The Effects of Trade Liberalization on Dairy Trade and Domestic Milk Production in CARICOM

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Abstract

Domestic milk production in the major CARICOM states appears to be in crisis, with shrinking domestic production and increasing milk imports. This paper therefore investigates the impact of trade liberalization on domestic milk production and imports in Jamaica, Trinidad and Tobago and Barbados and determines trade factors that influence changes in these variables. The study demonstrates the dominance of dairy imports into CARICOM from New Zealand and the EU and the significant effects of trade liberalization in causing structural changes in domestic milk production and imports in the cases of Barbados and Jamaica. Changes in GDP per capita highly influence changes in milk imports for the three countries and for Jamaica also the price of imported powdered milk. The *Nestle* countries, Jamaica, and Trinidad and Tobago show greater declines in milk production than Barbados, therefore further research is recommended on the role of *Nestle* in the Caribbean milk industry.

Keywords: milk production, imports, trade liberalization, Caribbean

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Introduction

The CARICOM Dairy Industry

Little has been written about the Caribbean dairy industry since Aneja (1993). According to Aneja, the region (with a population of approximately 35 million) is one of the world's largest export markets for dairy products (20–25% of the world exports) and has a per capita consumption of milk of about 60kg per annum which is comparable with India's (Aneja 1993). He also states that local production then accounted for approximately 60% of total Caribbean milk consumption, with milk prices at US $1 per liter being among the highest in the world and a farm gate price of $0.25 per liter being lower than farm gate prices for milk producers in developed countries in Europe and North America (Aneja 1993).

The member states of the Caribbean Community (CARICOM) have never been major producers of milk and have imported substantial quantities of their dairy requirements. However there have been programs in the major states to increase milk production. One outstanding example of such a program is the State Lands Development Program in Trinidad and Tobago (Ministry of Agriculture, Land and Marine Resources 2005). The main fresh milk producers in the Caribbean region are Jamaica, Barbados, Trinidad and Tobago, Guyana and the Dominican Republic. The dairy industries of Jamaica and Trinidad and Tobago are organized around the multinational firm, Nestle Caribbean Ltd., headquartered in the Dominican Republic, whereas in Barbados, the industry is centered on a local firm, the Barbados Dairy Industries Limited.

The majority of the CARICOM states became members in 1995 of the World Trade Organization (WTO) and complied with the stipulations for membership under the Uruguay Round of GATT, which required the lowering of duties on the imports of agricultural commodities. Even prior to 1995 however: "Caribbean economies adopted liberal trade policies in the latter 1980's and (early) 1990's often as conditionalities for accessing finance from the International Monetary Fund (IMF) and the World Bank in the wake of macroeconomic disequilibrium" (ECLAC 2007). Even prior to 1995 also there appears to have been a drop in milk production and an increase in milk imports into the Caribbean. This paper examines these trends in the three major producing countries with organized dairy industries in CARICOM: Jamaica, Trinidad and Tobago and Barbados which have the "status as net-importers of basic foodstuffs" (WTO 2012). The paper also determines if there exists any relationship between these trends in the dairy industry in the Caribbean and trade liberalization.

Fresh milk in the Caribbean is largely produced by small farmers using a mixture of hand and machine milking (CTA 2012). Feeding systems vary but usually include a mixture of pastures (some with improved grasses) and high levels of concentrate feed, along with cut-and-carry systems (where feed is cut/gathered and taken to the cattle) (CTA 2012). Goat milk production by small producers is also a feature of the Caribbean dairy industry, especially with door to door delivery in rural areas. These producers often also rear small herds of sheep. However the lack of reliable information precluded an analysis of goat milk production and trade in this study.

Domestic milk production in several major Caribbean states became closely linked to the Swiss company *Nestle*, which introduced technologically advanced, consumer-ready milk packaging, most notably Tetra Pak packaging technology. *Nestle* Trinidad and Tobago Ltd. also initiated

production of evaporated milk in Tetra Pak packaging in 1989 (CTA 2000). *Nestle* has subsidiaries in Trinidad and Tobago, Jamaica, Puerto Rico and the Dominican Republic (*Nestle* Caribbean 2015).[1] In Trinidad and Tobago, the company also administers the state's milk price support program.

Barbados Dairy Industries Ltd. (BDIL) was established as a joint venture between the Government of Barbados, Northern Dairies of England, a Barbadian private enterprise and the New Zealand Dairy Board in 1966 (Banks Holdings Ltd.). Approximately 40% of local milk production was purchased by BDIL between 1970 and 1992, with this level increasing to almost 75% after 1993 (Kellman 2011). Banks Holding Limited acquired the BDIL in 1997, making it a wholly local enterprise, and the lone dairy processing plant on the island, with a collective capacity of 15,000 liters of milk per day. The processing plant controlled the supply of fresh milk through a quota system for the dairy farmers. The processing plant however suspended the milk quota system in July 2011 paying the full price for all milk (Barbados Dairy Industries Ltd. 2011). This resulted in an increase in milk supply and an ensuing milk glut, which forced the firm to re-instate the quota system from 1-July 2012 and to state that reform is needed in the fresh milk industry if the dairy farmer and the processor are to achieve growth (Barbados Dairy Industries Ltd. 2013). One of the major challenges to the industry identified by the company is the increasing input costs due to the relatively high cost of raw milk from local farms, as compared to imports of powdered milk-based products (Barbados Dairy Industries Ltd. 2013).

The shortfall of local milk production in the Caribbean has traditionally been met through imports of milk powder and other processed forms of milk from the United Kingdom, Canada, New Zealand, Denmark, the United States of America, as well as other countries. In recent years however there have been increasing imports of liquid products including 'fresh' ultra-heat treated (UHT) milk and other milk drinks, aided in large measure by government policies to enhance access to "cheap foods" (CTA 2012). Also, according to the CTA (2012) "notwithstanding high production costs and operational efficiency considerations, trade liberalization is widely blamed by Caribbean milk producers for the big contraction in the size of domestic dairy industries in all Caribbean dairy producing countries. In Trinidad and Tobago, for example, local milk production fell from 52% of consumption to 27% between 2000 and 2010. This can be taken as indicative of a general trend across the Caribbean" (CTA 2012). CTA (2012) concludes as follows: "(Thus) despite the efforts of dairy farmers, local processors and governments, by the end of 2011 the dairy industry in Caribbean countries, particularly local fresh milk production, was described as one of crisis, with dwindling profits, shrinking markets, no incentives and a lack of clear rules for the management of milk powder imports."

Objectives of the Paper

This paper has three objectives, the first of which is to trace the recent trends in domestic milk production and milk imports in three major producing states of CARICOM, Trinidad and Tobago and Jamaica as *Nestle* dairy states and Barbados with a dominant, locally owned dairy firm. The second objective is to determine the influence of trade liberalization on milk imports and the level of domestic milk production in the three CARICOM states. Specifically the paper assesses whether trade liberalization, including membership in the WTO has been a major influence on

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[1] The Nestle website unlike most progressive international firms is almost bereft of relevant corporate information.

reducing domestic milk production in the Caribbean. The third objective is to determine and compare factors that have influenced changes in the level of production and exports for milk and milk products in the three CARICOM states.

