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Differential Impacts of Country of Origin Labeling: COOL Econometric Evidence from Cattle Markets

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Abstract
Country of origin labeling (COOL) is a common practice. It occurs routinely for many products in many places, but the US implementation of mandatory COOL for meat, whose purpose is to identify the origin of the livestock used to produce the meat, generated much controversy and a major WTO dispute that has yet to be settled. This working paper estimates econometrically differential market impacts of mandatory country of origin labels on cattle raised in Canada and imported into the United States. We find significant evidence of differential impacts of COOL through widening of the price bases and a decline in ratios of imports to total domestic use for both fed and feeder cattle.

Résumé
L'étiquetage indiquant le pays d'origine (EPO) est une pratique courante qui est appliquée à plusieurs produits par plusieurs pays. Toutefois, son application pour la viande commercialisée aux États-Unis, qui a pour but d'identifier la provenance des animaux à partir desquels la viande est produite, a généré une énorme controverse et fait l'objet d'une dispute à l'OMC qui n'est pas encore réglée. Ce cahier de recherche présente des résultats économétriques des effets de segmentation de l'EPO sur le marché pour les importations américaines de bovins canadiens. Nos résultats indiquent que l'EPO a eu un effet de segmentation important en élargissant les écarts de prix et en réduisant les ratios d'importation et de consommation apparente pour les bouvillons d'abattage et les veaux d'embouche.

JEL codes: Q17, Q18, F1, L15.

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Introduction

Many countries mandate Country Of Origin Labeling (COOL) for many food products. The market implications of such labeling depend on whether they are mandatory or market driven, the characteristics of the industry, including the role of imports, and how labeling rules are implemented. This article explores econometrically the effects on cattle markets of mandatory COOL applied to sales of beef in the United States.

The Farm Security Act of 2002 (the 2002 Farm Bill) required COOL for selected food products sold in the United States. The law specified that retailers, other than very small outlets and food service operations such as restaurants, must notify consumers of the country of origin for muscle cuts of beef (including veal), lamb, and pork; ground beef, lamb, and pork; fish and shellfish; many perishable agricultural commodities; and peanuts.

The United States Department of Agriculture (USDA) completed the implementation process for fish and shellfish in 2005. For other products, the USDA had difficulties establishing acceptable rules to implement the COOL legislation. Even as Congress began developing the 2002 Farm Bill, part of the US cattle industry, for example, raised concerns that implementation would raise their costs. After extended comment periods and withdrawal of the initial proposed rule, further implementation of COOL was delayed. The Food, Conservation, and Energy Act of 2008 (the 2008 Farm Bill) extended the list of covered commodities to include chicken, goat meat, ginseng, pecans and macadamia nuts and revised the 2002 provisions to facilitate rulemaking. On August 1, 2008, the USDA Agricultural Marketing Service (AMS) published the *final interim rule*, which became effective on September 30, 2008. The AMS published on

January 15, 2009 the *final rule*, which was unchanged in its essentials. Full enforcement of COOL began on March 16, 2009 (AMS 2012).

Country of origin labeling is common and for many products in many countries (WTO 2011, p. 157). In most cases, labels listing country of origin are not controversial even when mandatory. However, the recent implementation COOL for muscle cuts of beef and pork sold in the United States has raised international trade concerns. Less than three months after the United States released its interim final rule, Canada requested WTO consultations. Mexico joined the consultation in May 2009 and a WTO dispute panel was established in October 2009. The WTO panel determined that US implementation of COOL violated the provisions of the WTO agreement on Technical Barriers to Trade for cattle and hogs (WTO, 2011). A subsequent Appellate body ruling was accepted in July 2012 and the United States agreed to bring its regulations implementing COOL into compliance (WTO, 2012). However, as of November 2012, acceptable US policy changes have not yet been implemented.

Nature of the labels and their interpretation

The regulations implementing COOL for muscle cuts of beef and pork provide for three labels. Label A applies to products of US origin only (Product of USA). Label B is for packages that may contain some imported livestock not entering the US solely at time of slaughter (e.g. Product of USA and Canada). Label B applies, for example, to muscle cuts from cattle born in Canada but fed and slaughtered in the United States. Label C is for products from imported livestock entering the United States for immediate slaughter (e.g. Product of Canada and USA). That label is used, for example, for muscle cuts from cattle raised in Canada but slaughtered in the United States. Two additional labels, not subject to dispute and not the subject of our econometrics, cover imported meat and ground meat.

At first, US packing plants that sourced cattle of multiple origins believed that they could use label B or label C for all their production, therefore avoiding the cost segregating cattle of different origins. However, in mid-September 2008, the Chair of the House Agriculture Committee, Congressman Peterson from Minnesota, met with representative of the US slaughter industry and made clear that he expected that cuts from US origin cattle and hogs would carry an A label and, if the industry did not comply with that expectation, new legislation would codify that requirement (Informa Economics Inc. 2008, Food and Fiber Letter 2008, Food and Drink Weekly 2008). In late September, USDA updated its question and answer documents on COOL implementation to indicate that label A was to be used if only US products were slaughtered on a given day. These interpretations were reinforced early in 2009 in a letter from USDA Secretary Vilsack that discouraged the use of labels B and C when label A can be used. The result is that US feedlots and packers that accept livestock from multiple origins must segregate animals according to their origin and segregation by origin must be maintained at all stages of the supply chain.[1]

Key WTO issues in the context of North American cattle markets

The main economic issues in the WTO dispute revolved around the provision of the WTO Technical Barriers to Trade (TBT) agreement that "Members shall ensure that in respect of

[1] The new interpretations of how COOL would be enforced stimulated a letter from James Lochner, Senior Group vice President, Tyson Fresh Meats, Inc. to "Tyson Fresh Meats Cattle Supplier," dated October 14, 2008. Wesley M. Batista, President & CEO, JBS USA, Inc. sent a letter to Valued Customer dated October 23, 2008. The same response is documented in a Smithfield News Release, September 24, 2008, "Smithfield Foods Announces Use of American Born, Raised and Processed Label on All US Fresh Retail Products" and a CANFAX Update, April 24, 2009, "US Packer procurements policies for Canadian Cattle."

technical regulations, products imported from the territory of any Member shall be accorded treatment no less favourable than that accorded to like products of national origin and to like products originating in any other country (WTO 2012b).” And, “Members shall ensure that technical regulations are not prepared, adopted or applied with a view to or with the effect of creating unnecessary obstacles to international trade (WTO 2012b).”

