The impact of biofuel policies on the Brazilian dairy sector

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Abstract

Brazil is the fourth largest country in milk production and both production and consumption of dairy products are growing fast. However, it is unknown how the dairy sector reacts to exogenous shocks. A structural econometric model of the Brazilian dairy sector is used to analyze the consequences of biofuel policies on the production, consumption, and price of milk. The paper aims to evaluate how the Renewable Fuel Standard policy in the U.S. and the sugar cane policy in Brazil affect the dairy industry in Brazil. The policies are analyzed relative to a ten-year baseline scenario ending in 2022. Data from 1980 to 2012 are used to estimate the Brazilian dairy sector model. Annual equilibrium prices are solved by minimizing the squared difference between supply and demand for four different markets: cheese, butter, milk powder, and fresh dairy products. Both RFS and sugar cane acreage expansion have negative impact on milk production in Brazil and positive effect on consumer price. However, the impact of US' RFS program is small. The model estimates appear to perform well in representing the actual dairy sector. The milk production forecasts were reasonable and the effects of shocks were well supported by the economic theory.

Keywords: policy analysis, dairy market, structural econometric model, partial equilibrium.

JEL Code: C50, C54, Q18.

Introduction

Studies related to market analysis have played an important role in understanding price dynamics, supply, and demand behavior. Those studies have assisted policy makers and the dairy industry in terms of strategic decisions regarding investments and policies. In Brazil, the dairy sector is an important segment of the agribusiness. From the supply side, Brazil is the fourth largest producer in the world according to the Food and Agriculture Organization (FAO, 2014), and the whole sector is composed of nearly 1.3 million farmers. From the demand side, dairy products account for approximately 11.5% of household expenditure for food (IBGE, 2010). Therefore, Brazilian's families are relatively more sensitive to changes in dairy prices than in other types of food.

The Brazilian dairy sector has changed significantly over time. Until the early 1990s, a price controlling policy by the Brazilian federal government was in place. Government regulations were not favorable to the development of the local dairy sector because price instability caused reluctance for investment at the farm level. Therefore, during the regulation period a low production per cow, small production per farm, inferior milk quality, and high production costs were observed. However, most of these problems are still in place, thus

inhibiting the local industry to become more internationally competitive (Rodrigues, 1999). As a consequence of those factors, there has been a sudden decrease in the number of operating dairy farms. In 1996, around 1.8 million dairy farms were in operation compared to 1.3 million in 2006 (IBGE, 2009).

The dairy sector is one of the most complex segments of the agribusiness. The raw milk flows to a bundle of products that uses different transformation methods, packages and inputs. At the farm level, the complexity of managing dairy farms is also increasing due to recent policies like biofuel promotion around the world and the impact on feed cost, land price, among others. Such policies have different drivers depending on each country where the policy is implemented. In the United States, for example, new uses for corn were observed after the Renewable Fuel Standard (RFS) program regulations in 2005, which established the renewable fuel volume mandate in the US. In Brazil, the sugar cane expansion has increased land competition on agricultural fields mainly in *São Paulo* state, which hold most of the sugar cane acreage and ethanol industry. The future of the dairy sector depends also on how these policies are managed over time.

In terms of impacts of biofuels mandates on livestock, a general equilibrium approach was used by Taheripour, et al. (2011) to study this issue. They suggested that biofuel policies had important implications for the global livestock industry, mainly by raising the cost of feed grains. They also found that growth in the US and E.U. biofuels industries had greater negative impacts on livestock production overseas than in those regions. The biofuel mandates increase the price of pastureland because more pastureland is converted into crop land. Therefore, the changes in the US's Renewable Fuel Standards impacted corn prices and livestock production in the United States and in other places as well (Miljkovic, 2012).

Dumortier, et al. (2009) used a partial equilibrium model to measure the impacts of biofuel policies on food prices. The change in biofuel policies and energy prices leads to changes in corn prices and the prices of other crops that compete with corn for land. Moreover, part of this change in price will be transferred to consumers since it impacts the prices of dairy, livestock, and bakery products. In addition, by increasing corn prices in the US, they found that the soybean acreage in the US will decrease, raising soybean price. A spillover effect will also be expected, increasing corn and soybean acreage in Brazil, Argentina, and other countries.

In the case of the Brazilian sugar cane expansion, the relationships between the ethanol industry and the dairy industry were studied by Novo, et al. (2010). As the authors mentioned, the sugar and ethanol industry expansion is definitely not new since it started in the early-1970's in *São Paulo* state. However, predominance of relatively small dairy farms contrasts with a strong ethanol industry with dynamic and fast growth. Moreover, while historically the Ethanol industry has been promoted by a range of public policies, such as tax benefits and mandatory use of blending ethanol and gasoline, public policies for the dairy sector were much less directed toward the development of the sector, and usually have served other interests, such as inflation

control (Martins (2004), Novo, et al. (2010)). Novo, et al. (2010) concluded that many dairy farmers in *São Paulo* decided to stop production to sell or rent their land to the sugar cane sector. Increased land prices and high rents offered by the sugar cane/ethanol industry attracted farmers to this new opportunity.

An econometric model that attempts to replicate the dairy sector in Brazil, and capture important decision points, is developed in this study. Understanding how milk flows from raw materials to the final products, and how the supply curve responds to price and cost changes, provide insights of impacts for future dairy policies and social planning. A system of equations is built to simulate how well the entire system represents the sector over a historical period. As for specific interest, the research evaluates impacts on the dairy sector to changes in RFS requirement in the US, and sugar cane acreage in Brazil. Policymakers and the dairy industry may benefit from the research.

Data and Background

Collecting Brazilian data to build the model was challenging. Different sources were combined due to a strong limitation in organized and complete datasets. Annual data from 1980 to 2012 were used to estimate the model and the policies were analyzed relative to a 10-year baseline scenario ending in 2022.

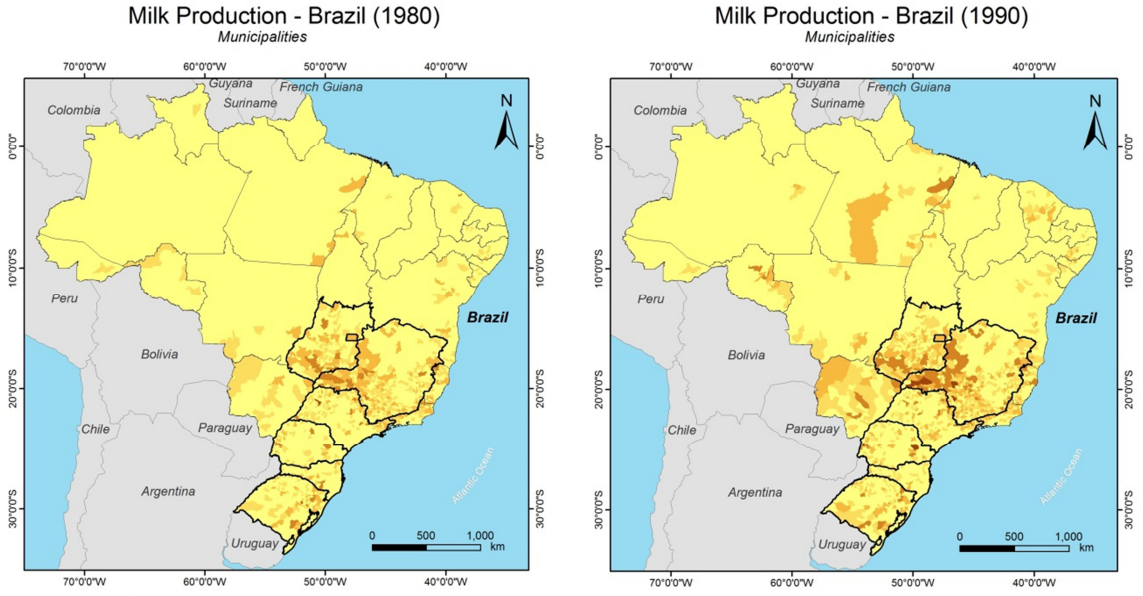
As for the number of dairy cow and total milk production, data from Organisation for Economic Co-operation and Development (OECD)-FAO and the Bureau of Statistic of Brazil, namely Brazilian Institute of Geography and Statistics (IBGE) were used. Retail price index for dairy products is also published by IBGE. Data about supply and demand of dairy products (cheese, butter, milk powder and fresh dairy), on the other hand, was offered only by OECD-FAO.

