

## **SPILOVER EFFECTS OF U.S. FEDERAL RESERVE'S RECENT QUANTITATIVE EASING ON CANADIAN COMMODITY PRICES**

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### **Abstract**

*In this study, we evaluate the spillover effects of the recent U.S. Federal Reserve's purchase of long-term assets (quantitative easing) on prices of Canadian commodities. The first large-scale asset purchases happened after the Great Recession, at the end of 2008, and the second purchases were in November of 2010. Since the U.S. is a large country, those policies have international spillover effects, particularly on Canada, a major economic partner. The commodities included in this analysis are Canadian livestock (cattle, hogs, and poultry), cereal grains (corn, soybeans, and wheat), softs (sugar, coffee, and cocoa), and energy (crude oil and natural gas). Using historical decomposition graphs, we find significant spillover effects on the Canadian commodity prices under investigation in the immediate neighborhood (seven-month horizon) of the large-scale asset purchases, especially the second round of quantitative easing.*

**Key Words:** *Quantitative easing, Canadian agricultural commodity prices, spillover effects, historical decomposition graphs*

### **1. Introduction**

The worst recession since the Great Depression hit the United States in 2007. It was not the typical recession where inventories simply needed to be depleted, but instead was a financial recession where balance sheets needed to be improved. The federal government already had a large budget deficit, so the Federal Reserve Board (Fed) lowered interest rates to very low levels. After the federal funds rate went below 0.25 percent, the Fed needed other means to stabilize financial markets and restore confidence in the economy. Those policies included purchasing assets, such as long-term Treasury and mortgage-backed securities, on a large scale. This policy is referred to as quantitative easing (QE).

The first large-scale asset purchases (LSAPs) were announced at the end of 2008 (QE1). As the recession worries continued, and the fact that the federal funds rate could go no lower, the Fed implemented another round of LSAPs in order to provide additional stimulus to the U.S. economy. The second LSAPs were formally announced on November of 2010 (QE2 in 2010-2011). The motivation for these purchases was to decrease long-term interest rates faced by households and businesses in order to increase private investment and consumption spending.

There has been some research on the effects of these two QE episodes on the U.S. macro economy (i.e., Hancock and Passmore 2011; Krishnamurthy and Vissing-Jorgenson 2011; Wright 2011; Doh 2010; D'Amico and King 2010; Gagnon *et al.* 2010; Hamilton and Wu 2010; Joyce *et al.* 2010; and Neely 2010) and some analyses are specifically oriented towards their effects on commodity prices (Kozicki *et al.* 2012; Glick and Leduc 2011). Glick and Leduc (2011) argue that QE2 increased global food prices by almost 50 percent within seven months of its announcement; a huge impact. Kozicki *et*

*al.* (2012) argue that QE1 increased commodity prices by 42 percent throughout 2009, and commodity prices rose another 37 percent between the Fed Chairman's speech on August 10, 2010 and the end of March 2011. Saghaian and Reed (2014) estimate that QE1 had virtually no effects on commodity prices, while QE2 increased most commodity prices by 15-40 percent. These commodity studies used prices in U.S. dollars, but no study has explored the effects of quantitative easing on prices in other countries. There is reason to suspect that changes in exchange rates might not fully compensate for U.S. dollar price increases, resulting in price effects for other countries.

This study investigates the impacts of quantitative easing on Canadian commodity prices. We use historical decomposition graphs to investigate the effects of LSAPs on prices of 11 Canadian commodities in the immediate (time) neighborhood of QE1 in 2008-2009 and QE2 in 2010-2011. It is hypothesized that these atypical U.S. expansionary policy actions had international spillover effects, given the large size of the U.S. economy and its integration with the Canadian economy through geographic proximity and the North American Free Trade Agreement (NAFTA). Canada is the perfect choice to study these spillover effects. We allow the announcement effects of QE1 and QE2 to differ because the world economic situation differed at those times. Much of the world financial economy was in disarray when QE1 was announced, whereas the financial world was more stable when QE2 was announced (though economic growth was still negative in many locations). These impacts of U.S. monetary policy are important to Canada and the results of this study could be indicative of the effects QEs have had on other economies that are closely linked to the U.S.