Prior to COOL, cattle slaughter operations treated cattle from US feedlots that had been born in Mexico or Canada as interchangeable with US born cattle. Similarly fed cattle from Canada were not differentiated and the cattle and meat was not segregated. Retailers purchased meat without regard to the geographic history of the livestock used to produce the meat products and did not apply country of origin labels. This fully integrated system reflected efficiencies in using facilities and in avoiding costs. Retailers did not perceive consumer demand for country of origin labeling as sufficient to cover the costs of segregation and separate labeling. Thus, the government mandate for country of origin labeling did change the behavior of the cattle and beef industry in North America.

This article estimates econometrically the impact of COOL, specifically on imports from Canada *relative* to US use and price bases for Canadian feeder and fed cattle in the US market. We estimate how COOL *differentially* affected quantities and prices of fed and feeder cattle according to their origins. The interpretation of our results follows from our conceptual model that is developed after a brief discussion of relevant prior literature.

Literature on COOL in Beef and Cattle Markets

A considerable academic literature has developed around country of origin labeling, especially applied to meat products. Several papers investigate, with surveys and experiments, consumer willingness to pay for origin information and meat from different origins. Another strand of literature develops simulations of the impacts of COOL, but this literature is applied to assumed implementation rules that were never adopted and does not consider differential impacts by origin. Hence they have little relevance for the trade impacts estimated here. Third, two prior econometric studies have attempted to estimate the impact of COOL on cattle prices.

The willingness to pay study of Klain et al. (2011) use a field experiment conducted during October 2010 and January 2011 in two Texas locations. Klain et al. (2011) find that consumers in two locations were willing to pay more for a steak labeled as a US product relative to a steak with no origin label. Results are inconsistent for the value of steak from Canada across the two Texas locations - one indicating a premium for beef from Canada, the other indicating a discount. Although COOL had been in place for more than two years at the time of the experiment, more than 80 percent of the participants were not aware that mandatory country of origin labeling was in place. Unfortunately, Klain et al. (2011) and the other experimental and survey studies on willingness to pay consider labels about the origin of the meat, not origin of the livestock from which the meat was derived (Loureiro and Umberger 2003, 2005, 2007; Lusk and Briggeman 2009; Tonsor, Schoeder and Lusk 2012). The COOL disputes have all revolved around labels for meat from animals not born in the United States, but may have been raised in the United States, and then slaughtered in the United States. Moreover, the experiments and surveys have consistently found that food safety is the major concern of participants (Lusk et al. 2006; Loureiro and Umberger 2007; Lusk and Briggeman 2009; and Tonsor, Schoeder and Lusk 2012) and food safety is a characteristic primarily associated with sanitation in the slaughter facility. All imported animals meet standards at least as high as domestic livestock. Moreover, the United States stated explicitly that food safety was not a rationale for mandatory COOL.

Thus, these studies tell us little about preference related to the origin of cattle that are used in the production of meat.

Several studies simulated market effects of the version of COOL passed in 2002. The basic simulation approach of these studies was to introduce a COOL related cost or demand shift into a system of calibrated demand and supply equations and simulate how equilibrium prices and quantities change as a response (Brester, Marsh and Atwood 2004; Lusk and Anderson 2004; and Rude, Iqbal and Brewin 2006). These studies do not attempt to model the potential for differential implementation costs or requirement for segregation and traceability. Because of the major revisions in 2008 for how COOL was actually implemented, these studies are of limited current relevance for assessing COOL. Indeed, if COOL had been implemented as planned in 2003, the international trade disputes about COOL probably would not have occurred.

A study by Informa Economics Inc. (2010) provides information regarding the direct cost to livestock and meat processing and marketing firms of COOL as actually implemented. Based on surveys of feedlots, slaughter operations and retailers, Informa Economics Inc. (2010) reported that compliance with COOL was mainly associated with segregation and management of products of multiple origins. The study found that the sum of costs incurred at each link of the supply chain is equivalent to $6 per hundredweight (cwt) of live cattle.

Two previous econometric studies have examined how COOL related to cattle prices.[2] Using weekly market prices reported weekly, Ward, Schroeder and Schulz (2009) find that COOL caused a significant widening by $1.91/cwt of the Alberta fed cattle basis, while the

[2] Rude, Gervais and Felt (2010) find that COOL significantly affected the trade flows of slaughter hogs, significantly affected the price of feeder hogs in Canada, but had little effect on the trade flows of feeder hogs. Kuchler, Krissoff and Harvey (2010) found little willingness to pay for US origin shrimp relative to shrimp from Southeast Asia. Plastina, Giannakas and Pick (2011) investigate in a calibrated model the effects of COOL on the US market for fresh apples.

Ontario basis widened by $3.58/cwt. Schulz, Schroeder and Ward (2011) use observations on more than 4,000 individual transactions for Alberta fed cattle sales from January 2006 and April 2009 to examine the price difference between those sold in Alberta and those sold to Nebraska slaughter plants. These unique data allow for a rich analysis despite that only aggregate data is available for prices of comparable cattle sold in Nebraska. Control variables include monthly dummies, day-of-the-week dummies, feedlot dummies, sex, pricing methods, variables for the characteristics of cattle, packer dummies and dummies for policy and regulatory changes, including COOL. Schulz, Schroeder and Ward (2011) find a widening of the basis from COOL by about $6 per cwt. The authors summarize this result by stating: "… US companies that continue to purchase Canadian cattle have reduced their bid prices to offset additional costs of managing inventories."