The paper in the first instance provides a detailed review of the trends in milk production and imports in the major dairy producing states in CARICOM, utilizing mainly FAOSTAT data (FAOSTAT). The literature is examined to determine factors that have been hypothesized to affect milk production and imports in the region. Then Vector Autoregressive Models for Multivariate Time Series (VAR) analysis is utilized to examine the relationships between time series of these factors or variables and milk production and imports in the Caribbean. This analysis includes the determination of Granger causality between the time series. Chow tests are also used to detect structural changes in dairy imports and milk production in the Caribbean which may be attributable to the impact of trade liberalization.

Trends in Production and Trade

Production

As seen in Figure 1, Jamaica has been the largest CARICOM milk producing state with milk production attaining a peak of 53,000 tons in 1991.[2] From 1991 however, there has been a major fall off in production which declined to 12,500 tons by 2013. Miller, Ffrench, Duffus and Jennings (2007) report that the Jamaican dairy sector recorded a decline in annual output of milk of approximately 63% since trade liberalization in 1992, primarily because of the inability of the local industry to compete with imports of dairy products (principally powdered milk), which "enjoyed massive producer and export subsidies at origin". They suggest that without effective countervailing measures to minimize trade distortions in the local market, the local industry was unable to compete with dumped substitutes, which reached the market place at retail prices as low as 45% below the price of locally produced fresh milk (fluid equivalent basis), even after the local trade had extracted retail margins (over FOB) as high as 118% (Miller, Ffrench, Duffus and Jennings 2007).

In another article, Rendleman (2011) states that in the late 1980s, Jamaica had a successful milk industry, in part because of policies that increased tariffs on imported milk powder. The tariff revenue was passed on to local dairy producers as a subsidy. Rendleman (2011) also states that in 1992, the World Bank required Jamaica to lift the tariff on imported milk powder as a condition for granting a loan. "Soon enough, Jamaica was flooded with imported, heavily-subsidized powdered milk. The milk powder wasn't all bad though because it was cheaper and didn't require refrigeration, which benefited poor families. On the other hand, the destruction of the local dairy industry weakened the long-term food security of Jamaica" (Rendleman 2011). In a similar vein CTA (2012) reports that the Jamaica Dairy Development Board and the Beef and Dairy Producers' Association of Jamaica openly stated in 2009 that the Jamaican dairy sector has undergone severe attrition, consequent to the adoption of a policy of trade liberalization in 1992, resulting in milk production declining 64% to current levels bordering on 14 million liters per annum.

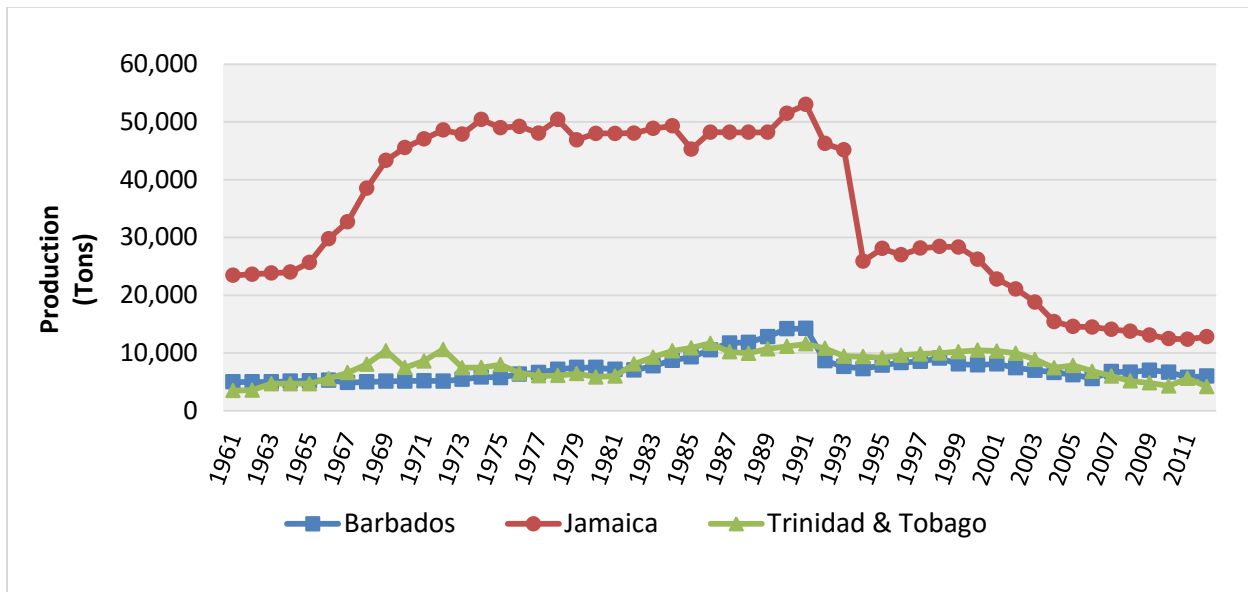[2] In this paper 1 ton = 1,000kg or metric ton.

Figure 1. Milk production in major CARICOM producing states
Source. FAOSTAT 2015

Trinidad and Tobago's milk production also declined after reaching a high point of 11,578 tons in 1991. There was a short revival of production from 1999 to 2001, but thereafter production declined steadily reaching to 5,098 tons by 2013. In the late 1980's to early 1990's, according to Singh, Rankine and Seepersad (2005), Trinidad and Tobago was one of the CARICOM countries seeking external financial assistance and implementing a Structural Adjustment Program (SAP). The SAP policy measures included the liberalization of domestic markets including the removal of non-tariff barriers followed by the progressive reduction in the level of tariffs and the reduction of agricultural subsidies with the intention of eventually eliminating them. Thus many of the policy requirements for membership of the WTO were already in place in 1995. On joining the WTO in 1995, Trinidad and Tobago implemented a four-phase schedule of tariff reductions between January 1, 1995 and July 1998 which resulted in the abolition of the import surcharge of 20% on liquid milk at the beginning of 1998 and by 2002, the average Most Favored Nation (MFN) tariff for dairy products was 20.2%, with a tariff of 40% on fresh milk and a tariff of 5% on powdered milk (Singh, Rankine and Seepersad 2005).

Domestic production of milk in Barbados has shown a similar trend. After reaching a high point in production of 14,253 tons in 1991, production fell sharply to 8656 tons in 1992 and since then it has fallen slowly but persistently to reach 6200 by 2013. However the slower rate of fall has meant that domestic milk production in Barbados has exceeded the level of domestic milk production in Trinidad and Tobago since 2007.

Kellman (2012) reports that the dairy industry in Barbados is under stress, in spite of the relatively more stable performance of the industry over the period under review. She states that (as already noted above) the Government reduced its role in the industry during the 1990's SAP and a quota system took effect for dairy farmers (Kellman 2012). By the end of 2010, she states "16 commercial dairy farmers remained in the industry—less than half of the thirty-seven registered farmers in 1990" (Kellman 2012). She also suggests that it is unlikely that milk-based imports had been responsible for the sharp drop in milk production in 1992; instead she states

that "the evidence suggests that trade liberalization is exerting pressure on the local industry" (Kellman 2012). She stated finally that her questionnaire-based responses identified several structural defects in the dairy industry which may have also contributed to the decline in milk production including: high farm-level costs of production; high input prices, reproductive and management issues, a paucity of industry support services and the absence of both industry-specific research and independent quality control (Kellman 2012).