## **2. Monetary Policy Impacts and their Potential Spillovers for Canada**

An increase in the U.S. money supply increases commodity prices through an array of transmission channels (Kozicki *et al.* 2012; Glick and Leduc 2011). One important mechanism for traded goods is through depreciation of the U.S. dollar. Since commodities are traded internationally and priced in U.S. dollars, they become more affordable and their demand increases, increasing dollar prices. For Canadian commodities, though, these two effects tend to cancel each other and could leave the Canadian dollar price for commodities unchanged if both own price and exchange rate changes are fully transmitted into Canada.

Expansionary U.S. monetary policy also increases aggregate demand and promotes economic growth, which increases demand for commodities and their prices. This should lead to higher U.S. dollar prices and also higher Canadian dollar prices as more goods are consumed in the U.S., *ceterus paribus*. This effect would exacerbate the increase in U.S. commodity prices with potential impacts for all countries.

Interest rates in the U.S. fall with expansionary monetary policy, which decreases the cost of carrying inventories and boosts inventory demand for commodities. That in turn, leads to an increase in the price of storable commodities. Lower U.S. interest rates might lead the Bank of Canada to lower its interest rates to stem an inflow of international investment into Canadian assets (and an appreciation of the Canadian dollar). These lower U.S. interest rates also lead to portfolio reallocation, leading to increased demand for other assets such as commodities (Kozicki *et al.* 2012). Lower Canadian interest rates would provide the same signal and incentives.

Finally, expansionary monetary policy can lead to more pronounced commodity price movements due to overshooting (Dornbusch 1976; Frankel 1986). Prices of agricultural commodities are relatively flexible and respond more quickly to monetary shocks than prices of other goods. As a result, QE could lead to higher inflationary expectations that manifest quicker in the prices of agricultural commodities. These overshooting impacts can have particularly important impacts on commodity prices in the short-run.

Since QE happened in two different economic circumstances, we investigate the effects of LSAPs on Canadian agricultural commodity prices during both rounds of QE announcements, and compare those results. The analysis of eleven agricultural commodities will allow us to see whether QE effects differ by individual market situations as well. The first round of QEs (QE1 in 2008-2009) was announced in

the middle of the Great Recession when the U.S. economy was in disarray. QE2 was announced (2010-2011) when financial turmoil had eased greatly and the U.S. economy was showing some signs of recovery. Therefore, these events could have different spillover effects on Canadian agricultural commodity prices.

### **3. Data Description and Empirical Method**

The commodities analyzed are Canadian price of corn, soybeans, wheat, cattle, hogs, poultry, sugar, coffee, cocoa, crude oil and natural gas. The findings may be linked to different characteristics of the markets for these commodities. For example, corn and soybean products are used as an input in livestock production, while cattle, hogs, and poultry are livestock products (outputs). Coffee and cocoa are imported perennial crops while crude oil and natural gas are important natural resources for Canada.

The dataset is monthly for the 2000:01 through 2013:06 time periods. The prices for Canadian corn and soybeans are both in terms of Canadian dollars per metric ton. Natural gas prices are Canadian cents per cubic meter. Corn, soybeans and natural gas price data are from Statistics Canada. Sugar, green coffee, cocoa, wheat, cattle for slaughter, hogs for slaughter, poultry and crude oil are indexed values taken from Statistics Canada raw materials CANSIM database.