Economic Model and Reasoning underlying the Econometric Analysis

COOL has a number of impacts on the business practices of farms and firms within the United States. Differential effects on the demand for Canadian livestock arise through segregation costs and other pressures on US operations to favor US livestock and products. In addition, as shipping options are limited by segregation requirements and other supply pressures are created by COOL mandates, COOL has likely raised the cost of movement of livestock across the border from Canada to the United States. Such impacts on livestock movement raise import barriers that reduce exports directly, rather than working through import demand as do segregation costs and related measures affecting US buyers of imported livestock.

If COOL has had significant negative impacts on the relative demand for Canadian livestock by US firms, we expect increases in the (negative) differences between prices of

Canadian and US livestock (a widening of the basis), or reductions in the relative quantities of animals shipped to the United States, or both.[3] This section shows how the magnitudes of price and quantity effects depend on the nature of the Canadian export supply functions for livestock and the US import demand functions for livestock. We use a graphical illustration of the competitive model, but allowing for market power by US buyers would not impact the results qualitatively.

The export supply quantity at each price is equal to the difference between the quantity of livestock supplied by Canadian livestock producers and the quantity of livestock demanded by Canadian buyers (net of changes in inventory numbers). Responses by livestock producers and buyers in Canada determine the characteristics of the export supply function. The import demand quantity at any given price is determined by the profitability of using Canadian livestock in the United States. The share of Canadian imports in the US market is quite small. Therefore, the dominant factors in the US market are conditions that surround livestock of US origin. Against this backdrop, the import demand function can shift when regulations change and affect the profitability of using imports relative to using domestic livestock. In particular, by raising costs of importing from Canada and by introducing segregation costs to US firms (feeders and packers) that buy imported livestock, COOL shifts down the import demand function facing Canadian livestock.

Figure 1 illustrates the simple supply and demand model underlying the econometric analysis of livestock prices and quantities. For concreteness, let us use fed cattle as an example while recognizing that an illustration like Figure 1 also applies to feeder cattle. Prices for fed

[3] The markets for cattle in the United States and Canada have been integrated for many years (Vollrath and Hallahan 2006; Rude, Carlberg and Pellow 2007). Only a temporary interruption to market integration occurred for cattle and beef during the two years following the discovery of a BSE contaminated cow in Canada in 2003. Otherwise, livestock and meat has flowed relatively freely across the border in both directions and prices move closely together.

cattle are shown along the vertical axes. Quantities supplied and demanded are shown along the horizontal axes. The supply function for fed cattle in Canada is illustrated by the upward sloping line, “CA supply,” on the left of Figure 1. The demand to slaughter those cattle in Canada is shown by the downward sloping line labeled “CA demand.” The horizontal distance between the Canadian quantity supplied and the quantity demanded in Canada at any price translates into the “CA export supply” function shown as an upward sloping line on the right of Figure 1. In Figure 1, COOL does not shift this export supply function because COOL does not shift the underlying supply and demand relationships in Canada.

On the right of Figure 1 we illustrate the US demand for imports from Canada. The quantity of imports without COOL is the horizontal distance from the origin to where the US import demand crosses the export supply function. Accounting for transaction cost and quality, the price of fed cattle in Canada and the United States is the same at “Price, no COOL”.

COOL shifts the US demand function for imports down and to the left. That means that at any given price, US slaughter operations find Canadian fed cattle less profitable and therefore buy fewer of them. Likewise, after the COOL mandate, at any given import quantity, US buyers would be willing to pay a lower price for Canadian fed cattle. As Figure 1 shows, COOL reduces both the price of Canadian livestock to “CA price, COOL” and the quantity imported to the degree that it shifts down US demand for imports while the price in the United States rises to “US price, COOL.” As the US import demand is nearly perfectly elastic, we expect only a small increase in the US price.

Examination of the supply and demand curves in Figure 1 shows that for a given shift of the demand curve due to COOL, the price effects are smaller and the import quantity effects are larger when the supply of exports are more elastic (more responsive to price). For a given shift in the import demand function, the more that the quantity imported falls, the less the price will decline and *vice versa*.

Expected Effects of COOL on Fed cattle

Consider first the magnitude of the export supply elasticity of fed cattle, which, as laid out above, depends on the underlying price responsiveness of fed cattle supply and demand within Canada. These cattle are 18 to 24 months old. Both fed steers and fed heifers have no other outlet than slaughter. There is limited opportunity to reduce total animal numbers in Canada that are ready for market, except over a horizon of several months or years. Therefore, the supply function in Canada of fed cattle is expected to be much less than perfectly elastic in response to the potential price reductions caused by the market impacts of a reduced import demand caused by COOL.

Demand for fed cattle in Canada derives from the behavior of slaughter plants. These operations have capacity limits and planning horizons that make it difficult to expand their use of cattle much over a several year horizon in response to lower US import demand caused by the implementation of COOL. So, on the demand side, we expect a relatively low elasticity of response to lower prices caused by fewer cattle demanded for import into the United States.

Putting the supply side and the demand side together, we expect an export supply for fed cattle from Canada that is elastic but much less than perfectly elastic. This means that the reduction of import demand engendered by COOL would cause a significant fall in the price of Canada fed cattle, as well as a reduction in import quantity.

Expected Effects of COOL on Feeder cattle

Next consider the domestic supply and demand considerations that determine the export supply elasticity of feeder cattle. The underlying feeder cattle quantity supplied in Canada depends on the size of the calf crop, which may be reduced if returns are expected to be lower, given some months in the planning horizon, by more severe culling of the breeding cow herd. Then, prior to placing animals on feed, an additional reduction in the quantity of feeder cattle supplied to the market can be achieved, if the short term demand for feeder cattle is low, by allowing additional heifers to enter the breeding herd. Thus, the supply of feeder cattle may be somewhat more elastic than the supply of fed cattle.