Viability of Domestic Production

Figure 2 shows the ratio of 'domestic fresh milk production' to 'total milk supply' for the major CARICOM producing states, where the 'total milk supply' is the sum of 'domestic fresh milk production' plus 'total milk imports in terms of fresh milk equivalents'.[3] This Figure indicates that domestic fresh milk production remains a very important source of total milk supply for Jamaica and Barbados but has shown declining importance in Trinidad and Tobago. For Jamaica domestic fresh milk production provided almost all of the total milk supply for the period 1961-1963, falling to 63% of total milk supply by 1970. From 1977 it remained above 80% until 1990, when there was a precipitous fall to 48% in 1991, reaching a low 32% in 1997. There was a brief recovery to 67% in 1999 but thereafter it remained below 60% until 2011, with an all-time low of 26% in 2004.
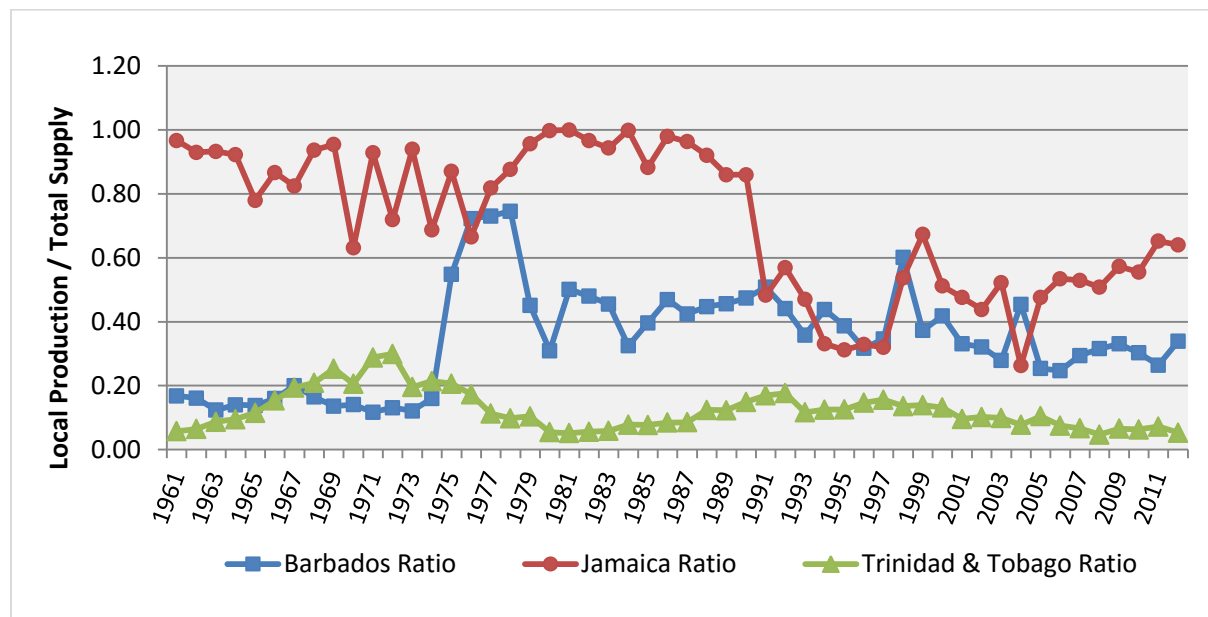

Figure 2. Ratio of local production to total milk supply for major CARICOM producing states
Source. FAOSTAT 2015

For Barbados, domestic fresh milk production provided below 20% of the total milk supply until 1974 and increased rapidly to 75% in 1978, with a rapid fall to 31% in 1980 and thereafter it has fluctuated between 30% and 50% until 1997. An increase of the percentage contribution of

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[3] The equivalents to whole fresh milk utilize the International Livestock Research Institute (ILRI) standards: Evaporated and Condensed milk - 6.6 and powdered milk - 7.6 milk equivalents. (International Livestock Research Institute).

domestic fresh milk production (60% in 1998) did follow the purchase by Banks Holding Limited of the BDIL in 1997. However this contribution had again fallen below 40% by 1999 and it has remained below 46% thereafter. For Trinidad and Tobago the domestic fresh milk production reached a high of 30% of the total milk supply in 1972 and thereafter it has remained below 20% to 2012.

Imports

Figure 3 provides the imports of milk products into the three major CARICOM states in milk equivalents. The major importer of milk products has been Trinidad and Tobago. For this country in Figure 3, the increased levels of imports after 1976 are due *inter alia* to both the inclusion of whole dried milk imports after 1979 and the very large imports of evaporated milk between 1982 and 1989. The plot for Jamaica shows a low level of milk imports before 1969 and fluctuating levels of imports between 1970 and 1977 and substantially lower imports thereafter until 1990. From 1991 there was a very large increase in milk imports corresponding to the fall-off in domestic production discussed above, with importation again falling rapidly after 2004. A possible reason for the rapid falloff in the milk imports after 2004 is the rapid rise in the price of imported whole dried milk into CARICOM from that year as shown in Figure 4. Miller, Ffrench, Duffus and Jennings (2007) suggest that this rapid price rise was "triggered by changing consumption patterns in the emerging economies of China and South Asia".
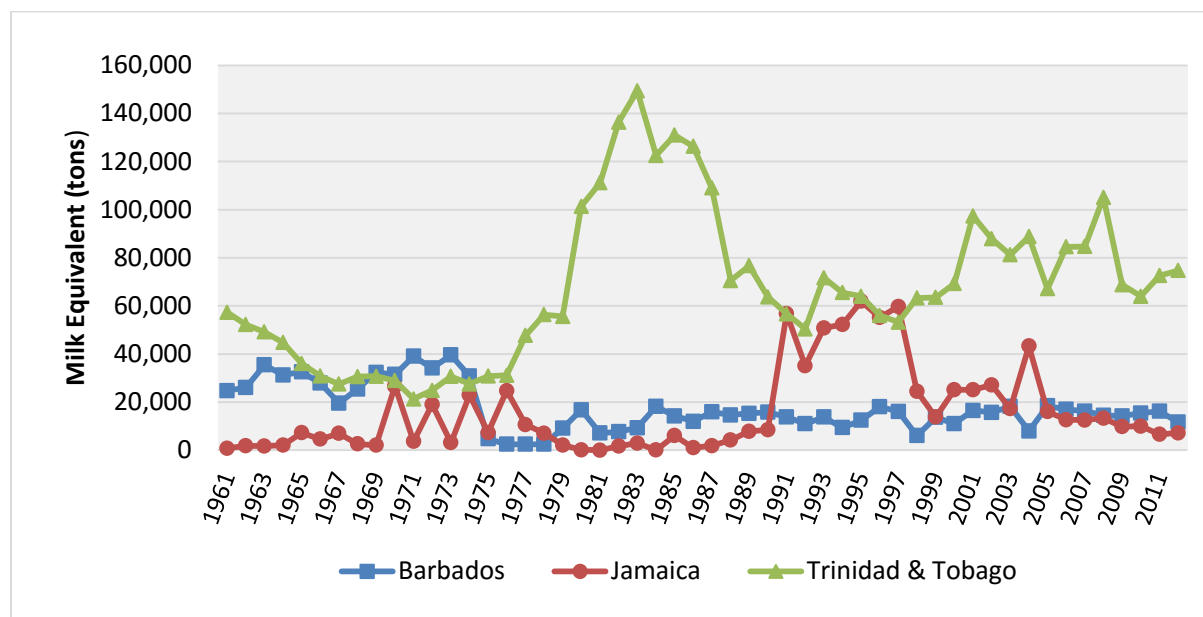