In terms of raw milk prices, corn, and soybean prices the *Fundação Getúlio Vargas* (FGV) were the main source. In some cases those series were merged with more recent data provided by the Center for Advanced Studies on Applied Economics (Cepea), and *Instituto de Economia Agrícola* (IEA-SP). Cost of milk production and minimum milk prices were given by the National Food Supply Agency (Conab). Macroeconomic data is published by a number of different sources such as IBGE, the Brazilian Central Bank, and the Institute of Applied Economic Research (IPEA). Finally, historical corn and soybean prices in the US was provided by USDA, while forecast were offered by the Agriculture and Food Policy Center (AFPC), located at Texas A&M University, according to their renewable fuel standard scenarios (Rhew, 2014).

The total milk supply is estimated on a state-by-state basis and considers the top six states in the Brazilian milk production. Dairy farms in Brazil are very heterogeneous in terms of size,

management, and use of technology. There are a mix of farms with professional management and good technical and financial control, contrasting with other farms where the cost of milk production is still unknown. Similarly, in some regions of the country a higher yield per cow is observed, while in other regions the production per cow does not reach 1,000 kg of milk per year. On average, the three states located in the southern Brazil (*Paraná*, *Santa Catarina*, and *Rio Grande do Sul*) have a more homogeneous production system and better management tools. The production of these is also growing relatively faster than in the other regions.

Figure 1 presents the spatial distribution of milk production in Brazil. Basically, dairy farms are located throughout the country. Two main points can be noticed in Figure 1. First, the production has consistently increased as the dark color became more visible in 2012. By pointing out that the city limits did not change over time, the production per acreage has increased as well. Second, the total milk production has been growing in both traditional and nontraditional areas with few exceptions. The top six states, highlighted in the map, represented 76.5% of the total milk production in 1980. In 2012, the same states accounted for 77% of the total production. Therefore, the top six states kept the same share of the total milk production despite the weak performance of *São Paulo*, where the share of the total production decreased from 16% to 5% in the same comparison. As cited by Novo, et al. (2010), the expansion of sugar cane acreages played an important role in explaining the reduction in milk production in *São Paulo*.



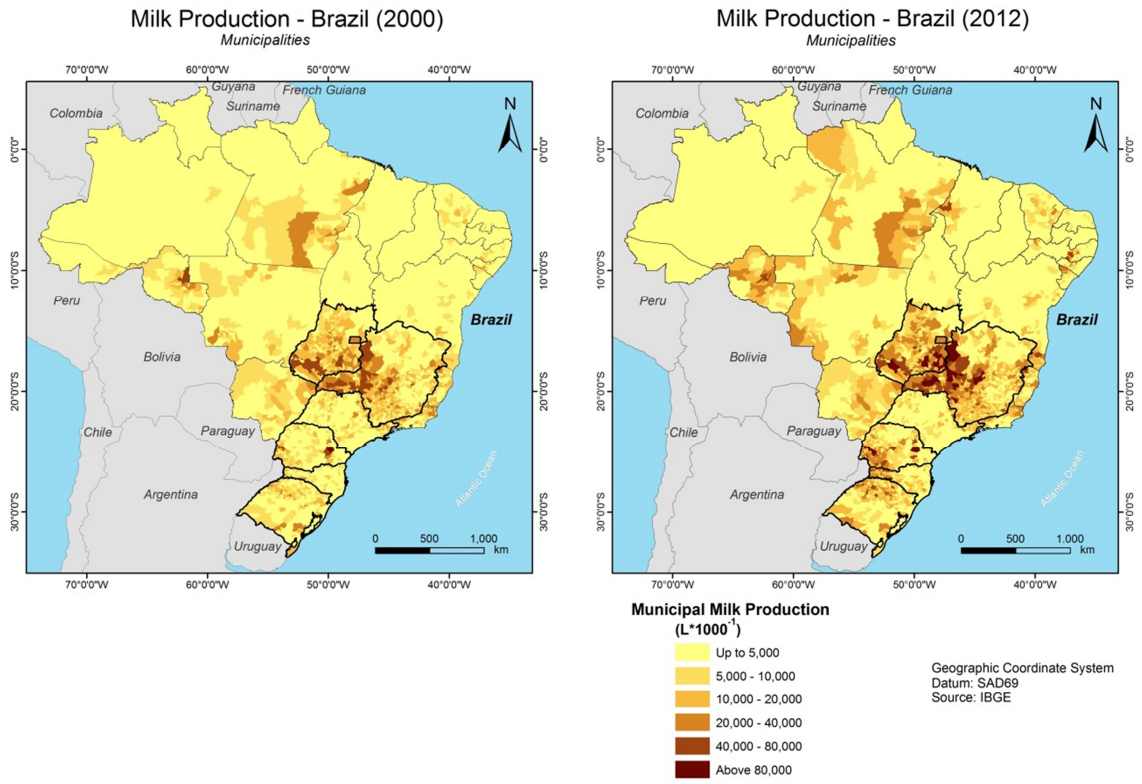


Figure 1. Milk production in Brazil: 1980 to 2012.

The sugar cane cultivation is not new in Brazil. In fact, the first fields were introduced during the colonization of the country. The main state in production is *São Paulo*. In 1980, 49% of the total sugar cane production was located in *São Paulo*. This share increased to 56% in 2011. Figure 2 shows the sugar cane production throughout the country. *São Paulo* has always been the leading state in sugar cane cultivation and the production increased very fast during the 2000s. A spillover effects is also observed in neighboring states, where the expansion of sugar cane was strong as well. The ethanol policies in Brazil consist of mandatory blend level (18% up to 27.5%) of ethanol in gasoline, credit offers with special interest rate, and tax rebate.