The demand in Canada for feeder cattle arises from decisions to feed cattle locally. Such demand responds to the relative price of feeder cattle by adjusting the capacity of feedlots in Canada. Canada has the capability to feed additional cattle when the market for imports into the United States deteriorates. Feedlots have more flexible capacity than do slaughter plants. Overall, the flexibility to expand the feeding of cattle in Canada in response to lower demand for imports into the United States means that Canadian demand for feeder cattle is relatively elastic.

Under these conditions, the export supply function is elastic. Therefore, in response to COOL, we expect to observe greater reductions in import quantities, and at most, modest reductions in the price of feeder cattle.

The data and preliminary time series analysis

In the econometric analysis below, we use price, quantity and related data for the period between September 2005 and December 2010 from several sources in Canada and in the United States.

Table 1 gives a short description of the variables that enter our regression models. We provide details about their sources in the paragraphs below, with full citations in the reference list.

We set the beginning date of the dataset to September 1, 2005, which is a month and a half after the reopening of the US border to Canada cattle less than 30 months of age following the discovery of BSE in Canada in 2003. By September 2005, the trade of cattle between Canada and the United States and was no longer affected directly by the ban triggered by the BSE incident.

We obtained from Canfax (2011) the weekly average price in $CA/cwt for fed cattle and feeder cattle in Alberta. Canfax is a division of the Canadian Cattlemen's Association that provides market news and analysis. The price of fed cattle is the average price of fed steers and fed heifers. We calculate the Canadian price of feeders at 550 lbs as the mean price of three Alberta markets: Northern, Central and Southern. We use prices in Alberta because it is the largest cattle producing and exporting province in Canada.

Canfax (2011) reports other useful data: the exchange rate in $US/$CA published by the Bank of Canada, the price of barley in Alberta in $CA per metric ton and the price of corn in Nebraska $US per bushel. We converted the price of barley from $CA per metric ton to $CA per bushel using a conversion rate of 45.93 bushel per metric ton. We also converted the price of corn in Nebraska to $CA per bushel using the exchange rate published by Canfax (2011). We obtained from Canfax the weekly US imports of feeders and fed cattle from Canada collected by the USDA Animal and Plant Health Inspection Service (APHIS). Official US Customs Bureau import data are only reported monthly, but the APHIS data, based on physical inspections at the border, are the most reliable source of weekly imports data for livestock.[4]

We collected the price of fed cattle and the price of 550 lb feeders in Nebraska from the Livestock Marketing Information Center (LMIC, 2011). We converted US cattle prices to $CA/cwt. using the exchange rate reported by Canfax (2011). The price of fed cattle is the weekly average Nebraska price of fed steers and fed heifers. We use the price in Nebraska because it is a central point in the United States, a large producing State and a destination for Canada cattle. We also obtained from LMIC (2011) the USDA data on weekly slaughter of cattle in the United States and the weekly placement of feeders.

The econometric model includes variables that control for the cost of transport and transactions between Canada and the United States and the relative strength of Canadian and US economies. We obtained from the Bureau of Labor Statistics (2012) the monthly producer price index for truck transportation in the United States. We use this price index as a proxy for the cost of transportation in Canada and in the United States. A similar price index for truck transportation costs in Canada is not available. Truck transportation costs are similar across the border.

We use the difference in unemployment rates to measure the state of the macroeconomic conditions in Canada and the United States. We obtained the monthly unemployment rate in Canada from Statistics Canada (2012) and the monthly unemployment rate in the United States from the Bureau of Labor Statistics (2012). We use the United States unemployment rate minus the Canadian unemployment rate to measure macroeconomic conditions that may affect the

[4] We performed the same econometric analysis as reported in the text using monthly data and found that regression coefficients are not sensitive to data frequency, although estimates using monthly variables have slightly wider confidence intervals consistent with fewer observations.

demand for beef and therefore live cattle. In the WTO litigation, the United States argued that impacts attributed to COOL were really caused by the US recession (Jurenas and Greene 2012).

The data on transportation costs and the difference in unemployment rates are monthly while other variables are reported weekly. To make the data at the same frequency, we perform Loess regressions in R on the transportation index and the difference in unemployment, and then predict the data at a weekly frequency.[5]

We control for seasonality using monthly dummy variables. We also use dummy variables for the week of Independence Day, Thanksgiving and Christmas as these holidays reduce the number of working days in the week. To control for other events we add a dummy that equals one after November 19, 2007, the date that the United States removed the ban on imports of cattle more than 30 months of age from Canada and a dummy variable that equals one after July 12, 2007 to control for the new regulation regarding the disposal by packers in Canada of specified risk material (SRM).[6]

We indicate the application of COOL using a dummy that takes a value equal to one after September 29, 2008, when the interim final rule became effective. That date is appropriate for the beginning of the COOL regulation as it represents the day when the law became effective.[7] In addition, as discussed earlier in the text, it followed Congressman Peterson's meeting, which triggered an immediate reaction from US packers and it closely followed the publication by USDA AMS of clarifications regarding rules for the enforcement COOL (AMS 2008).

[5] Loess regression is a class of local regression that weighs nearby variables according to their distance from the location where a regression takes place. As such, Loess regressions provide a smoothing method which allows us to obtain predictions from monthly data at a weekly frequency.
[6] Since July 2004, slaughterhouses in Canada must segregate and dispose of beef cuts that have a higher risk of carrying the prion responsible for BSE. The ban was reinforced in July 2007 such that SRMs can no longer be used in pet food. These tissues now have no market value.
[7] Implementation of the final rules in March 2009 essentially confirmed the September preliminary rules.

Fed cattle imported from Canada spend little time in the United States before slaughter. The COOL regulation therefore affected imports within a week of its implementation. The situation is different for feeder cattle that spend about six months in the United States before slaughter. To account for lags between imports and slaughter, the law specified that feeders imported before July 15, 2008 would not be subject to the regulation. But that date passed with no interim rule. The Peterson meeting and the USDA AMS publication provided information that COOL labeling flexibility was removed, therefore making the end of September the effective date for which COOL became effective for feeders as well.