Figure 3. Milk imports into major CARICOM producing states
Note. The data for whole dried milk imports before 1979 was not available for Trinidad and Tobago.
Source. FAOSTAT (2015)

For Barbados in Figure 3, the level of imports fell after a peak level around 40,000 tons in 1973 and has been consistently below 20,000 tons thereafter. Imports fell after 2005, perhaps in response to the rapid rise in the prices of these imports after 2004 (see Figure 4). Also shown in Figure 4, whole dried milk imports, a relatively inexpensive product in 1961 at $1.06/kg peaked at $4.94/kg by 2008. The price was still $4.61/kg in 2012. Similarly, whole evaporated milk prices moved from $0.36/kg in 1961 to peak at $2.31/kg in 1990. There was a steep drop off in

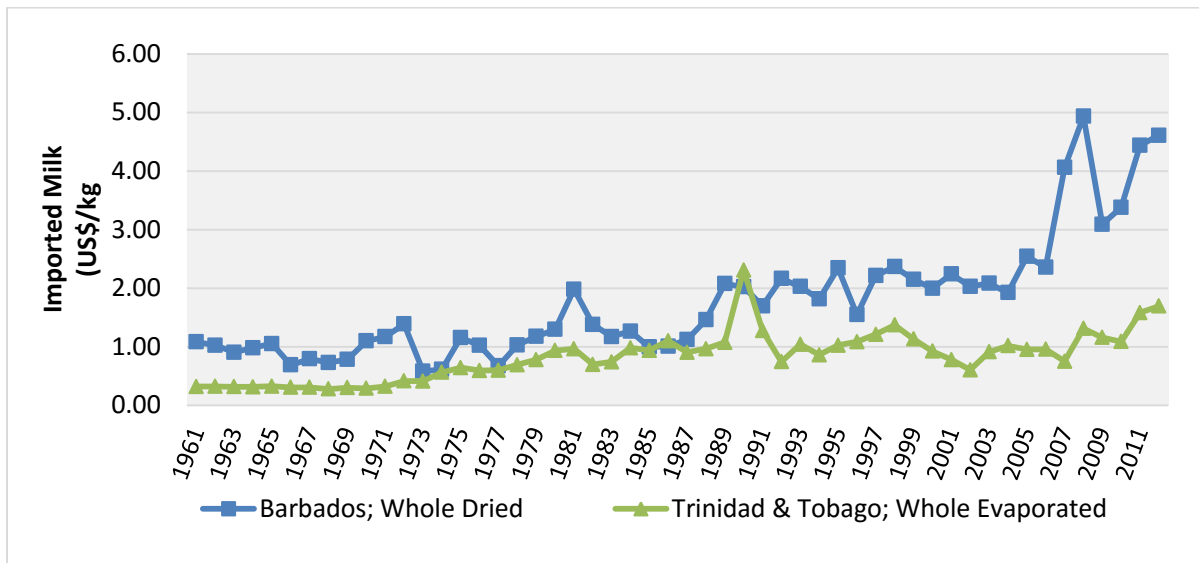prices to $0.75 in 1992 and thereafter the price has fluctuated between $0.61/kg and $1.70/kg up until 2012.

Figure 4. Average prices of selected milk imports into major CARICOM producing states
Source. FAOSTAT (2015)

Figure 5 gives an indication of the GDP per capita (current US $) for the three CARICOM states over the period 1961 to 2012, which indicates that all the countries have been experiencing an upward trend in GDP per capita. Trinidad and Tobago's petroleum based economy has shown a more erratic growth pattern over the period with high economic growth exhibited between 1977 and 1982 and 2002 to 2008 corresponding to periods of high oil prices.
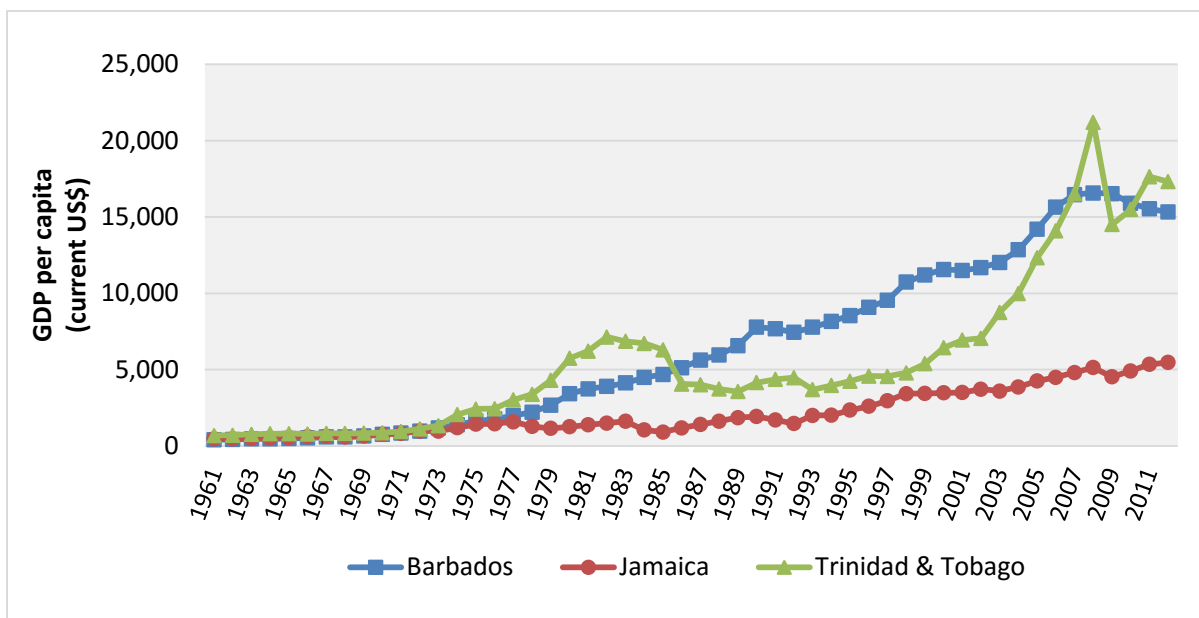

Figure 5. GDP per capita in current $ USD of major CARICOM producing states
Source. The World Bank (2015)

Gerosa and Skoet (2012) in an analysis of 100 middle to low income countries report that the income elasticity of demand for dairy products is positive (>0.72) so they conclude that increases in per capita income (or GDP per capita) lead to increased demand for dairy (and other livestock) products. OECD/FAO (2013) state that the demand for dairy products in developing countries in terms of milk equivalents is expected to grow at an average rate of two percent per annum because of inter alia "robust income growth". Hence for the three CARICOM countries increased GDP per capita could have been a factor causing increased demand for dairy products and hence increased dairy imports, with declining domestic fresh milk production in these countries.