This study uses contemporary time-series analysis for very short-run projections of commodity prices. All variables in the time series model are checked for unit roots and co-integration using standard techniques (Enders 1995; Johansen and Juselius 1992; and Juselius 2006). Because the variables were co-integrated a vector error correction model was employed and in that context we used historical decomposition graphs to focus on a short window after each QE announcement. The time series estimations are available upon request. Thus the VEC models are used to come up with the counterfactual estimates for commodity prices in the very short run. This method does not address the long-run growth impacts on commodity prices, but that is beyond the scope of the present study.

The challenge in the analysis of macroeconomic linkages to commodity prices is to isolate the effects of macroeconomic variables from the individual commodity supply-demand effects within the data. Hence, it is difficult to isolate the effects of more encompassing variables such as LSAPs. The historical decomposition graphs are applied to individual commodity prices to investigate possible differences in responses to LSAPs. Historical decomposition graphs clarify the dynamic properties of commodity price effects from LSAPs. Understanding the dynamic responses of different commodity prices will increase our insight about monetary policy spillover effects and the relationship among commodities such as corn and soybean as livestock inputs, and cattle, hogs, and poultry as livestock outputs. Different price paths can be justified by differing characteristics of the commodities under investigation such as their production process, tradability, and storability.

Historical decomposition is usually applied to macroeconomic shocks; and measuring the magnitude of price transmission due to the QEs can be handled by historical decomposition graphs. Using historical decomposition graphs and examining the time-path of commodity prices can help explain how Canadian commodity prices react to U.S. monetary policy actions, while also taking into consideration the simultaneity among those prices. Historical decomposition decomposes the historical values of a set of time series into a base projection and the accumulated effects of current and past innovations. Historical decomposition has been used for the investigation of market events such as the 1987 U.S. stock market crash (Yang and Bessler 2008) or oil supply shocks (Kilian 2008). We employ historical decompositions to quantify contributions of the QEs to changes in the price series.

A great merit of the historical decomposition is that we can follow the effects of changes in monetary policy on commodity prices along time. Other methods such as impulse response functions or forecast error variance decomposition analyze the overall effects of monetary policy changes. In contrast, historical decomposition can analyze the role of monetary policy changes in a specific and short time-period. Even though the overall effects of monetary policy changes could be relatively small, they might be the dominant source in some specific time-period.

Historical decomposition graphs are based on partitioning the moving average series into two parts:

$$P_{t+j} = \sum_{s=0}^{j-1} \psi_s U_{t+j-s} + \left[ X_{t+j} \beta + \sum_{s=j}^{\infty} \psi_s U_{t+j-s} \right] \quad (1)$$

where  $P_{t+j}$  is the multivariate stochastic process,  $U$  is its multivariate noise process,  $X$  is the deterministic part of  $P_{t+j}$  and  $s$  is counter for the number of time periods (RATS software 2006; and Fackler and McMillin 2002). The first sum represents that part of  $P_{t+j}$  due to innovations that drive the joint behavior of commodity prices for period  $t + 1$  to  $t + j$ , the horizon of interest, and the second is the forecast of price series based on information available at time  $t$ , the date of an event—that is, how prices would have evolved if there had been no changes (RATS 2006). The noise process is included in both parts, but for two different time periods. It drives the moving average for the two partitions, one for the process that incorporates the change, and another for the purpose of forecast estimates.

#### 4. Empirical Results

Figures 1 show the historical decomposition graphs of the Canadian commodity prices under investigation for a seven-month time horizon using RATS software. The left column shows the results for U.S. QE1 in 2008-2009, and the right column shows those for QE2 in 2010-2011. The solid lines are the actual prices which include the impact of the LSAPs and the dashed lines are the predicted prices excluding the effects of any change. The dynamic impacts of LSAPs can spread over many time periods or dissipate quickly. However, we do not focus on prices very far into the future because we are more interested in the contemporaneous nature of their impacts. Furthermore, it is likely that other shocks would occur after a few months to cloud their impacts. For this study, we have emphasized a seven-month time period for forecasting and testing the impact of U.S. LSAPs while utilizing all the observations from the data set.