Dependent variables: basis and import ratio

We construct two variables to measure the differential impacts of COOL on prices and import quantities.

The basis is measured as the difference between the price of cattle in Canada and the price of cattle in the United States. The basis is negative since Canada ships cattle to the United States and therefore the price in Canada must be lower to compensate for higher transport and related costs. If the basis widens, i.e. becomes more negative, it means that the price of cattle in Canada falls compared to the price of cattle in the United States.

Figure 2 shows the basis between Canada and the United States for fed cattle and feeder cattle. A vertical line identifies when COOL became effective on Sept. 29, 2008. For fed cattle, the basis tends to remain between $CA -5 and $CA -10 per cwt, while the basis for feeder cattle was between $CA-20 and $CA-30 per cwt. Although there is no obvious decline in the bases after the introduction of COOL, observe that seasonality seems to be different after COOL became effective.

To measure the differential market effects of COOL on quantities, we use for fed cattle the weekly ratio of imports of fed cattle from Canada and the slaughter of US-born cattle. In calculating that ratio, we subtract from the weekly slaughter of cattle in the US imports of fed cattle from Canada during that week and the US imports of feeder cattle from Canada 28 weeks earlier.[8] We use a 28-week lag as the approximate duration to grow a feeder into fed cattle ready for slaughter. When subtracting imports of feeders, we do not use the actual import numbers, but rather a prediction that smoothes the import quantities. Feeders are not all slaughtered 28 weeks after import which means that the high variability in import volumes does not translate into a high variability in the slaughter of imported feeders from Canada 28 weeks later. We calculate the feeder import ratio as the imports of feeders from Canada divided by the US placement of feeders net of imports from Canada. If the import ratio falls, it shows a fall in the demand for cattle from Canada relative to the demand for cattle from the United States.

Figure 3 shows the ratios for the imports of fed and feeder cattle. For both fed and feeder cattle, imports from Canada represented between 2 and 4 percent of US slaughter or placements. No dramatic change occurred after COOL in the import ratio for fed cattle, although seasonality seems to be affected. For feeders, the import share clearly declines in the months following the implementation of COOL and remains below 2 percent for almost all weeks after COOL.

Time series properties of the data

Table 2 shows results of Augmented-Dickey-Fuller (ADF) and Philips-Perron (PP) unit root tests on our time series variables. The tests show evidence that the basis and ratio variables are

[8] We do not subtract imports from Mexico off the slaughter of US cattle because cattle from Mexico are a small share of all cattle in the United States. If we find that COOL had a negative impact on cattle from Canada and if the same negative impact occurs on imports of Mexican feeders, then ignoring imports from Mexico causes an underestimation of the effects of COOL on imports from Canada.

stationary but that the exchange rate, the transportation index, the difference in unemployment and the prices for corn and barley are not stationary. All variables are first difference stationary except for the transportation index, for which the PP test shows evidence of a unit root. We will include in our econometric model the first difference in the exchange rate because it is meaningful given how transactions in the cattle market take place. The exchange rate most often is fixed before the shipment of cattle from Canada to the United States. For example, suppose that the exchange rate is fixed one week before a transaction occurs and the exchange rate increases just before Canadian cattle are shipped to the United States. The price reported by the Canadian farms is the one at which the exchange was fixed in the previous week. Thus, it is the change in the exchange rate that affects the basis because of how prices are set before the physical transaction. For that reason, we expect the change in the exchange rate to influence the basis but not trade volumes.

We use the transportation index, difference in unemployment and the prices for grains in levels in our econometric models. Unlike the exchange rate, these variables do not have useful interpretation in first difference. One option to control for the unit-root problem with these variables is to write the model in first difference. However, a model in first difference would not allow us to estimate the effect of COOL, which we measure using a dummy variable. The presence of variables with a unit root does not bias regression coefficients but may affect standard errors. We estimate models with non-stationary regressors, keeping in mind possible bias in measures of statistical significance.

Econometric model and results

We estimate reduced form equations to measure the impacts of COOL on the price basis and the ratio of imports over US domestic use of feeder and fed cattle. We begin by describing our empirical approach and then present and discuss econometric results.

Econometric model

We estimate autoregressive distributed lag models to account for autocorrelation.[9] The basic regression model is

(1) $$\beta(L)z_t = \alpha + \phi(L)\Delta E_t + \boldsymbol{\varphi}\mathbf{S}_t + \lambda COOL_t + \varepsilon_t .$$

We denote the dependent variable, either the basis or ratio, by z_t. We use polynomial lag operators to identify lags in the dependent and the independent variables. The variable ΔE_t is the first difference in the exchange rate. $\mathbf{S}_t$ is a vector of control variables that includes dummy variables and in some models includes the transportation index and the differential unemployment rate. In some specifications of the model for feeders, the vector $\mathbf{S}_t$ includes the price of corn in the United States and the price of barley in Canada.

We set the number of lags on the change in the exchange rate to one such that the model controls for the effect of changes in the exchange rate in the previous two weeks. The number of lags on the dependent variable equals two in all regression models. Durbin-Watson and Q tests, as well as graphs of correlation and autocorrelation functions (all provided in an appendix available from the authors) show that two lags were sufficient to control for autocorrelation in all

[9] Another option is to use an error-correction model. However, as our data do not all have the same order of integration, an error correction model would not improve the properties of our coefficient estimates.

regression models. In addition, we provide in the appendix, available from the authors, test results that show no evidence of unit roots in the residuals.

We estimate (1) by ordinary least square. We calculate the long run effects by dividing the right-hand side coefficients by one minus the sum of the coefficients for the lag dependent variable. For example, the long run effect of the change in the exchange rate is $\Gamma = (\phi + \phi L) / \left(1 - \beta L - (\beta L)^2\right)$ and for the COOL variable the long run effect equals $\Lambda = \lambda / \left(1 - \beta L - (\beta L)^2\right)$. Calculations of long run effects for other variables follow the same procedure.