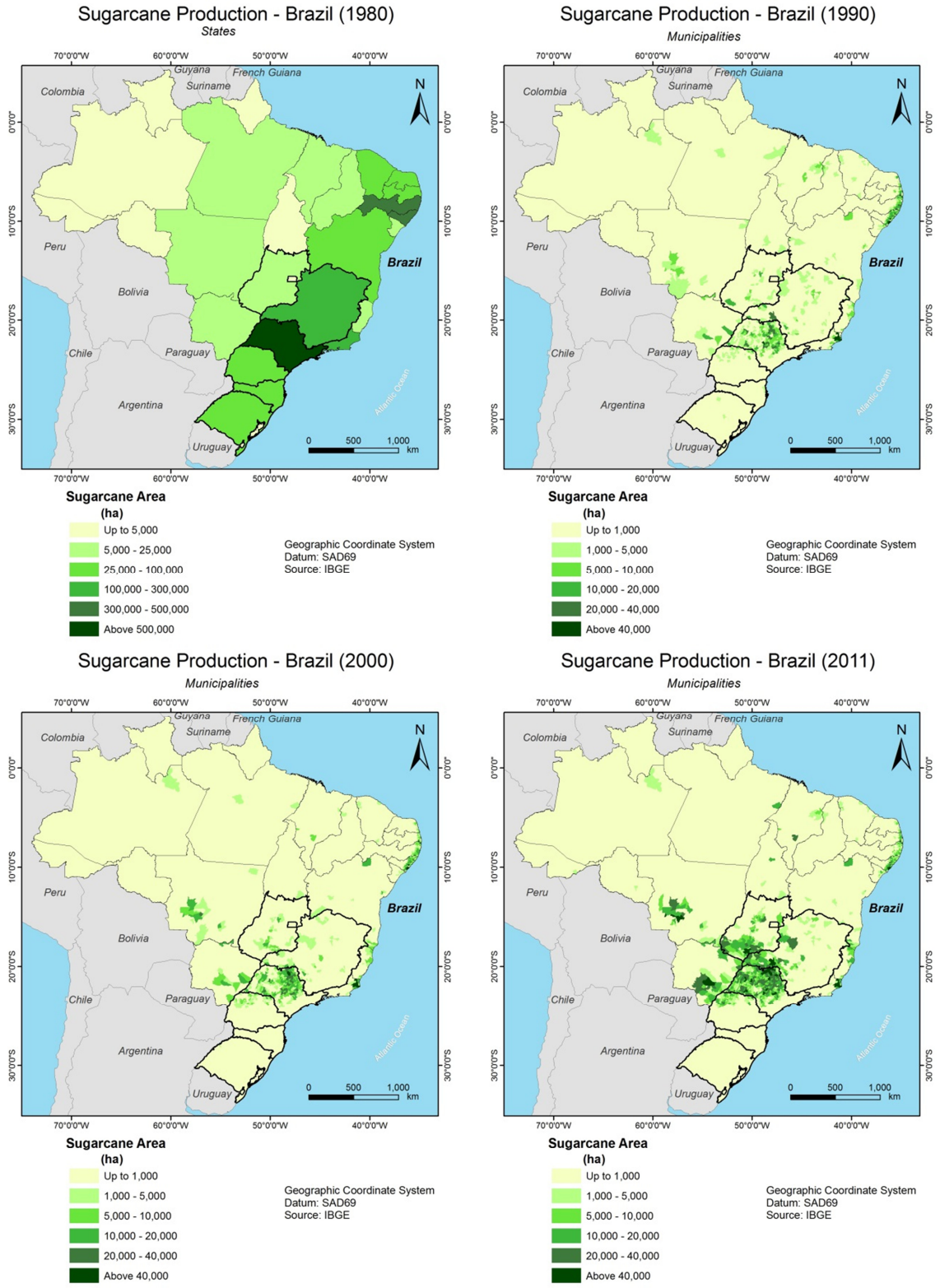


Figure 2. Sugar cane production in Brazil: 1980 to 2011

As for the RFS-requirement, the program was created under the Energy Policy Act (EPAct) of 2005, and established the renewable fuel volume mandate in the United States. The RFS sets mandatory blend levels for renewable fuels beginning with 9 billion gallons in 2008 and ending at 36 billion gallons in 2022. The corn-based ethanol is the most popular renewable fuel in use. Such a policy creates new use for corn and corn-based feed and those inputs account for the majority of grain-based diets in a dairy farm.

Methods

The entire model consists of a partial equilibrium approach to estimate structural supply and demand functions for the Brazilian dairy sector to replicate the actual sector. The equations are estimated using least squares criterion following the classical multiple linear regression model as described in Greene (2008). For each equation that contains the lagged dependent variable, the Breusch-Godfrey Lagrange multiplier test was run to test for the presence of serial correlation. This procedure was applied because Greene (2008) shows that in the presence of serial correlation, all coefficients on the right hand side are inconsistent.

As for the other equations, without lagged dependent variables, the coefficient estimates are consistent but not efficient. Nevertheless, in some equations where inference was important the first order serial correlation problem was fixed using the Prais-Winsten estimator described in Prais and Winsten (1954) and Greene (2008). Information criteria, such as Schwarz loss (Schwarz, 1978) and Akaike information criterion (Enders, 2003) were used for selection between different specifications.

As for the empirical model, the milk production is a result of production per cow, multiplied by the number of dairy cows in each year (Figure 3). The equations used to estimate the number of dairy cows are expressed as a function of dairy cows lagged one year, deflated net revenue lagged one year, and exogenous variables. Following Greene (2008), a Breusch-Godfrey Lagrange multiplier test was run to check for the presence of serial correlation. Milk production per cow depends upon time trend, and costs deflated net revenue. The time trend variable represents the effects of technology over time. The net revenue variable, on the other hand, considers the effect of relative profitability of producing milk. The total milk production is determined by the number of dairy cows on the farm and the production per cow. The total supply of milk is an aggregation of each region and represents the entire country.

The structural model incorporated the RFS policy by connecting the corn and soybean prices in Brazil to the US corn and soybean prices. Corn and soybean prices in Brazil are part of the net revenue indicator, and therefore, are impacting the estimated number of dairy cows and production per cow equations. These two equations are used to calculate the total milk production.

Sugar cane acreage is incorporated into the model through the number of dairy cows equation only in São Paulo. The inclusion of sugar cane acreage in the number of dairy cow equations in other states of Brazil did not provide any benefit in terms of goodness of fit. Moreover, the variable was not statistically significant at the 10% confidence level.

As for dairy products, the total raw milk supply flows to different products and the total supply of each product is defined as the sum of production, imports, and beginning stocks. On the other hand, the total demand is calculated by total consumption, exports, and ending stocks. For both the supply and the demand side of the model, international trade is mostly marginal in the Brazilian dairy sector. Brazil is historically a net importer country, and trade is still not consolidated in the dairy industry. Most of the transactions are sporadic and usually happen to fulfil eventual gaps in the supply or demand.