The historical decomposition results show that QEs impacted commodity prices differently and the magnitude of price effects were also substantially different for the Canadian commodity prices under investigation. The spillover effects of QE1 on Canadian prices in 2008-2009, when the economy was in the middle the financial crisis and amid great uncertainty, were mixed, even though the first round of expansionary monetary policy led to reduction in long-term interest rates (Gagnon *at al.* 2010). Prices of Canadian corn, wheat and soybeans fell right after the monetary expansion, but soybean prices rebounded after December while corn and wheat did not. Prices of hogs fell, but cattle prices increased. In the latter case, the predicted prices (dashed line) increased as well, an indication that spillover effects were minor. The price of poultry was up in September of 2009, but came back down in October. Coffee and cocoa prices fell, while sugar prices increased; again mixed results. The price of crude oil fell, but the natural gas price was up in September and then back down. There don't seem to be any clear effects of QE1 among these Canadian prices.

The actual prices of most commodities (the solid lines), which include the impact of the QE event, are below or very close to the predicted prices that exclude the effects of the QE (dashed lines). Therefore, even though the U.S. Fed had engaged in an unprecedented expansionary monetary policy, the actual prices depicted by the historical decomposition graphs in the time interval right after the announcement, show no positive impacts on Canadian prices. If one concentrates on the two months after the announcement (November – January), there were four commodities that were negatively affected (corn, hogs, poultry, and oil) and three commodities that were positively affected (wheat, cocoa, and sugar). Most of these effects were less than 15 percent with the largest being for oil (around 60 percent), which could reflect non-macroeconomic factors. These results are somewhat consistent with the results of Glick and Leduc (2011). They found that U.S. commodity prices declined with the looser monetary policy in 2008-2009. The differing results by commodity may reflect the economic agents' uncertainty regarding the current and future state of the economy at the time and enormity of the Great Recession of 2007.

The historical decomposition graphs depicting the spillover effects of U.S. QE2 in 2010-2011 on Canadian commodity prices tell a very different story. Looking at the historical decomposition graphs in the right column of the figure, we see a jump in actual prices (solid lines) of all 11 Canadian commodities under investigation. The results for the QE2 effects on commodity prices are contrary to Glick and Leduc (2011) results; they found U.S. commodity prices falling with the new round of expansionary monetary policy, but are consistent with the findings of Saghaian and Reed (2014). These price jumps started mostly in September, right after the Fed's second LSAP announcement was released on August 10, 2010 and the U.S. Fed Chairman's speech relating to the new round of LSAPs on August 27.

The historical decomposition graphs reveal that prices fluctuate differently among the commodities and have different magnitudes in response to the monetary policy change, but mostly have a positive trend, so the inflationary impacts linger for a while. If one calculates the price uplifting effects in January 2011, they vary from natural gas at two percent to corn at 25 percent; hogs is the only commodity with a negative effect from QE2, though the effect turned positive by February. These impacts are all lower than the impacts found by Saghaian and Reed (2014) for U.S. agricultural commodity prices, which is expected since their findings of higher U.S. commodity prices would be tempered by a depreciated U.S./Canada exchange rate.

These different findings among commodities could be due to the differences in product and market characteristics. Corn, soybeans, and wheat are storable products and corn and soybeans are important feed ingredients; their prices seem more sensitive to the monetary stimulus. Hog and poultry prices are also quite sensitive to the monetary stimulus, though cattle prices are less so. The potential overshooting of agricultural prices may explain the differences in these results. Frankel (1986 and 2008) emphasizes the impact of monetary policy on overshooting of commodity prices. He focuses on the role of interest rates on the desire to hold commodity inventories. He argues easy monetary policy reduces interest rates and that could increase commodity prices, particularly storable commodities.