We calculate the standard errors of the long run coefficients using a stationary bootstrap (Politis and Romano 1994).[10] One advantage of the bootstrap is in generating consistent standard-errors or confidence intervals for long run coefficients that involve non-linear transformation without relying on a linear approximation. To calculate bootstrap standard errors, we begin by estimating the model in (1) to find the vector of residuals $\boldsymbol{\varepsilon}^*$. We then generate a bootstrap sample by stacking blocks of observations drawn at random from our data. The first observation of each block is sampled from a discrete uniform distribution on $\{1, \ldots, T\}$, where T is the total number of observations in the dataset. The length of a block is sampled from a geometric distribution with a mean length of 6 weeks.[11] Note that we wrap around the data in constructing blocks such that observation number 1 follows observation number T. We stack up blocks of observations until the size of the sample equals $T + 50$.

[10] Another option is to use the delta-method, which yields similar standard errors to our bootstrap estimates.

[11] Finding the optimal block bootstrap length is a difficult task. Politis and White (2004) and Patton and White (2004) provide expressions for calculating optimal block length but these expressions are valid only under accurate estimation of some distribution parameters. Politis and White (2004) note that a stationary bootstrap, such as the one that we perform, is less sensitive to block size misspecification than a circular bootstrap. The stationary bootstrap is, however, less accurate than a circular bootstrap. In our estimations, the mean block size has very little effect on parameters' standard errors.

The second step involves generating the dependent variable by recursion. We initiate the recursion by randomly selecting a value for z_0 from the original dataset. Therefore, the whole bootstrap sample depends on the value of that variable but its effects diminish with respect to the observation number. To reduce the effect of selecting a starting value, we delete the first 50 observations, such that we are left with a bootstrap sample of size T (Enders 2010, p. 265). We perform one thousand bootstraps for every regression model.

Discussion of econometric results on the effects of COOL

We show regression results in table 3 for fed cattle and in table 4 for feeder cattle. We do not report estimates for monthly dummies or the dummies for the three holidays. (These are available from the authors). For both fed cattle and feeder cattle regressions, model 1 does not include variables with a unit-root and model 2 includes all variables. In tables 3 and 4, we report standard errors in parentheses below coefficient estimates. The numbers in brackets are bootstrap probabilities that individual coefficients are smaller than zero. That is, the percentile of bootstrap estimates that are negative. As their calculation does not rely on the assumption of a normal distribution, the statistical significance from those probabilities differ from p-values calculated from the standard errors, assuming a normal distribution.

Let us turn to the effects of COOL shown for models 1 and 2 for the price basis and the import ratio.

Estimates of the effect of COOL on fed cattle prices show economically and statistically significant widening of the basis. The effect is $CA 3.30 per cwt. in model 1 and $CA 8.22 per cwt in model 2.[12] We find the larger effect on the basis in model 2, when variables for transportation cost and difference in unemployment are included. Before COOL, the average basis for fed cattle was about minus $CA 9.90 per cwt. Results in Table 3 show that after controlling for other factors that affect the basis, COOL widened the basis by 30 percent (Model 1) and 90 percent (Model 2).

The two coefficients for the effect of COOL on the import ratio for fed cattle are negative. In Model 1, the coefficient (with a value of -0.52) is negative 96 percent of the time using the bootstrap method. In Model 2, the coefficient (with a value of -0.97) is negative 89 percent of the time using the bootstrap method. The values of the coefficients for the effect of COOL in the import ratio show a sizeable decline in the share of Canada fed cattle in the United States. Before COOL, the import ratio for fed cattle was 2.95. Regression results suggest a decline in the ratio of 0.52 in Model 1 and 0.97 in Model 2.

The estimates of COOL in our regressions for fed cattle are consistent with COOL having a negative impact on imports of fed cattle from Canada relative to fed cattle from the United States. The stronger effects of COOL in the fed cattle market appear on the price basis and more moderate (and less statistically significant) effects on the import ratio. These results are consistent with a moderate elasticity of supply of fed cattle from Canada over the horizon of the COOL impacts measured.

Table 4 shows coefficient estimates for regression for price basis for feeder cattle and the ratio of imports to US use of feeder cattle. In Model 1, the estimated effect of COOL on the basis

[12] Note that the price of US cattle includes some cattle of Canadian origin fed and slaughtered in the United States. As our results show that COOL has a negative effect on the basis for price of cattle between Canada and the United States, it means that the inclusion of Canadian cattle in the US price causes us to underestimate the differential impact of COOL on the basis for fed cattle. That bias should however be small as cattle from Canada are only a small share of all cattle in the United States.

for feeder cattle is positive but not statistically significant (probability of a negative coefficient is 0.26, meaning the probability of a positive coefficient is 0.74). Adding variables for grain prices, transportation cost and difference in unemployment to the regression model (Model 2), the effect of COOL on the basis is negative, large and smaller than zero 79 percent using the bootstrap method.

Estimates of the effect of COOL in the import ratio for feeder cattle show evidence that is has had a strong and significantly negative impact. In Model 1, COOL has a significant negative effect on the ratio. The coefficient is -3.36 and 100 percent of the values in the bootstrap sample are negative. In Model 2, the impact of COOL is also negative but smaller in magnitude (-1.27). The coefficient for COOL in Model 2 is significant at the 12 percent level using the bootstrap probability. Again, the inclusion of the transportation cost variable and the difference in unemployment rates affects the value of the coefficient for COOL. Although the differential unemployment rate itself is significant in Model 2 for the ratio of imports of feeder cattle, we have no convincing economic rationale for why that should be true since one would expect a more direct and immediate effect of macroeconomic conditions on the consumption of beef and on the use of slaughter cattle rather than on feeder cattle that will not enter the retail market for many months. In both models, the effect of COOL appears important given that the import ratio averaged about 3.15 percent prior to the introduction of COOL. The strong effect of COOL on the import ratio for feeder cattle is consistent the export with the relatively elastic export supply.