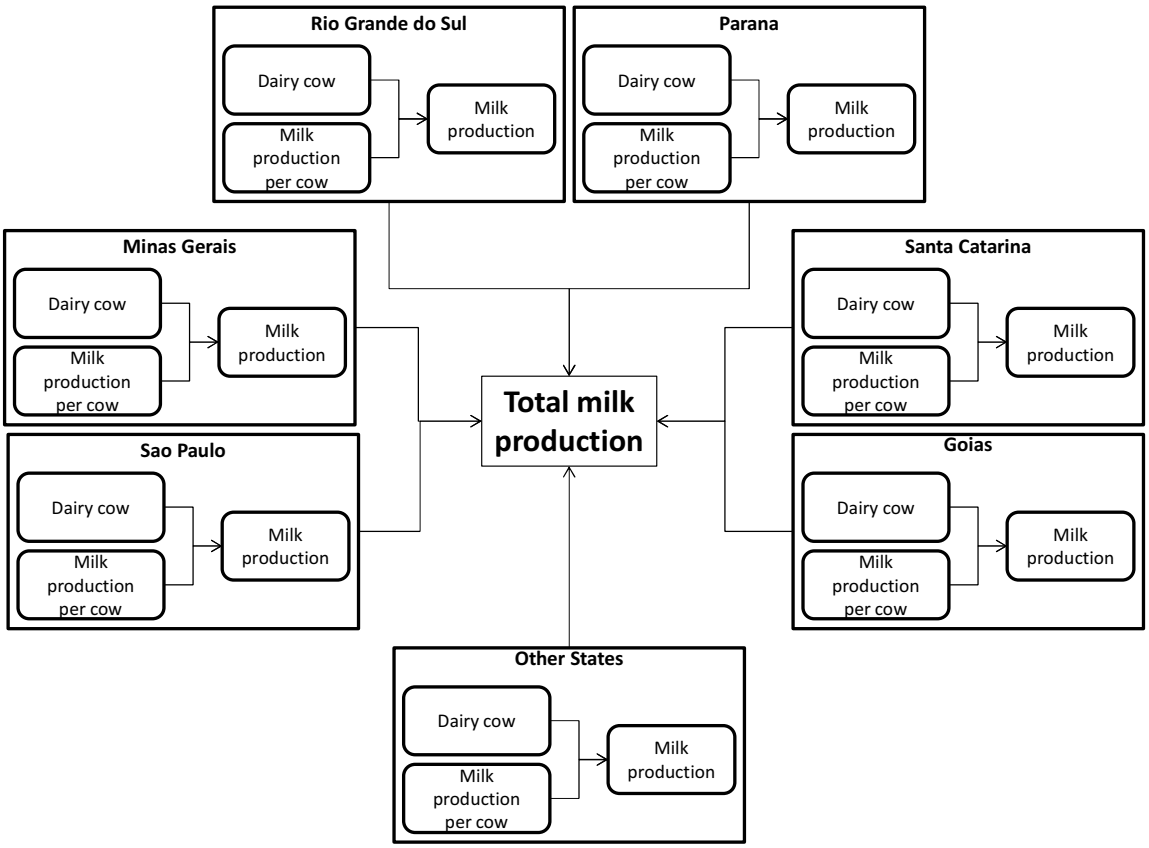


Figure 3 - Milk production estimation on a state basis
Note: Adapted from Brown (1994).

To complete the structural procedure, a non-linear optimization method is used for the partial equilibrium model, which solved for four different dairy markets: butter, cheese, milk powder, and fresh products. The objective of each market is to minimize the squared difference of the excess supply in a given year as described in equation 1.

$$Obj.function = Min \Sigma_k (supply_k - demand_k)^2 \quad 1$$

where, k = butter, cheese, milk powder, fresh products.

The method is dynamic and recursive where each endogenous variable is explicitly followed over time. The entire model is solved sequentially, one period at a time, for the 10-year forecast. The model is exercised by running different scenarios with the baseline as the reference scenario. The baseline considers the *status quo* of the exogenous variables and current policies. The sugar cane acreage is set constant at 2012 level and the RFS policy refers to the current requirement. Alternatives scenarios are used to contrast with the existing conditions and consider a 30% increase in sugar cane acreage in São Paulo, and the absence of RFS policy in the US.

Results

The total milk production in Brazil is presented in Table 1. The baseline forecast is in between the scenarios developed by both OECD/FAO (2013) and the Brazilian Ministry of Agriculture (MAPA, 2013). It is worth mentioning that in our baseline scenario the world's economy is assumed to perform somewhat worse in the next ten years compared to the last decade. For that reason, the overall growth rate is lower than that of the previous period. The production per cow is expected to grow a little faster than before, but it is still very low, with annual production smaller than 2,000 kg/cow by 2022. An expected lower number of dairy farms and greater competition with alternative agricultural activities may cause management improvement for the coming years, inducing better use of technologies.

Table 1. Total milk production in Brazil: 1,000 ton

2012	2022 (forecast)		
	Baseline	OECD-FAO (1)	MAPA (2)
33,055	41,649	38,839	44,514

Note: (1) OECD-FAO outlook 2013-2022; (2) MAPA: Brazilian Ministry of Agriculture.

Conceptual evaluation

Figure 4 represents a negative shock in the milk supply at farm level. Some examples of negative shocks in the context of the study are increase in feed cost, and expansion of sugar cane acreage. Suppose, for example, the increase in feed cost because of the new demand for corn to produce ethanol. Such a policy would shift the supply curve to the left reaching the new price/quantity equilibrium at P'_F and Q'_F as represented in Figure 4. The total milk production is now represented by S' and the wholesale and retail prices by P'_W and P'_R, respectively.

Therefore, an increase in the cost of milk production would lead to a lower supply and higher prices in the entire supply chain. On the other hand, a reduction in the cost of milk production would have the opposite impact, with higher supply and lower prices.

The expansion of sugar cane acreage in *São Paulo* can be analyzed in the same manner described in Figure 4. However, the shift of the supply curve to the left is caused by the reduction of the number of dairy cows on a farm instead of the increase of the cost of milk production. Therefore, the shrink in the milk supply would end up increasing the milk price throughout the supply chain.