There are other factors that could explain the differences in commodity price reactions to monetary change, such as biological lags, the vertical nature of production (including the percentage of fixed assets), and product differentiation. One might hypothesize that a commodity with long biological lags, highly vertical production systems, and less product differentiation to have more price overshooting and longer adjustment times. In each of these cases, producers have less control over their supply or demand conditions, so if macroeconomic factors move the market in one way, it takes more time to adjust to a new equilibrium.

Beef, which has the longest biological lag among the commodities analyzed, could react more than broilers (*ceteris paribus*) to monetary change because it takes time for economic decisions to be manifested in output changes. Yet, beef production typically is less vertically integrated and has fewer fixed assets in the production process. This might shorten the adjustment and result in a smaller but faster reaction. In this analysis we find that the spillover effects are larger for hogs and poultry than beef. Note that there are likely to be conflicting influences for all commodities, yet overall there are clearly positive price effects of QE2.

The softs analyzed were all imported goods (cocoa, coffee, and sugar) and their reactions to QE2 were different also. Without QE2, all of these goods would have had a downward trend over the seven months. However, with QE2, each of the three goods experienced price increases right after the announcement in November (though their price reactions before the announcement differed). Each reached a peak within the time period analyzed but the drop in coffee prices was very small, whereas the drops in cocoa and sugar prices were large and rapid. At their peak coffee and sugar prices were 17% above the level without QE2, while cocoa prices were 8% above the level without QE2.

Natural gas prices in Canada were lower because of QE2, while oil prices were higher, though neither change was large. These natural resource prices were likely influenced by many other factors during this period that swamped any spillover impacts from QE2. The changes in demand for oil from Canadian tar sands, political factors in the Middle East and other energy-producing countries, and the transformation of the natural gas industry in the U.S. through fracking technology were very important

factors in these prices. These other factors either cloud the macroeconomic spillover effects or there were simply not spillovers for these energy-related commodities.

Overall the two LSAPs events had different spillover effects on the Canadian commodity prices under investigation. As was indicated earlier, the impacts of those announcements depend on the state of the economy at the time, the characteristics of the products, as well as perceptions of risks associated with the expansionary policy actions. Price reactions under QE1 were mixed, but mostly fell with the announcement, while QE2 had just the opposite impact. With QE2, actual prices (solid lines that include the impact of the LSAP) were all higher than forecast prices (dashed lines that exclude the effects) immediately after the second monetary announcement.

## **5. Summary and Conclusions**

The U.S. Federal Reserve Board implemented unprecedented expansionary monetary policy programs on two different recent occasions, purchasing long-term securities and other assets in order to decrease long-term interest rates and stimulate the economy. This paper examined the spillover impacts of these LSAPs on Canadian commodity prices using historical decomposition graphs.

Monetary policy affects commodity prices through various channels. When the Federal Reserve lowers interest rates to stimulate the economy by buying bonds and other assets, demand for commodities could rise, increasing commodity prices (Frankel 2008). Like other financial market prices, commodity prices are relatively flexible and adjust quickly in response to macroeconomic changes. Any effects of monetary policy announcements on commodity prices likely occur within a short period around a particular news-related event. The event days are when the Federal Reserve's Open Markets Committee meets and financial markets acquire new information about the course of monetary policy.

This paper visually demonstrates the spillover effects of those monetary policy changes on Canadian commodity prices. Our results show those money supply changes had spillover impacts from QE1 and QE2, affecting Canadian commodity prices, increasing their volatility, and causing large swings in those prices during the first seven months after the LSAPs events. The effects for QE2 were more consistent and positive among commodities.

While our focus in this research is on agricultural commodities, international prices of other commodities such as Aluminum, Copper, Lead, Nickel, and Zinc also increased right after QE2, though the *Economist* (November 11, 2010) attributed that to change in growth policies of China, a major consumer of those metals. We feel that analysts might be overlooking the short-term impacts of expansionary U.S. monetary policy. This is a future avenue for research, since these findings indicate that the specific effect by commodity varies.