Recent data for CARICOM on imports are available on the CARICOM Secretariat's Tradsys Online platform which allows access to the Regional Trade Information System (CARICOM Secretariat 2015). However, the data base only allows access to the SITC division and aggregate figures for "Dairy Products and Eggs". Utilizing this source, the principal sources of imports of dairy products and eggs into CARICOM are given in Figures 6 and 7. Figure 6 shows that the United States is the major exporter to CARICOM in this commodity code, although given the strong trade links between CARICOM and the United States in the poultry industry, these exports may consist of a substantial volume of hatching eggs. The next largest exporter to the Caribbean is New Zealand and these exports are likely to be almost exclusively dairy products as is the case of the next largest exporter the Netherlands. New Zealand and the European Union (EU) are the world's largest exporters of dairy products (Dairy Australia and FAO 2013). Figure 7 gives the next three largest exporters of dairy products and eggs to CARICOM which are the EU countries of Ireland and the UK (which again are almost exclusively dairy products) and also Mexico.
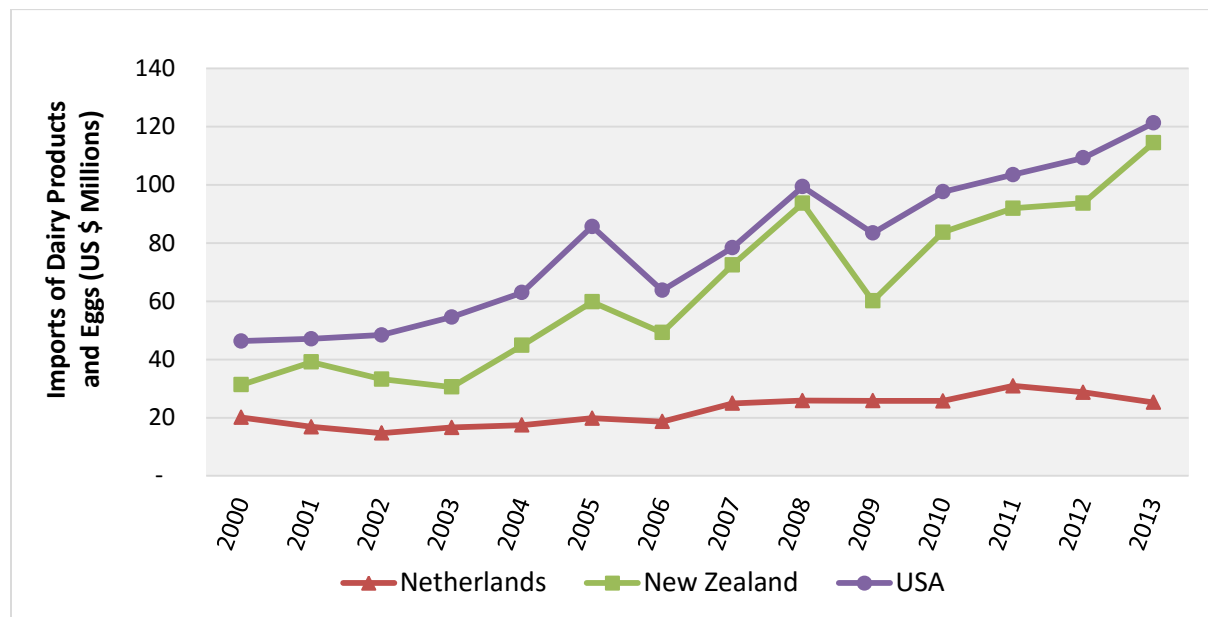

Figure 6. Three major sources of dairy products and eggs imports into major CARICOM producing states
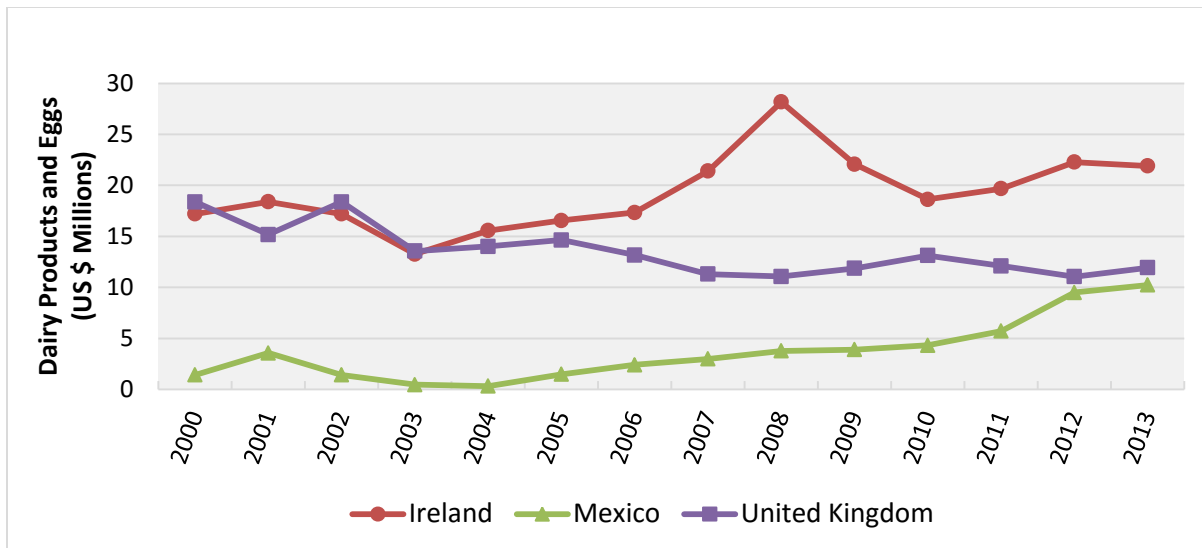**Source.** CARICOM Secretariat (2015).

Figure 7. Next three major sources of dairy products and eggs imports into major CARICOM producing states

Source. CARICOM Secretariat (2015)

Analytical Framework

The analysis in this study is based on tracing the changes in the domestic production as well as the level of imports (target variables) over time for milk for the three major CARICOM dairy producers, Jamaica, Trinidad and Tobago and Barbados and performing a determination of the causality of these changes. Since the domestic production and imports are likely to exhibit time trends, the data series for these variables are likely to be non-stationary, ruling out the direct application of ordinary least squares in simple explanatory models, because of the likelihood of spurious correlation (Buck 1999).

The study therefore determines whether other time series of variables associated with trade Granger-cause the target data series - domestic milk production and milk imports. Economic logic and the discussion from the literature of possible determinants of the changes in these data series given above suggest the possible causal variables for the target variables. Thus the following variables are hypothesized to Granger-cause the time series on milk imports: the GDP per capita representing the purchasing power of domestic consumers; the price of these milk imports; as well as the price of domestic milk if domestic milk is an effective competitor for imported milk products. The variables associated with trade that are hypothesized to Granger-cause the data series for domestic milk production are: the price of domestic milk, the level of importation of milk and the GDP per capita, if increasing household incomes cause dairy farmers to seek non-agricultural occupations.

VAR models are utilized in the study. As an example given three different time series variables, denoted by y_{1t}, y_{2t} and x_t where y_{1t} and y_{2t} are endogenous variables and x_t is an exogenous variable, where all the variables are assumed to be stationary, the VAR model of order 1 can be denoted as follows (Hendry and Juselius n.d; Viegi 2010):

1) $\quad y_{1t} = \alpha_1 + \phi_{11} y_{1t-1} + \phi_{12} y_{2t-1} + \phi_{13} x_t + \phi_{14} x_{t-1} + w_{1t}$

2) $\quad y_{2t} = \alpha_2 + \phi_{21} y_{1t-1} + \phi_{22} y_{2t-1} + \phi_{23} x_t + \phi_{24} x_{t-1} + w_{2t}$

Because of the presence of the exogenous variable, this model is sometimes referred to as a VARX (1) model (Bierens, 2004). Each endogenous variable is a linear function of the lagged values for all endogenous variables in the set and the exogenous variable, appropriately lagged.