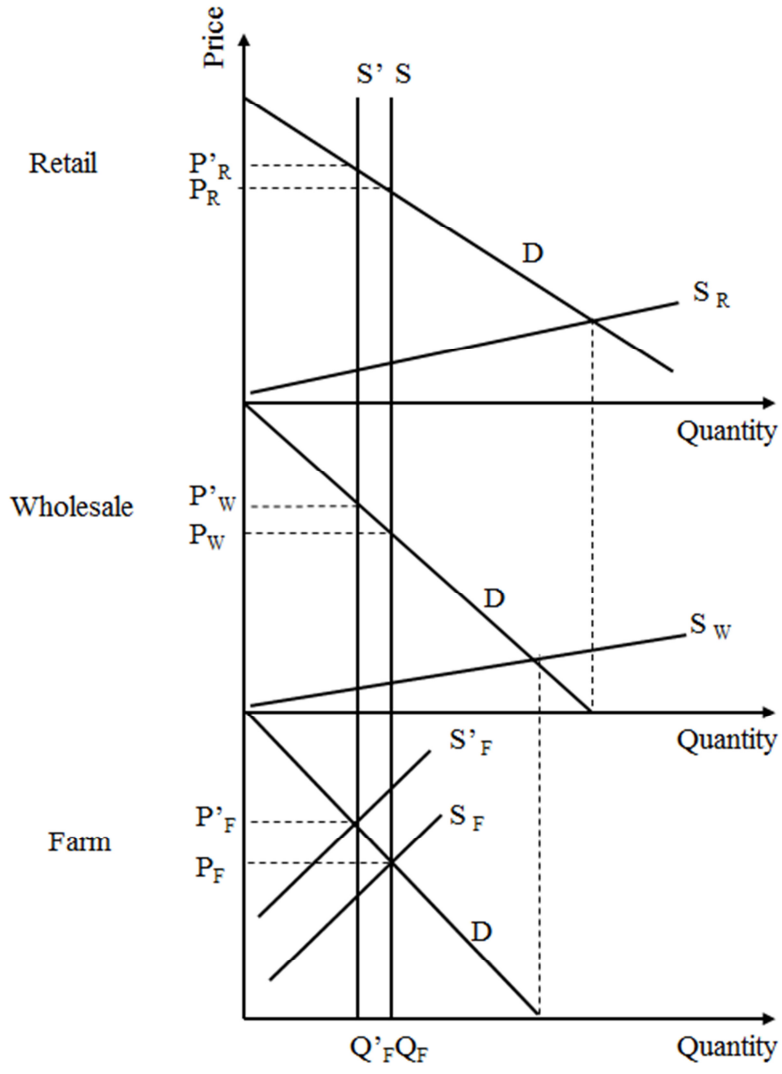


Figure 4. Negative supply shock on the dairy chain

No-RFS Requirement

The RFS regulation, established in 2005, opened up new uses for corn and soybean, which have affected the grain prices as pointed out by Dumortier, et al. (2009). The basic hypothesis about the impacts of such a policy is that the RFS requirement has positive effects on input prices (corn and soybean) for the dairy sector. Consequently, a negative impact on the Brazilian milk production is expected. Since the RFS-program is already in place it is incorporated into the baseline forecast. Therefore, the alternative scenario considers the effects of the absence of the US's RFS program. The structural model integrates the RFS policy by connecting the corn and soybean prices in Brazil to the US corn and soybean prices. Corn and soybean prices in Brazil are part of the net revenue indicator, and therefore, are impacting the estimated number of dairy cows and production per cow equations. These two equations are used to calculate the total milk production.

In terms of results, a positive impact on feed cost in Brazil was observed as reported in the baseline scenario (Figure 5). The absence of RFS, on the other hand, would reduce the feed cost compared to the baseline. Actually, the feed cost would be around 5.3 % lower than the baseline cost, on average.

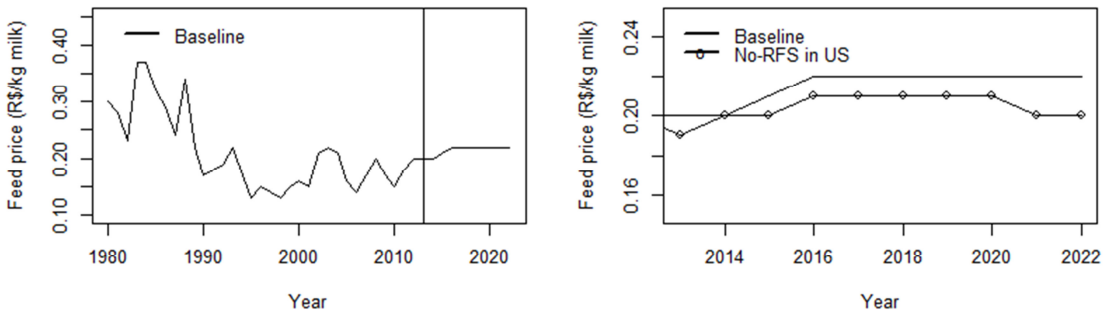


Figure 5. Feed price in Brazil and the RFS requirement effects

The impact of such a change in feed cost, caused by the absence of the RFS requirement, slightly alters both milk production and prices (Figure 6). A possible reason is twofold: first, feed cost is just a component of the total cost, and the magnitude of the feed cost variation was not big enough to cause significant changes in the milk production and prices. Second, only the direct effect of RFS requirement on feed cost is accounted for by the dairy model, while the indirect effect, described as the RFS policy impacts on the Brazilian corn and soybean sectors as a whole, is not considered. A more accurate evaluation of the RFS requirement would be possible by integrating the Brazilian dairy model and the Brazilian grain and oilseeds models since the connection would allow feedback.

In the case consumption and retail prices of dairy products, the RFS influences were just marginal. The small effects of RFS on dairy products are summarized in Figures 7-10.