The second round of quantitative easing was criticized by other central banks such as the European Central Bank. The major concern was that the increased liquidity could spill over to their markets. In response, they began tightening their money supplies and increasing interest rates (resulting in a stronger euro). The argument was that with interest rates being near zero, the increased liquidity was chasing commodities and other assets. This shows that countries sometimes change their macroeconomic policies to counteract changes in U.S. macroeconomic policy. We found that Canada did not change their macroeconomic policies enough to completely counteract the spillover effects from the U.S.

The conclusion from this study is that monetary policy changes by a large country like the U.S. have spillover effects, and can cause wide swings in commodity prices for other countries. Smooth, steady increases in the money supply allow fundamental supply and demand factors to be the predominant force behind price movements. Changes in the money supply might not affect commodity prices much in the long-run, but those money supply changes can initiate large price movements in the short-run, destabilizing agricultural commodity markets. If farmers are risk averse, they will prefer that monetary policy concentrate on stable changes in the money supply that will provide little stimulus for agricultural prices to change dramatically.

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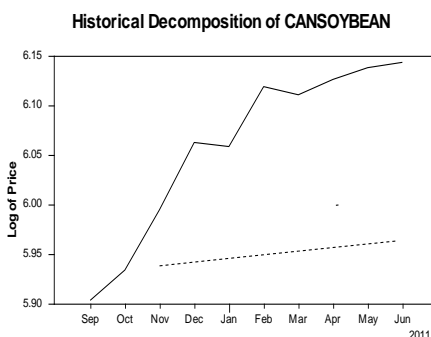
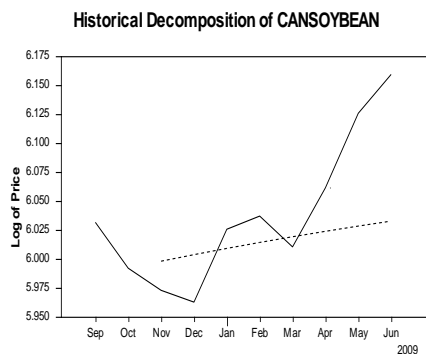
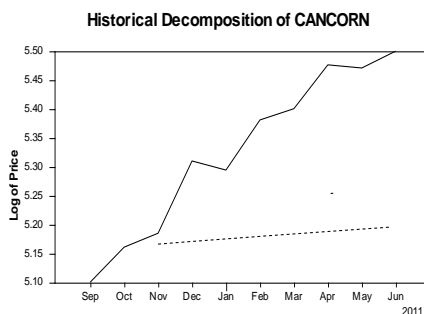
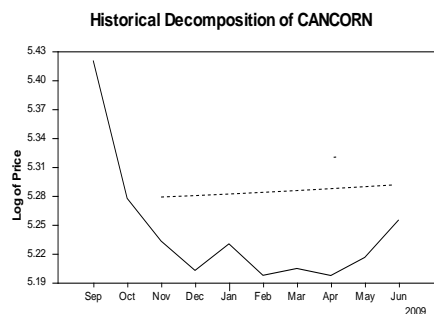
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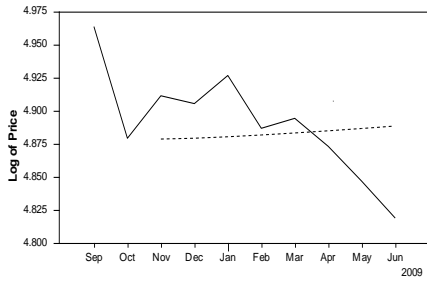
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**Appendix:**