We show in an appendix, available from the authors, estimates from other regression models that support the robustness of our results to the inclusion of variables for transportation cost and difference in unemployment. Results for the coefficients for COOL in these models tend to be in between the coefficient estimates we find in Model 1 and Model 2, both for the regressions for fed cattle and feeder cattle.

Conclusion

This is the first study to carefully investigate empirically the differential impacts on prices and import flows of mandatory country of origin labeling. We examine econometrically the price basis and import quantity ratios of fed cattle and feeder cattle shipped from Canada into the United States. In doing so, we develop a methodology that can be used more broadly to evaluate other cases of country of origin labeling and the differential impacts of other regulations that effect trade.

Our theoretical model shows that the relative sizes of the impacts of COOL on quantities and prices depend crucially on the size of Canada export supply elasticity. Given the conditions on demand and supply in Canada, the export supply of fed cattle should be less elastic than the export supply for feeder cattle. Hence, our model predicts that a strong effect of COOL on price in the fed cattle market and strong effect of COOL on import quantity ratios in the feeder cattle market.

Empirical results show economically and statistically significant effects of COOL that are consistent with our expectations from the theoretical model. In the fed cattle market, results show a significant widening of the basis from COOL and smaller and less significant effects on the ratio of imports to domestic use. In the market for feeder cattle, we find less significant results for the price basis, but significant reductions in the import ratios. Overall, we find that the implementation of COOL had a significant differential effect on the cattle market in Canada versus the US domestic cattle market.

The results reported here are fully consistent with the rulings of the WTO panel and appellate body. Based in part on econometric evidence of differential impacts, the WTO found that, as implemented by the United States, COOL gave a less favorable treatment to imports of live cattle in the production of muscle cuts of beef (WTO 2011, 2012a).

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Tables

Table 1: Definitions of variables

Name	Definition
Basis	Weekly price in Canada (Alberta) minus price in the United States (Nebraska) measured in Canadian dollars per cwt.
Ratio	Weekly ratio of US imports of Canada cattle and US domestic slaughter or placement of cattle.
Exchange rate	Weekly exchange rate measured $US/$CA.
US corn price	Price of corn in Nebraska in $CA per bushel.
Alberta barley price	Price of barley in Alberta in $CA per bushel.
Cow imports	Dummy variable that takes a value of one after the reopening of the US border to cattle of more than 30 month old on November 19, 2007.
SRM	Dummy variable that takes a value of one after the imposition of stricter rules for the disposal of specified risk material in Canada on July 12, 2007.
Independence Day	Dummy variable that takes a value of one on the week of Independence Day.
Thanksgiving	Dummy variable that takes a value of one on the week of Thanksgiving.
Christmas	Dummy variable that takes a value of one on the last week of December (Christmas) and the first week of January (New Years Day).
Transportation index	Producer price index for truck transportation from the Bureau of Labor Statistics (from monthly to weekly using Loess regression).
Difference in unemployment	Difference in the unemployment rate in the United States and Canada (from monthly to weekly from Loess regression).

Table 2: p-value for unit root tests

	Level		First difference	
Variable	ADF	PP	ADF	PP
Fed cattle basis	0.04	0.01	0.01	0.01
Feeder cattle basis	0.40	0.01	0.01	0.01
Fed cattle ratio	0.01	0.01	0.01	0.01
Feeder cattle ratio	0.21	0.01	0.01	0.01
Exchange rate	0.63	0.68	0.01	0.01
Transportation index	0.43	0.94	0.01	0.55
Difference in unemployment	0.22	0.86	0.01	0.01
Price of corn	0.65	0.70	0.01	0.01
Price of barley	0.75	0.87	0.01	0.01

Note: ADF is the augmented Dickey-Fuller test and PP is the Philips-Perron test. We performed the test using the tseries package in R (Trapletti and Hornik 2012). The minimum p-value reported is 0.01 and should be interpreted as less than or equal to 0.01.

Table 3: Coefficient estimates for fed cattle regressions

	Basis ($CA-$US)		**Ratio** (US imports/US slaughter)	
Variable	Model 1	Model 2	Model 1	Model 2
Intercept	-11.25 (1.75) [1.00]	25.17 (42.04) [0.26]	3.39 (0.38) [0.00]	4.06 (7.21) [0.28]
ΔE_t	2.99 (0.56) [0.00]	2.57 (0.55) [0.00]	0.04 (0.03) [0.10]	0.03 (0.03) [0.09]
Cow imports	5.11 (2.08) [0.01]	5.56 (3.49) [0.04]	-1.14 (0.49) [0.99]	-1.33 (0.77) [0.96]
SRM	-0.02 (2.02) [0.59]	0.23 (1.99) [0.51]	1.01 (0.46) [0.00]	0.96 (0.46) [0.01]
Transportation index		-32.68 (40.45) [0.79]		-0.21 (6.93) [0.52]
Difference in unemployment		2.00 (1.87) [0.11]		0.25 (0.34) [0.25]
COOL	-3.30 (1.29) [0.98]	-8.22 (4.76) [0.97]	-0.52 (0.29) [0.96]	-0.97 (0.80) [0.89]
R2-adj	0.77	0.77	0.86	0.86

Notes: Numbers in parentheses are bootstrap standard errors and numbers in brackets are bootstrap probabilities that individual variables are smaller than zero. Monthly dummies and dummies for the weeks including US Independence Day, US Thanksgiving and Christmas are included in the models but not displayed here.