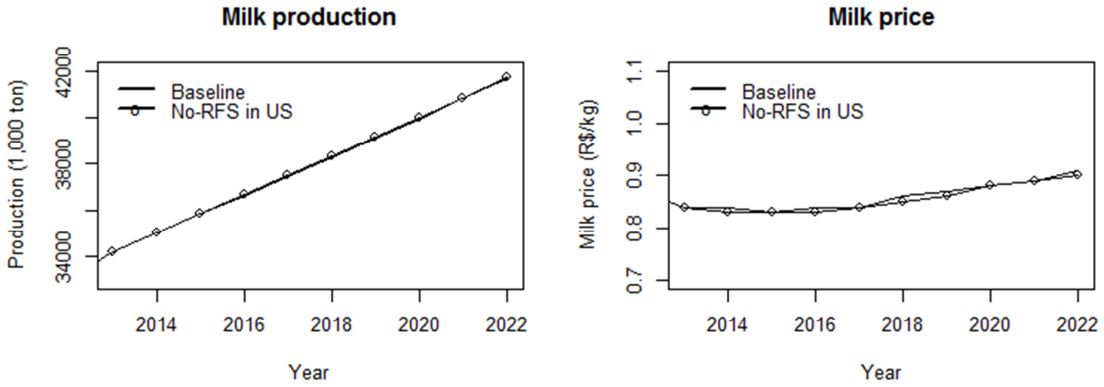


Figure 6. No RFS requirement effects on the milk production and price

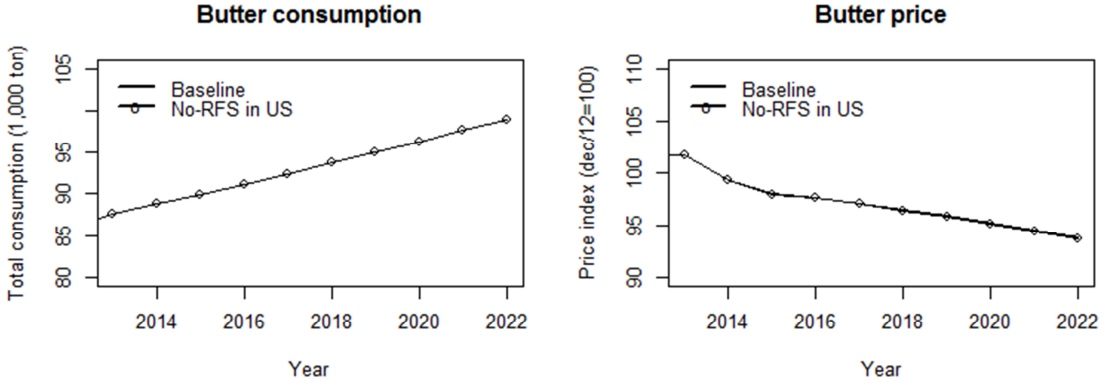


Figure 7. No RFS requirement effects on the butter market

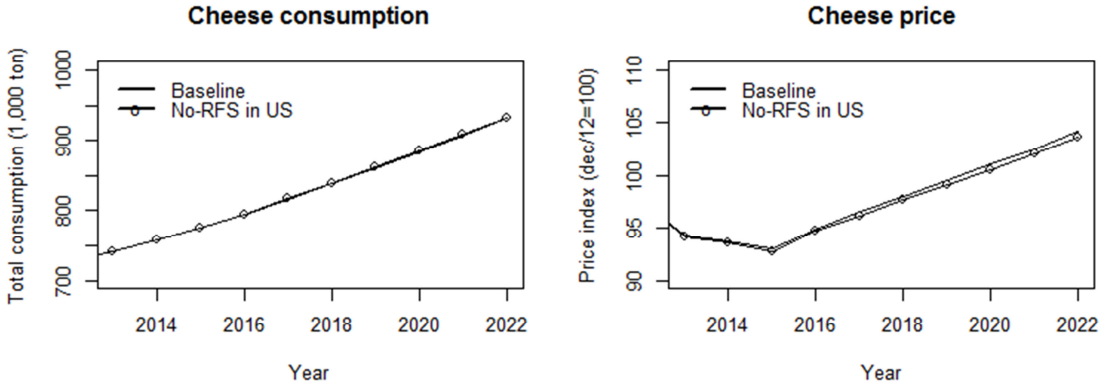


Figure 8. No RFS requirement effects on the cheese market

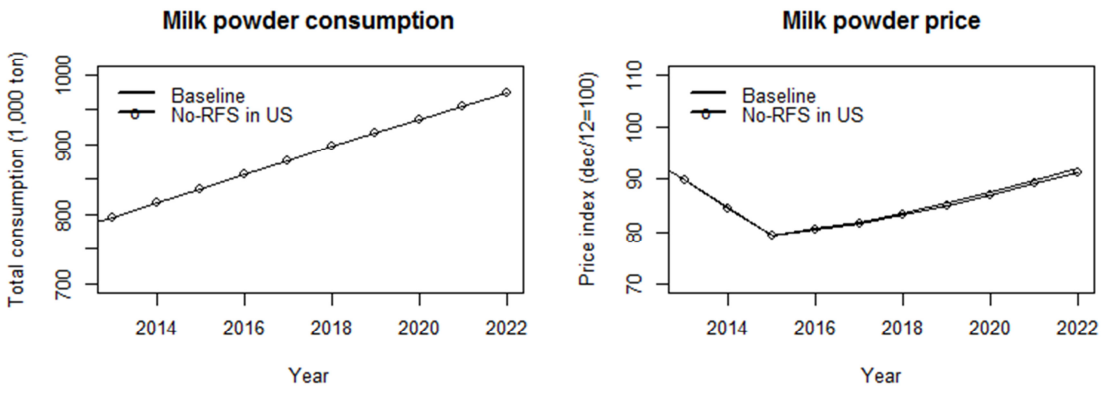


Figure 9. No RFS requirement effects on the milk powder market

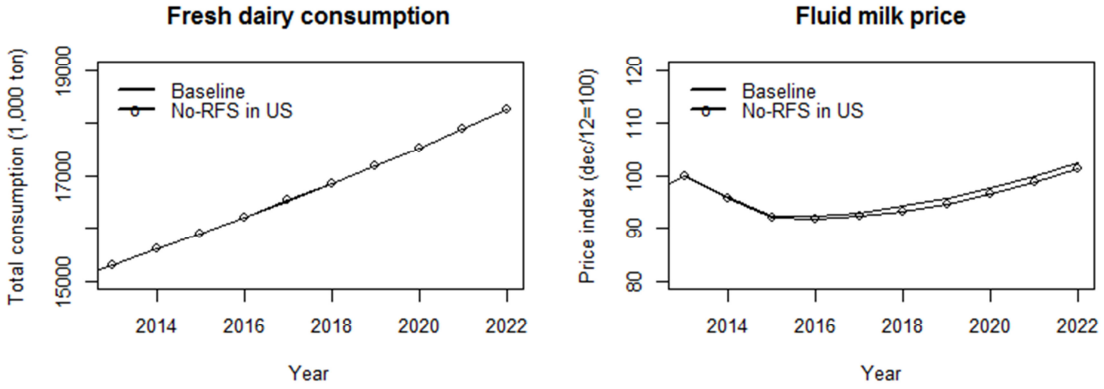


Figure 10. No RFS requirement effects on the fresh dairy market

Sugar Cane Expansion

In the case of biofuel policies in Brazil, the shock consists of a 30% increasing in sugar cane acreage in *São Paulo* from 2012 to 2022, reaching almost 7 million hectares. Such expansion is based on the Brazilian Ministry of Agriculture forecasts (MAPA, 2013). It is worth remembering that *São Paulo* is the main state in ethanol production, and the growth in sugar cane acreage must negatively affect the milk production in that state as suggested by Novo, et al. (2010).

Sugar cane acreage is incorporated into the model through the number of dairy cows equation. The results indicate that a 30% growth in sugar cane area, "*ceteris paribus*," will decrease the number of dairy cows in *São Paulo* by around 16.5% compared to the 2012 level, and 17.6% with respect to the baseline scenario at 2022 (Figure 11). Similarly, the total milk

production in *São Paulo* will shrink by 15.9% compared to the 2012 production. When contrasted with the baseline scenario, the production decreases by 17.5% in 2022.

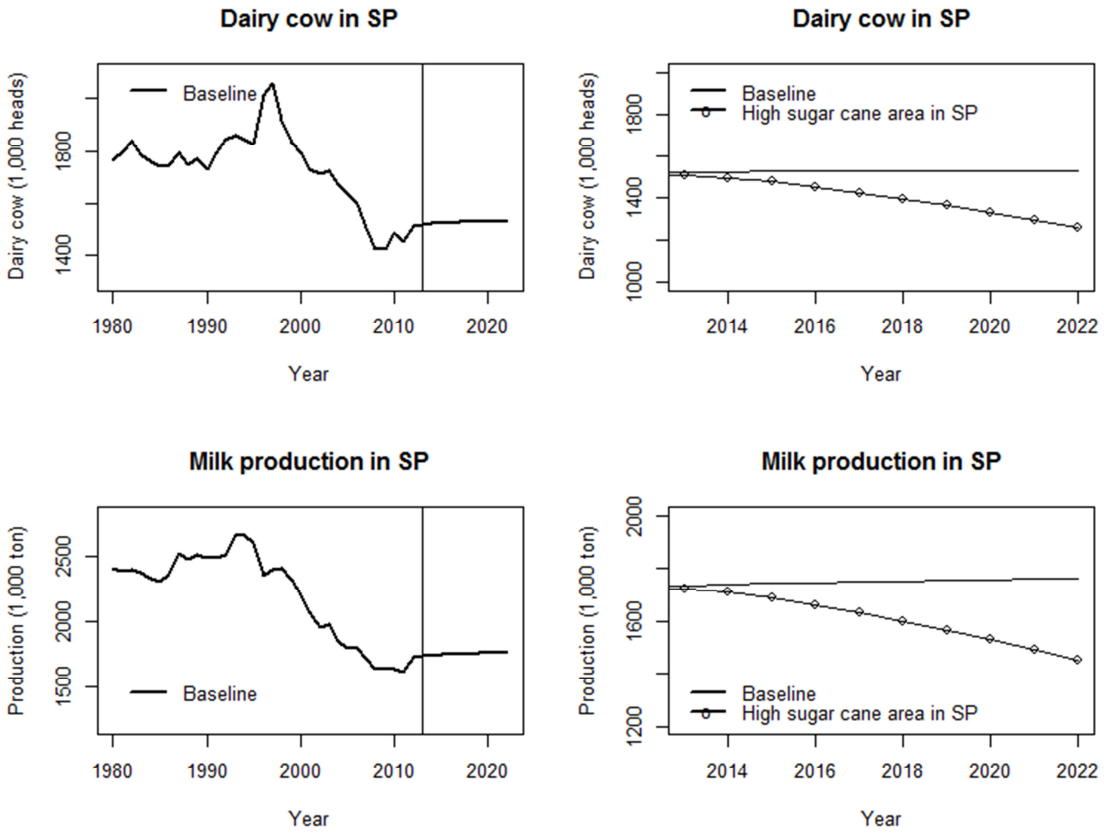


Figure 11. Sugar cane expansion effects on number of dairy cows and milk production in São Paulo
Note: Sugar cane acreage increasing 30%, linearly.