The error terms or structural shocks, w_{1t} and w_{2t} are white noise innovations with standard deviations σ_{wt1} and σ_{wt2} and a zero covariance. Structural shock w_{1t} affects y_{1t} directly and y_{2t} indirectly.

Information Criteria (IC) such as the Akaike (AIC), Bayesian-Schwartz (BIC) etc. are used to choose the most appropriate number of lags in a VARX(p) model that minimizes the $IC(p)$ for $p = 1, \ldots, P$. Given the lag length (assumed to be 1 in equations 1) and 2) above) then estimates of the equations are obtained by Ordinary Least Squares. Granger-causal hypothesis tests are carried out using the appropriate F-statistic with the null hypothesis:

H_0: $\phi_{13} = \phi_{14} = 0$ (*To test, for example, the hypothesis that x_t does not Granger-cause y_{1t}*) and with the alternative hypothesis:

H_a: *any of ϕ_{13}, ϕ_{14} not equal to zero.*

P-values for the F-statistic are obtained from AustVet (2016).

The determination of the impact of trade liberalization on milk production and imports in the three target countries focuses on whether this impact coincided with membership in the WTO in 1995, or preceded it in the SAPs that the countries initiated prior to WTO membership. Two alternative approaches can be used to assess this impact of trade liberalization. The first alternative is the performance of Chow tests which involve running two regression models for the two periods created by the break point (pre and post – trade liberalization) and the regression equation for the entire data period and carrying out the test of the hypothesis of no structural break using the appropriate F-statistic. This approach has the advantage of detecting structural changes caused by adjustments to both tariff and non-tariff barriers in trade liberalization in the dairy and related markets in these countries. An alternative approach is to include the 'tariff rates on milk imports' and 'the level of country foreign exchange reserves' over the study period, as variables in the VARX. However this latter alternative approach is limited to a consideration of only tariff barriers and also could not be used in this study over its data period, as Barbados did not achieve its independence until 1966 and therefore tariff data for this country are not available prior to that year. This issue for Barbados, also precluded the use of time series for the 'level of foreign exchange reserves' as another possible variable to Granger-cause the time series on dairy imports, besides which, this variable only provides an indirect indication of trade liberalization.

Chow tests are therefore carried out in this study because of their advantage and the limitations of the alternative approach. To test whether structural changes in the dairy markets could be detected because of membership of the WTO in 1995, for the three target countries, a break point

of 1994 is used (pre and post–WTO). To determine whether structural changes because of trade liberalization preceded membership in the WTO, earlier break points are chosen based on the evidence provided in the literature reviewed, and an examination of Figures 1 to 3 above, as follows: Jamaica –1990, Barbados –1991, and Trinidad and Tobago –1992.

Augmented Dickey-Fuller stationarity tests of the data for the three countries found that the time series are non-stationary and $I(1)$. However these time series fail the Engle-Granger tests for co-integration (residuals of the co-integrating regression are non-stationary or the unit-root hypothesis is not rejected). The time series are therefore transformed using an alternative to differencing in the form of the natural logarithm of the ratio of the two levels (*log difference*) to generate the continuously compounded rate of return r (McGowan and Ibrahim 2012). However for low values of r the log difference is almost equal to the percentage change (Hamilton 2014). Thus this nomenclature "percentage change" is adopted to facilitate the explanation of the results of the VARX estimation.

Data series on local farm milk prices are inadequate for the purposes of this study. Therefore the variables for the VARX analysis carried out, based on equations 1) and 2) are the *log differences* for the period **1961** to **2012** as follows:[4]

y_{1tk} = **Milkprod** = Annual milk production in Country k (Trinidad and Tobago, Barbados and Jamaica)[1]

y_{2tk} = **MilkEqimp** = Annual milk imports in milk equivalents into Country k [1]

      With two exogenous variables:

x_{1tk} = **TTgdp or BARgdp or JAMgdp** = GDP per capita in Country k [2]

x_{2tk} = **Evapmilkpr** or **Drymilkpr** = Import Price of the Milk Product in Country k [1]

Source. [1] FAOSTAT 2015; [2] World Bank 2015

All of the transformed series are stationary $I(0)$ using the Engel Granger test. Portmanteau tests, specifically the Ljung-Box (LB) Q-tests are carried out for residual autocorrelation with the null hypothesis being no autocorrelation (Mathworks n.d.). Heteroscedasticity and autocorrelation consistent" (HAC) standard errors are utilized to correct for any residual autocorrelation, and this procedure is most effective in the absence of strongly auto-correlated time series. (Muller 2014). Information criteria tests determined that the appropriate lag length for all the VARX models is one.

Results

Table 1 shows the results for the VARX estimation for Trinidad and Tobago. The LB Q-test shows no significant autocorrelation, which favored the use of HAC standard errors (Muller

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[4] The sources of the data for the variables are provided below the variables.

2014). No variable is significant in the equation for the percentage change in Milk Production. For the percentage change in Milk Imports (in milk equivalents) annual percentage changes in GDP per capita significantly positively Granger-cause the percentage changes in milk imports as evidenced by the significance of the coefficients and the F-test carried out. There is also evidence that lagged higher prices for evaporated milk may have influenced a fall-off in dairy imports (and vice versa) given the significance of lagged price coefficient but this evidence did not extend to Granger causation. There is evidence of a weak and positive Granger causation between Milk Production (lagged) and Milk Imports, but more in the nature of a complementary as opposed to substitute relationship. For Trinidad and Tobago, the Chow tests do not detect any structural change for both milk production and imports because of trade liberalization, prior to or after membership in the WTO in 1995.

Table 2 shows the results for the VARX estimation for Barbados and indicates that the LB Q-test showed the absence of significant autocorrelation. Annual percentage changes in GDP per capita weakly Granger-cause the annual percentage change in Milk Production. For the annual percentage change in Milk Imports (in milk equivalents) annual percentage changes in GDP per capita (lagged) weakly influence the annual percentage changes in milk imports, but this influence does not extend to Granger causation. For Barbados, the Chow tests detect significant structural changes in the time series of both the annual percentage changes in milk production and milk equivalent imports from 1993 (break point 1992), prior to membership in the WTO. The Chow test also detects further significant structural change in the time series for the annual percentage change in milk equivalent imports with membership in the WTO from 1995.