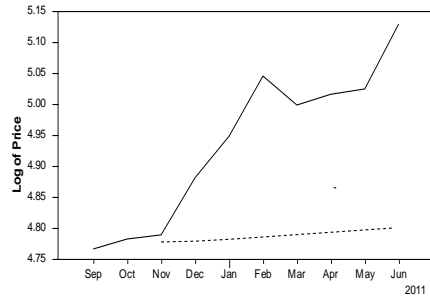




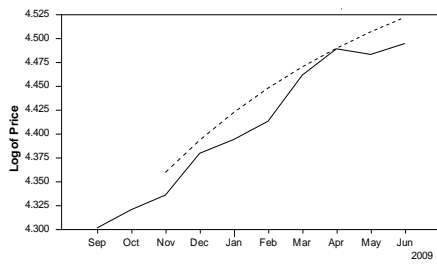
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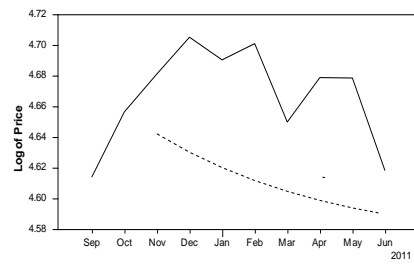
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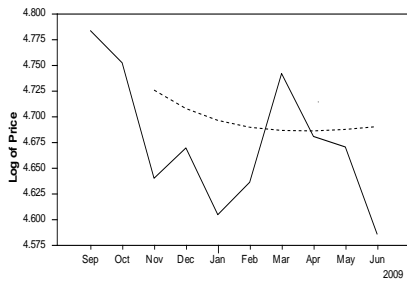
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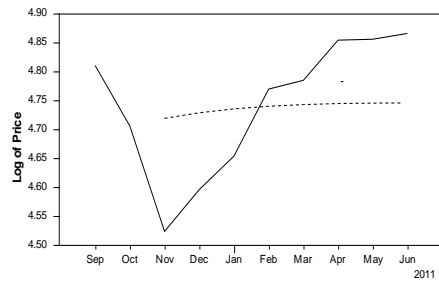
Historical Decomposition of CANCEATTLE