Considering the entire country, however, the sugar cane expansion is not strongly decreasing the total milk production since, historically, the importance of *São Paulo* as a milk supplier has diminished. In the early-1980s the state produced around 15% of the Brazilian milk production. In 2012, on the other hand, the contribution of *São Paulo* was only 5% of the total production. Nevertheless, some effects of the reduction in milk supply are observed in the price level throughout the supply chain. The national farm price is expected to increase around 1% on average (Figure 12). Dairy prices would also rise as a consequence of the ethanol policy, mainly the cheese and fluid milk prices. The effects on consumer price would be relatively small, increasing about 1% to 3%, on average (Figures 13-16).

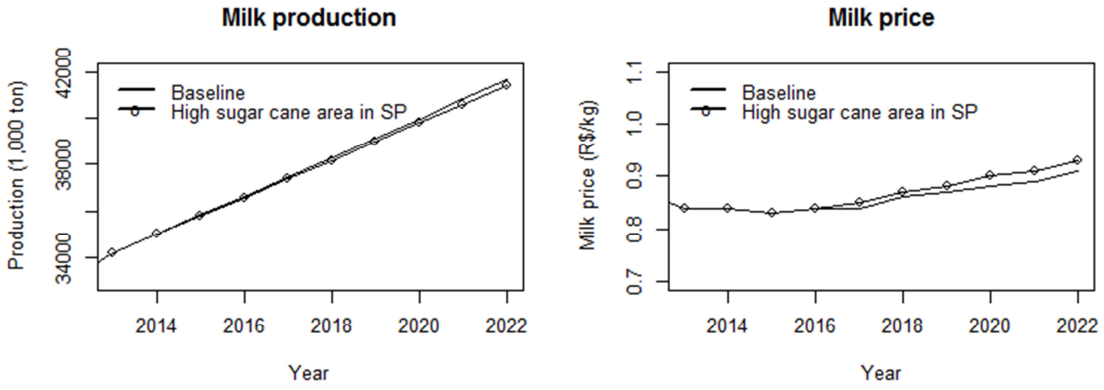


Figure 12. Sugar cane expansion effects on the milk production and price

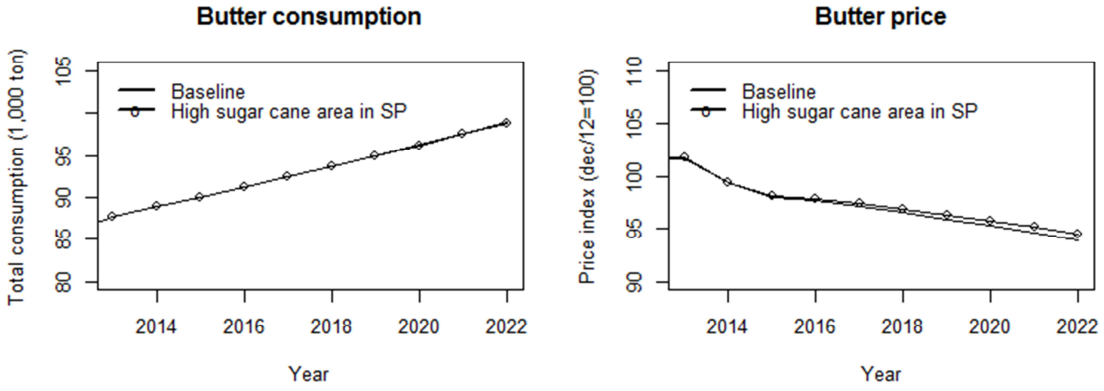


Figure 13. Sugar cane expansion effects on the butter market

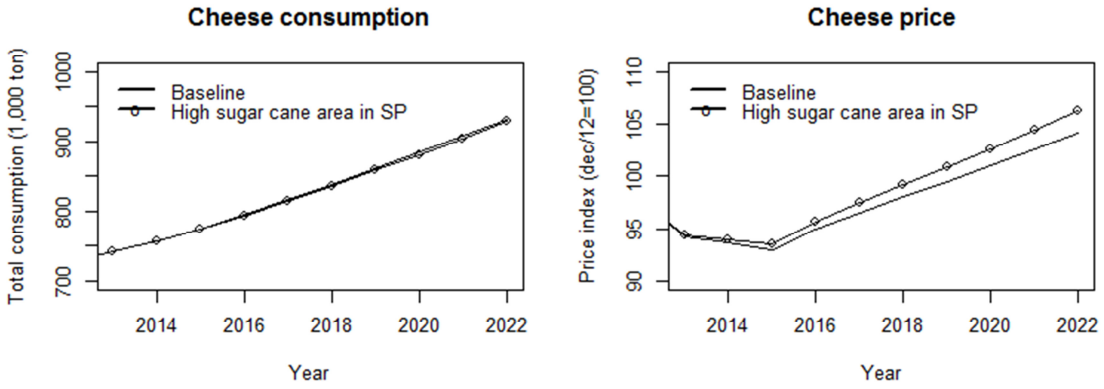


Figure 14. Sugar cane expansion effects on the cheese market

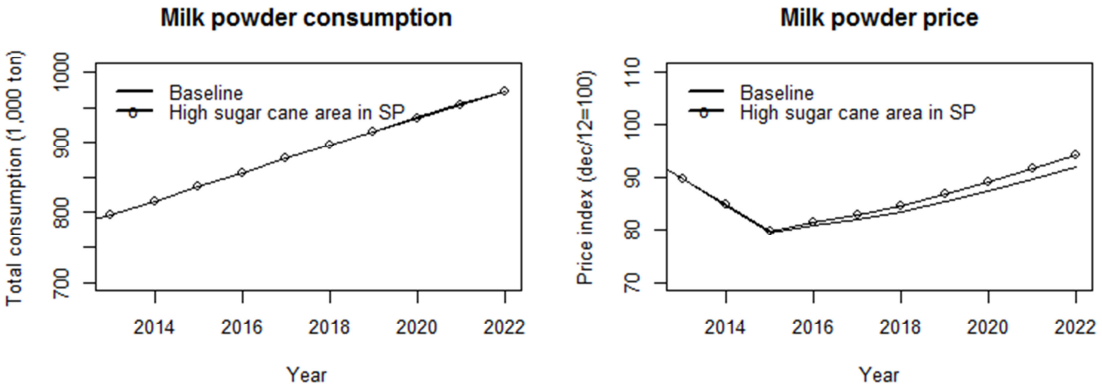


Figure 15. Sugar cane expansion effects on the milk powder market

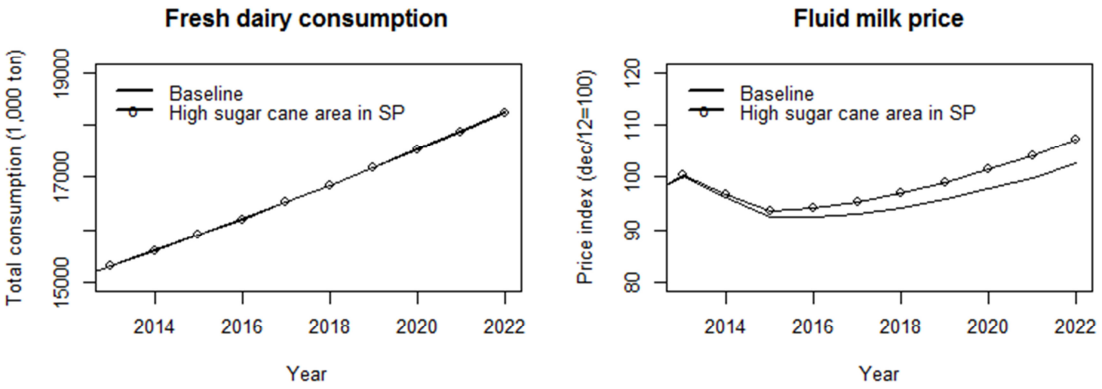


Figure 16. Sugar cane expansion effects on the fresh dairy market

Conclusions

The study presented has many important characteristics that contribute to policy makers and private companies understanding the Brazilian dairy industry. The 10-year forecasts provided important insights in terms of trends. In addition, the model helps to identify the sensitivity of the entire system of equations to changes in specific variables. Those are the major contributions of this research to the Brazilian dairy sector.

The dairy sector in Brazil is not very responsive to changes in biofuel policies, mainly the US's RFS program. The milk production suffers only marginal changes compared to the baseline scenario. Most of the dairy farmers are not professionally managed and the effects of changes in feed prices are not fully known by those farmers. Moreover, corn and soybean represents only a component of the total cost and the changes in those prices were not significant enough to cause

greater impact on total cost and net revenue. Similar results were found when studying the effects of biofuel policies on Brazilian milk prices.

Nevertheless, changes in sugar cane acreage cause greater impact on milk production compare to the US's RFS program. The total milk production is negatively related to sugar cane acreage because the expansion of sugar cane acreage has negative impacts on the number of dairy cows and therefore, on the milk production. The impact of sugar cane acreage on total milk production was not strong because the share of *São Paulo* on milk supply has decreased over time.

Most of the limitations of the study were related to data constraints. Different data sources had to be merged and generate problems in balancing supply, demand, and price. Some data are also published with two years delay, causing difficulties to incorporate up to date information. Another limitation is related to data aggregations. The dairy sector is composed of a wide variety of products that are produced from raw milk, but data are not available for most of the products. The model was built to solve for four dairy markets: butter, cheese, milk powder, and fresh products. The fresh market, however, represents a group of products, which generates drawback in terms of conversions, elasticities, and consumer preferences. If more milk prices and costs components were available, the supply side of the model could also incorporate more Brazilian States and not only the top six as considered in the research. The final limitation in terms of data refers to the inexistence of wholesale level information that penalizes a more detailed evaluation throughout the supply chain. Regarding the limitations, the model estimates appear to perform well in representing the actual dairy sector. The milk production forecasts were reasonable and the effects of shocks were well supported by the economic theory.

References