Table 1. VARX Results Trinidad and Tobago

Trinidad and Tobago VAR system, lag order 1
OLS estimates, observations 1963-2012 (T = 50)
Log-likelihood = 43.3969
Determinant of covariance matrix = 0.0006
AIC = -1.1759
BIC = -0.6405
HQC = -0.9720
Portmanteau test: LB(12) = 36.4278, df = 44 [0.7842]

Equation 1: Milkprod
HAC standard errors, bandwidth 2 (Bartlett kernel)

	Coefficient	*Std. Error*	*t-ratio*	*p-value*	
Constant	0.0089	0.0230	0.3858	0.7015	
Milkprod-1	−0.0531	0.1751	−0.3031	0.7633	
milkEqimp-1	−0.0728	0.0987	−0.7375	0.4648	
TTgdp	−0.0520	0.0907	−0.5734	0.5694	
TTgdp-1	−0.0107	0.1170	−0.0911	0.9278	
Evapmilkpr	0.0064	0.0642	0.0990	0.9216	
Evapmilkpr-1	−0.0368	0.0877	−0.4197	0.6768	

Mean dependent var	0.0030	S.D. dependent var	0.1469	
Sum squared resid	1.0359	S.E. of regression	0.1552	
R-squared	0.0200	Adjusted R-squared	–0.1167	
F(6, 43)	0.1736	P-value(F)	0.9825	
rho	–0.0077	Durbin-Watson	1.8833	

F-tests of Zero Restrictions:

All lags of Milkprod	F(1, 43)	= 0.0919 [0.7633]
All lags of MilkEqimp	F(1, 43)	= 0.5439 [0.4648]
All lags of TTgdp	F(2, 45)	= 0.0632 [0.9388]
CHOW Test: break point at 1994	F(7, 35)	= 0.5718 [0.7737]
CHOW Test: break point at 1992	F(7, 35)	= 1.0140 [0.4385]

Equation 2: MilkEqimp
HAC standard errors, bandwidth 2 (Bartlett kernel)

	Coefficient	*Std. Error*	*t-ratio*	*p-value*	
Constant	−0.0428	0.0280	−1.5258	0.1344	
Milkprod-1	0.3518	0.1871	1.8799	0.0669	*
MilkEqimp-1	−0.0564	0.0792	−0.7124	0.4801	
TTgdp	0.4053	0.2161	1.8754	0.0675	*
TTgdp-1	0.3791	0.1363	2.7802	0.0080	***
Evapmilkpr	0.0404	0.1006	0.4016	0.6900	
Evapmilkpr-1	−0.1616	0.0721	−2.2431	0.0301	**

Mean dependent var	0.0072	S.D. dependent var	0.2001	
Sum squared resid	1.4819	S.E. of regression	0.1856	
R-squared	0.2448	Adjusted R-squared	0.1394	
F(6, 43)	4.0028	P-value(F)	0.0029	
rho	−0.0436	Durbin-Watson	2.0832	

F-tests of Zero Restrictions:

All lags of Milkprod	F(1, 43)	= 3.534* [0.0669]
All lags of MilkEqimp	F(1, 43)	= 0.50748 [0.4801]
All lags of TTgdp	F(2, 45)	= 5.3087*** [0.0085]
All lags of Evapmilkpr	F(2, 45)	= 1.228 [0.3025]
CHOW Test: break point at 1994	F(7, 35)	= 0.3379 [0.931]
CHOW Test: break point at 1992	F(7, 35)	= 1.056 [0.4116]

Table 2. VARX Results Barbados

Barbados VAR system, lag order 1		AIC = -0.0718	
OLS estimates, observations 1963-2012 (T = 50)		BIC = 0.4635	
Log-likelihood = 15.7959		HQC = 0.1320	
Determinant of covariance matrix = 0.0018		Portmanteau test: LB(12) = 55.242, df = 44 [0.1192]	

Equation 1: Milkprod

HAC standard errors, bandwidth 2 (Bartlett kernel)

	Coefficient	*Std. Error*	*t-ratio*	*p-value*	
constant	−0.0366	0.0340	−1.0760	0.2879	
Milkprod-1	0.1465	0.0939	1.5604	0.1260	
MilkEqimp-1	−0.0206	0.0207	−0.9941	0.3257	
BARgdp	0.4120	0.2146	1.9203	0.0615	*
BARgdp-1	0.1528	0.2162	0.7069	0.4834	
Drymilkpr	−0.0338	0.0458	−0.7370	0.4651	
Drymilkpr-1	−0.0066	0.0349	−0.1881	0.8517	

Mean dependent var	0.0036	S.D. dependent var	0.1010
Sum squared resid	0.4223	S.E. of regression	0.0991
R-squared	0.1549	Adjusted R-squared	0.0370
F(6, 43)	1.7941	P-value(F)	0.1230
rho	0.0423	Durbin-Watson	1.8915

F-tests of Zero Restrictions:

All lags of Milkprod	F(1, 43)	= 2.4348 [0.1260]
All lags of MilkEqimp	F(1, 43)	= 0.9882 [0.3257]
All lags of BARgdp	F(2, 45)	= 2.493* [0.094]
CHOW Test: break point at 1994	F(7, 35)	= 0.5879 [0.7611]
CHOW Test: break point at 1991	F(7, 35)	= 7.224*** [<0.0001]

Equation 2: MilkEqimp

HAC standard errors, bandwidth 2 (Bartlett kernel)

	Coefficient	*Std. Error*	*t-ratio*	*p-value*	
constant	0.0414	0.0783	0.5285	0.5999	
Milkprod-1	0.3042	0.3354	0.9069	0.3695	
MilkEqimp-1	−0.0336	0.1871	−0.1797	0.8582	
BARgdp	1.4863	1.6356	0.9087	0.3686	
BARgdp-1	−2.1258	1.2014	−1.7695	0.0839	*
Drymilkpr	−0.2917	0.2875	−1.0145	0.3160	
Drymilkpr-1	−0.0555	0.2236	−0.2482	0.8051	

Mean dependent var	−0.0159	S.D. dependent var	0.4918
Sum squared resid	10.8276	S.E. of regression	0.5018
R-squared	0.0864	Adjusted R-squared	–0.0410
F(6, 43)	1.7612	P-value(F)	0.1301
rho	−0.0361	Durbin-Watson	2.0601

F-tests of Zero Restrictions:

All lags of Milkprod	F(1, 43)	= 0.8225 [0.3695]
All lags of MilkEqimp	F(1, 43)	= 0.0323 [0.8582]
All lags of BARgdp	F(2, 45)	= 1.2125 [0.307]
CHOW Test: break point at 1994	F(7, 35)	= 2.3391** [0.0454]
CHOW Test: break point at 1991	F(7, 35)	= 2.377** [0.0425]

Table 3 shows the results for the VARX estimation for Jamaica. The LB Q-test again shows the absence of significant autocorrelation. No variable is significant in the equation for the percentage change in Milk Production. For the percentage change in Milk Imports (in milk equivalents) there are two instances of significant exogenous Granger-causation: the annual percentage changes in GDP per capita as well as the annual percentage in the Price of Whole Dry Milk evidenced by the significant F-Tests and coefficients. The lagged percentage change in Milk Imports also significantly Granger-influences the current level of Milk Imports. For Jamaica the Chow tests detect significant structural changes in the time series of both the annual percentage changes in milk production and milk equivalent imports from 1991 (break point 1990) four years prior to membership in the WTO. No further structural change in both time series is detected by the Chow tests after membership of the WTO in 1995.