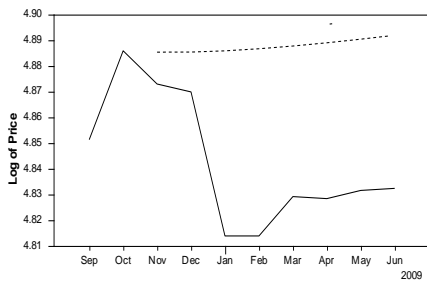
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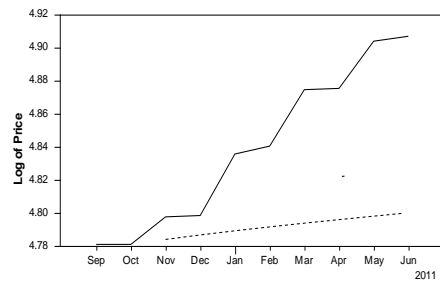
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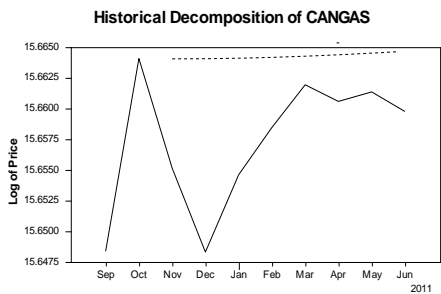
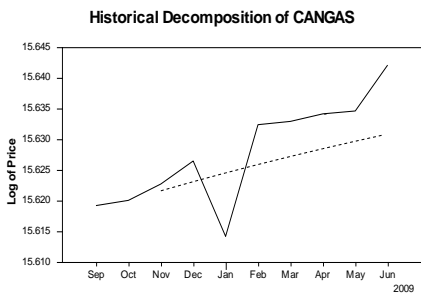
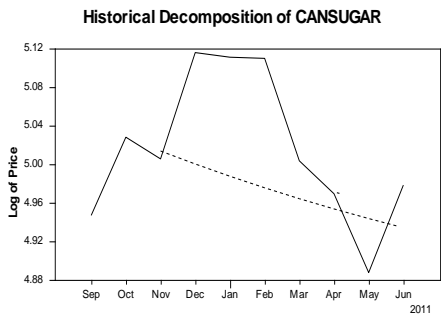
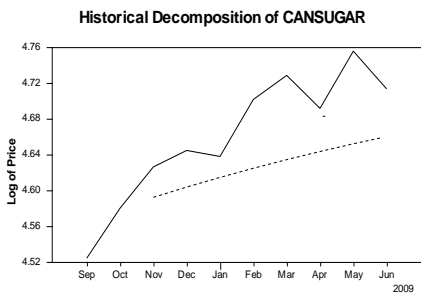
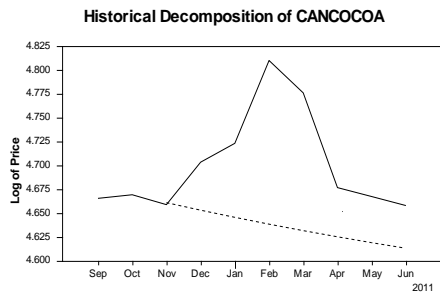
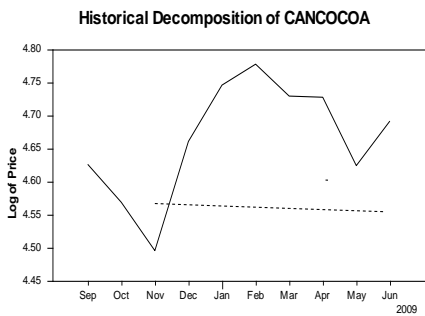
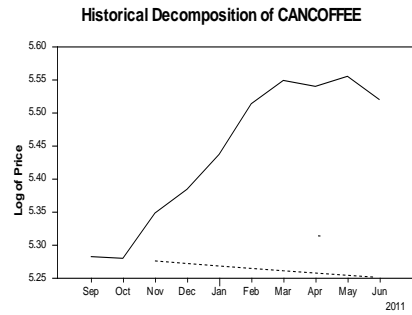
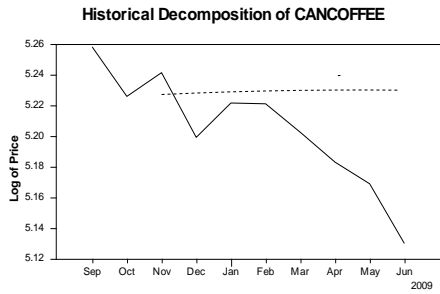
Historical Decomposition of CANPOULTRY

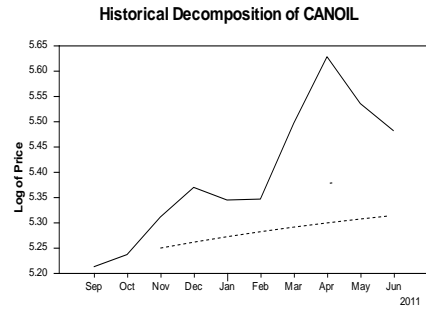
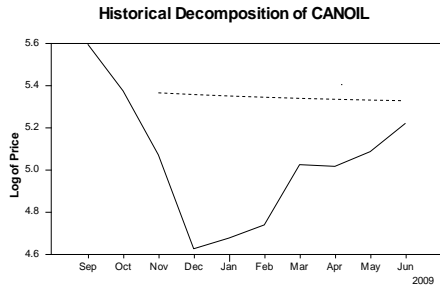


Historical Decomposition of CANPOULTRY



*Spillover Effects Of U.S. Federal Reserve's Recent Quantitative....*





*Actual Prices (including the events):* \_\_\_\_\_

*Forecasted prices (excluding the events):* -----

**Figure 1. The Effects of the Recent Federal Reserve’s Purchases of Long-Term Assets on Prices of Canadian Agricultural Commodities.**