviour 20.1, average salary 20.0, and active companies 19.9, forming the matrix of the research BN.

The fourth and final objective sought to perform simulations in the network, identifying the impacts of imports on job generation and behaviour in the textile industry of the municipality of São Bento/PB.

In a general analysis of the study, it can be said that with the increase in imports, the city's economy is affected, leading to a reduction in employability and the average salary of the population. Imports also influence the number of active companies, as local businesses struggle to compete with local products. As a result, companies need to improve their planning and seek a competitive edge to attract consumers, and even export products to other countries. Simulations showed that an increase in exports positively influences job creation. Thus, the overall objective of the study was satisfactorily achieved.

Among the limitations found, the use of different databases prevented the quantification of results up to the present day, which is why the research was standardized with information covering the time window from 2008 to 2017. A larger window of information that includes the behaviour of companies up to the present moment could present different results than those found in the study. Another limitation is the reduction of BN simulations, given that the generated model is capable of inferring 500,050 distinct total conditional probabilities. The decision to simulate other periods, different from those used, could alter the behaviour of the studied variables.

The study's scope, limited to the municipality of São Bento in the state of Paraiba, is another constraint. Research with the same approach conducted in a larger number of cities or within a national textile productive arrangement could provide perspectives that corroborate or diverge from the results found. Future research may use the same tool and method, adapting it to a new BN structure that accommodates different variables, focusing, for example, on exports as a means of developing competitive advantage for companies and economic development in the studied regions. Another interesting field for future research, given the conclusions of this study regarding the importance of exports, is the impact of sectoral projects or export consortia on local industries using the Bayesian Network model for a more robust analysis..

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