Table 3. VAR Results Jamaica

Jamaica VAR system, lag order 1	AIC = 1.4247
OLS estimates, observations 1963-2009 (T = 47)	BIC = 1.9759
Log-likelihood = -19.4816	HQC = 1.6321
Determinant of covariance matrix = 0.0078	Portmanteau test: LB(11) = 52.4829, df = 40 [0.0893]

Equation 1: Milkprod
HAC standard errors, bandwidth 2 (Bartlett kernel)

	Coefficient	Std. Error	t-ratio	p-value
constant	−0.0118	0.0167	−0.7092	0.4823
Milkprod-1	0.2075	0.2036	1.0191	0.3143
MilkEqimp-1	0.0050	0.0139	0.3615	0.7197
Drymilkpr	−0.0028	0.0378	−0.0746	0.9409
Drymilkpr-1	0.0179	0.0379	0.4714	0.6399
JAMgdp	0.1412	0.0947	1.4911	0.1438
JAMgdp-1	−0.1226	0.2476	−0.4951	0.6232

Mean dependent var	−0.0130	S.D. dependent var	0.1067
Sum squared resid	0.4897	S.E. of regression	0.1107
R-squared	0.0642	Adjusted R-squared	-0.0761
F(6, 40)	0.5773	P-value(F)	0.7461
rho	−0.0271	Durbin-Watson	2.0474

F-tests of Zero Restrictions:

All lags of Milkprod	F(1, 40)	= 1.0386 [0.3143]
All lags of MilkEqimp	F(1, 40)	= 0.131 [0.7197]
All lags of JAMgdp	F(2, 42)	= 0.7060 [0.4994]
All lags of Drymilkpr	F(2, 42)	= 0.0620 [0.9400]
CHOW Test: break point at 1994	F(7, 32)	= 1.514 [0.198]
CHOW Test: break point at 1990	F(7, 32)	= 3.234** [0.0104]

Table 3. VAR Results Jamaica- *Continued*

	Equation 2: MilkEqimp				
	HAC standard errors, bandwidth 2 (Bartlett kernel)				
	Coefficient	*Std. Error*	*t-ratio*	*p-value*	
constant	−0.1167	0.1918	−0.6084	0.5464	
Milkprod-1	0.6866	0.7629	0.9000	0.3735	
MilkEqimp-1	−0.6103	0.1161	−5.2554	<0.0001	***
BARgdp	−1.1316	0.3629	−3.1180	0.0034	***
BARgdp-1	−0.8009	0.4309	−1.8588	0.0704	*
Drymilkpr	3.2715	1.1400	2.8696	0.0065	***
Drymilkpr-1	1.3825	1.4334	0.9645	0.3406	

Mean dependent var	0.0296	S.D. dependent var	1.3304
Sum squared resid	35.7454	S.E. of regression	0.9453
R-squared	0.5610	Adjusted R-squared	0.4951
F(6, 40)	20.0316	P-value(F)	1.19e-10
rho	−0.0623	Durbin-Watson	2.1202

F-tests of Zero Restrictions:

All lags of Milkprod	F(1, 40)	= 0.80997 [0.3735]
All lags of MilkEqimp	F(1, 40)	= 27.619*** [<0.0001]
All lags of JAMgdp	F(2, 42)	= 4.5871** [0.0158]
All lags of Drymilkpr	F(2, 42)	= 3.7209** [0.0325]
CHOW Test: break point at 1994	F(7, 32)	= 1.238 [0.3116]
CHOW Test: break point at 1990	F(7, 32)	= 2.929** [0.0174]

Conclusions and Implications

Malcolm (1999) suggests that the Uruguay Round of GATT and its implementation through countries attaining membership of the WTO would have had a major impact on dairy industries in developing countries through increased access to their markets, which had previously been protected by restricting imports through tariff and non-tariff measures. There was a lot of anecdotal evidence of such an impact of the WTO Uruguay Round measures on the dairy industries of the Caribbean. This was not demonstrated in this study except for the case of milk imports into Barbados, where the study was able to detect a structural change in the annual percentage changes in milk imports after membership in the WTO in 1995. For Barbados and Jamaica however the impact of trade liberalization on both milk production and imports has been detected pre-1995 most likely caused by the various SAPs that had been implemented in those CARICOM states. For Jamaica the changes are detected from 1991 and for Barbados from 1992. No impact of trade liberalization has been detected for Trinidad and Tobago perhaps reflecting the minor contribution of domestic milk production to total milk supply in that state as opposed to Barbados and especially Jamaica.

The study exposes the pattern of dairy imports into the Caribbean and the dominant role played by New Zealand and the EU, the major two players on the international dairy export market. The study also demonstrates that the percentage change in milk imports for the CARICOM states is highly influenced by the percentage change in GDP per capita. For Jamaica the percentage change in milk imports is also highly influenced by the annual percentage in the price of whole

dry milk and for Trinidad and Tobago there is a weak influence of evaporated milk price on milk imports. Thus for the three CARICOM states, increased imported milk products are associated with increased household incomes, in addition to trade liberalization. Indeed the results of this study provide support to the conclusions of Kellman (2012) that it was unlikely that increased importation of milk products *alone* was responsible for the sharp drop in domestic milk production in the three main CARICOM producers after 1991. Non-trade factors are probably more influential for Trinidad and Tobago where no trade liberalization effects have been detected in this study. Therefore the study recommends research into the structural defects of the CARICOM dairy industry as other possible causal factors of declining production levels including: high farm-level costs of production; high input price levels, reproductive and management issues concerning cattle production, a paucity of industry support services and the absence of industry-specific research as suggested by Kellman (2012).

This paper has important implications for milk trade and production in the Caribbean. For Barbados and Jamaica, trade liberalization by the various SAPs had a significant impact in increasing milk imports—the competition influenced a reduction in domestic milk production, which itself was suffering from a number of deficiencies just noted. To prevent such future disruptions to the CARICOM agricultural sector including the dairy industry, the decisions of the Tenth Ministerial Conference in Nairobi on the Special Safeguard Mechanism (SSM) for Developing Countries could be crucial (WTO 2016). This mechanism would allow developing countries to temporarily increase tariffs on agricultural products in cases of import surges or price declines (WTO 2016). If such a mechanism had existed it may have been invoked to provide some relief to the crisis created in the CARICOM milk industry with trade liberalization in the 1990s.

Many CARICOM countries still experience foreign exchange shortages and restrictions. A major area of foreign exchange outflows is in the importation of dairy products. The results of this paper have shown very persistent downward trends in domestic milk production in these Caribbean states that may be very difficult to reverse. With the very significant relationship between per capita GDP and milk importation, economic problems lowering the per capita GDP of these countries can therefore cause a sharp fall-off in milk demand and importation, which may have severe impacts on the levels of food security of these countries, especially Jamaica.

The paper also demonstrates that the two countries influenced by the large multi-national firm *Nestle* show a greater fall-off in milk production since 1990 than Barbados, where the industry is coordinated by a locally owned firm Barbados Dairy Industries Limited. This situation has led to Barbados producing more milk than Trinidad and Tobago in the more recent years since 2007. The presence of this multinational firm thus may not have been of major benefit in recent years to the CARICOM dairy farmers, although the firm is supposed to provide a guaranteed market for farmers' milk. Research is therefore warranted on the contribution of *Nestle* to Caribbean dairy development and the feasibility of alternative dairy policy options for the Caribbean including cooperatives (Anderson et al. 2006; Aneja 1993).

Finally the paper has direct implications for the small milk producers in the Caribbean, many of whom still depend largely on this industry for their livelihood. It is therefore highly recommended that attention be placed on policies to assist in the alleviation of farm level

problems noted above, to assist in saving the dairy industry in the Caribbean and the livelihoods of thousands of small scale producers.

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