Brown, D.S. 1994. *A Structural Approach to Modeling the US Livestock and Dairy Industries: With Emphasis on the Dynamics Within the System*. PhD Thesis, University of Missouri, Columbia, MO.

Dumortier, J., M. Carriquiry, S. Pan, E. Chavez, C. Hart, F. Dong, T.-H. Yu, A. Elobeid, S. Tokgoz, and J. Fabiosa. 2009. *Biofuels: potential production capacity, effects on grain and livestock sectors, and implications for food prices and consumers*. Ames, Iowa State University - Center for Agricultural and Rural Development.

Enders, W. 2003. *Applied Econometric Time Series*: Wiley.

FAO. 2014. *FAOSTAT*. Rome, Italy, Food and Agriculture Organization of the United Nations (FAO)

Greene, W.H. 2008. *Econometric Analysis*: Pearson/Prentice Hall.

IBGE. 2009. *Censo Agropecuário 2006: Brasil, Grandes Regiões e Unidades da Federação.* Rio de Janeiro, RJ: Ministério do Planejamento, Orçamento e Gestão. Instituto Brasileiro de Geografia e Estatística (IBGE).

---. 2010. *Pesquisa de Orçamento Familiar 2008–2009: Despesas, rendimentos, e condições de vida.* Rio de Janeiro, RJ: Ministério do Planejamento, Orçamento e Gestão. Instituto Brasileiro de Geografia e Estatística (IBGE).

MAPA. 2013. *Agricultural Outlook: 2012/2013 - 2022/2023.* Brasília, DF: Ministério da Agricultura, Pecuária e Abastecimento/Assessoria de Gestão Estratégica.

Martins, P.d.C. 2004. *Políticas públicas e mercados deprimem o resultado do sistema agroindustrial do leite*. Juiz de Fora, MG: Embrapa Gado de Leite.

Miljkovic, D. 2012. Impact of biofuel policies on livestock production in the United States. *Journal of policy modeling* 34:817-831.

Novo, A., K. Jansen, M. Slingerland, and K. Giller. 2010. Biofuel, dairy production and beef in Brazil: competing claims on land use in São Paulo state. *The Journal of Peasant Studies* 37:769-792.

OECD/FAO. 2013. *OECD-FAO Agricultural Outlook 2013-2022.* OECD Publishing and FAO: http://dx.doi.org/10.1787/agr_outlook-2013-en.

Prais, S.J., and C.B. Winsten. 1954. Trend estimators and serial correlation. *Cowles Commission Discussion Paper*, n. 383. Chicago, IL, Cowles Commission.

Rodrigues, G.V. 1999. Estruturação e desafios do setor de produção de leite. In M.C.D. Castro, and P.C. Martins eds. *Organização da produção primária: um desafio para a indústria de laticínios.* . Juiz de Fora, Epamig/ILCT, pp. 36-40.

Rhew, C. 2014. *Economic Impact Analysis of Exchange Rate, RFS2, and Farm Program Support Changes on the U.S. Crop Sector*. Ph.D. thesis, Texas A&M University, College Station, TX.

Schwarz, G. 1978. Estimating the Dimension of a Model. *The Annals of Statistics* 6:461-464.

Taheripour, F., T.W. Hertel, and W.E. Tyner. 2011. Implications of biofuels mandates for the global livestock industry: a computable general equilibrium analysis. *Agricultural economics* 42:325-342.

Title: The impact of biofuel policies on the Brazilian dairy sector

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Abstract: Brazil is the fourth largest country in milk production and both production and consumption of dairy products are growing fast. However, it is unknown how the dairy sector reacts to exogenous shocks. A structural econometric model of the Brazilian dairy sector is used to analyze the consequences of biofuel policies on the production, consumption, and price of milk. The paper aims to evaluate how the Renewable Fuel Standard policy in the U.S. and the sugar cane policy in Brazil affect the dairy industry in Brazil. The policies are analyzed relative to a ten-year baseline scenario ending in 2022. Data from 1980 to 2012 are used to estimate the Brazilian dairy sector model. Annual equilibrium prices are solved by minimizing the squared difference between supply and demand for four different markets: cheese, butter, milk powder, and fresh dairy products. Both RFS and sugar cane acreage expansion have negative impact on milk production in Brazil and positive effect on consumer price. However, the impact of US' RFS program is small. The model estimates appear to perform well in representing the actual dairy sector. The milk production forecasts were reasonable and the effects of shocks were well supported by the economic theory.

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