Table 4: Coefficient estimates for feeder cattle regressions

	Basis ($CA-$US)		**Ratio** (US imports/US placements)	
Variable	Model 1	Model 2	Model 1	Model 2
Intercept	-26.02 (4.03) [1.00]	-35.59 (156.86) [0.75]	1.90 (0.52) [0.00]	-4.39 (18.22) [0.57]
US corn price		3.96 (4.42) [0.68]		-0.37 (0.44) [0.35]
Al barley price		-6.41 (6.37) [0.37]		0.40 (0.62) [0.59]
ΔE_t	13.87 (2.81) [0.00]	10.56 (2.96) [0.00]	0.05 (0.05) [0.33]	0.08 (0.05) [0.48]
Cow imports	11.42 (8.18) [0.07]	-0.96 (13.73) [0.52]	0.97 (0.86) [0.10]	1.90 (1.36) [0.08]
SRM	-4.69 (8.61) [0.77]	0.46 (10.56) [0.47]	1.85 (0.70) [0.02]	1.66 (1.13) [0.04]
Transportation index		28.87 (157.34) [0.28]		4.43 (18.37) [0.43]
Difference in unemployment		6.42 (6.41) [0.06]		-1.01 (0.59) [0.97]
COOL	1.96 (4.76) [0.26]	-11.41 (16.50) [0.79]	-3.36 (0.66) [1.00]	-1.27 (1.36) [0.88]
R2-adj	0.73	0.74	0.68	0.68

Notes: Numbers in parentheses are bootstrap standard errors and numbers in brackets are bootstrap probabilities that individual variables are smaller than zero. Monthly dummies and dummies for the weeks including U.S. Independence Day, US Thanksgiving and Christmas are included in the models but not displayed here.

Figures

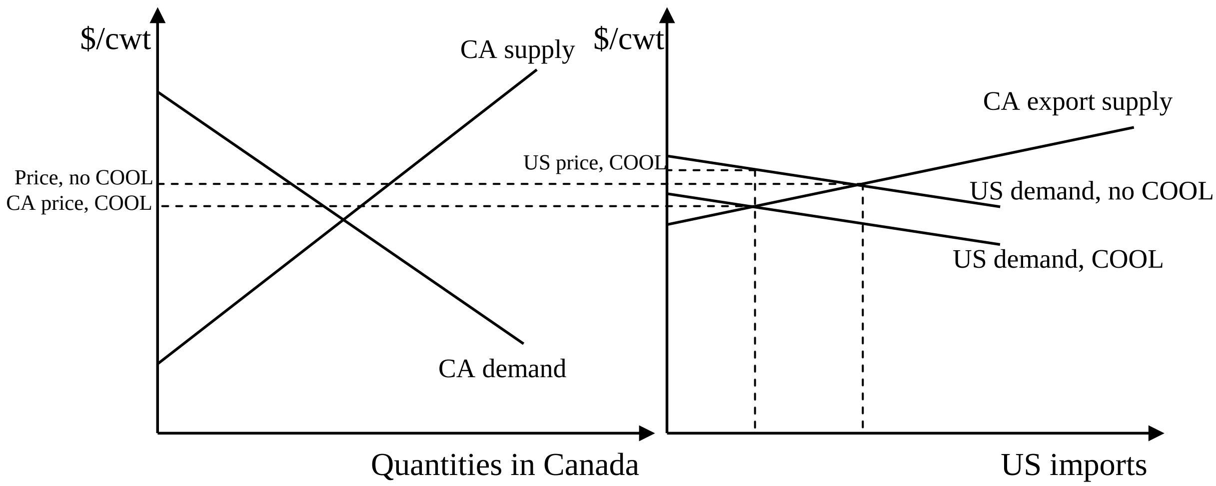

Figure 1: Market effects of COOL on Canadian livestock prices and US import quantities

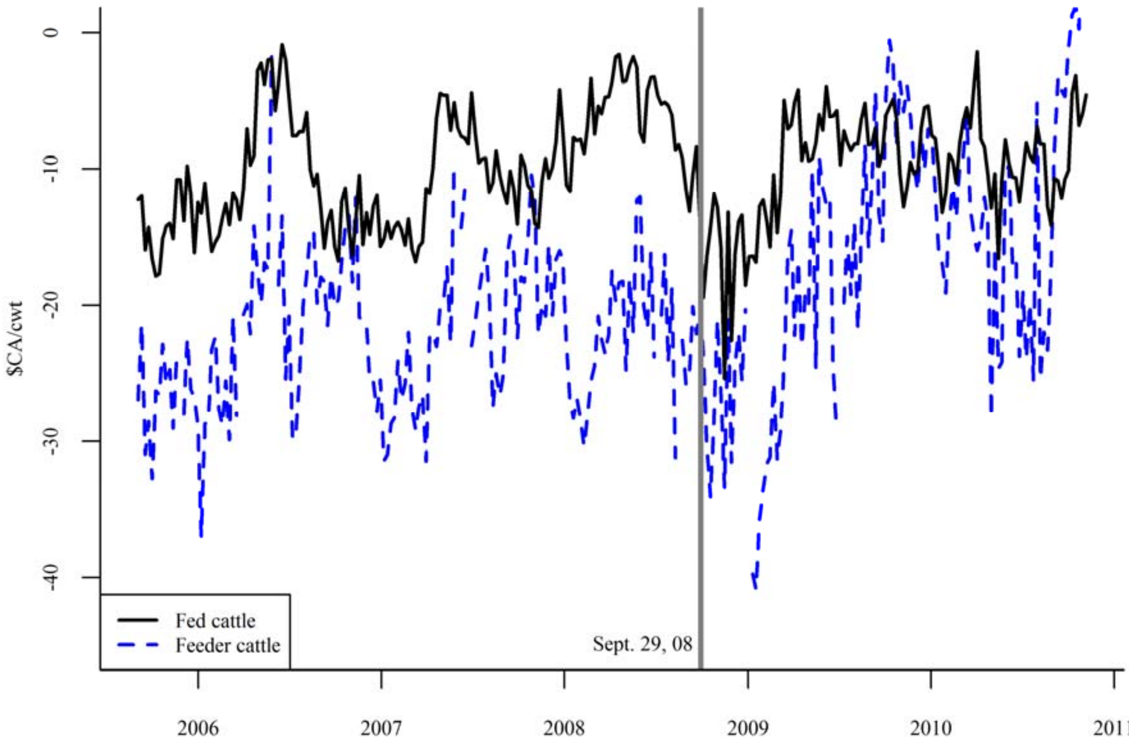

Figure 2: Basis in CA dollars per CWT for fed cattle and feeder cattle

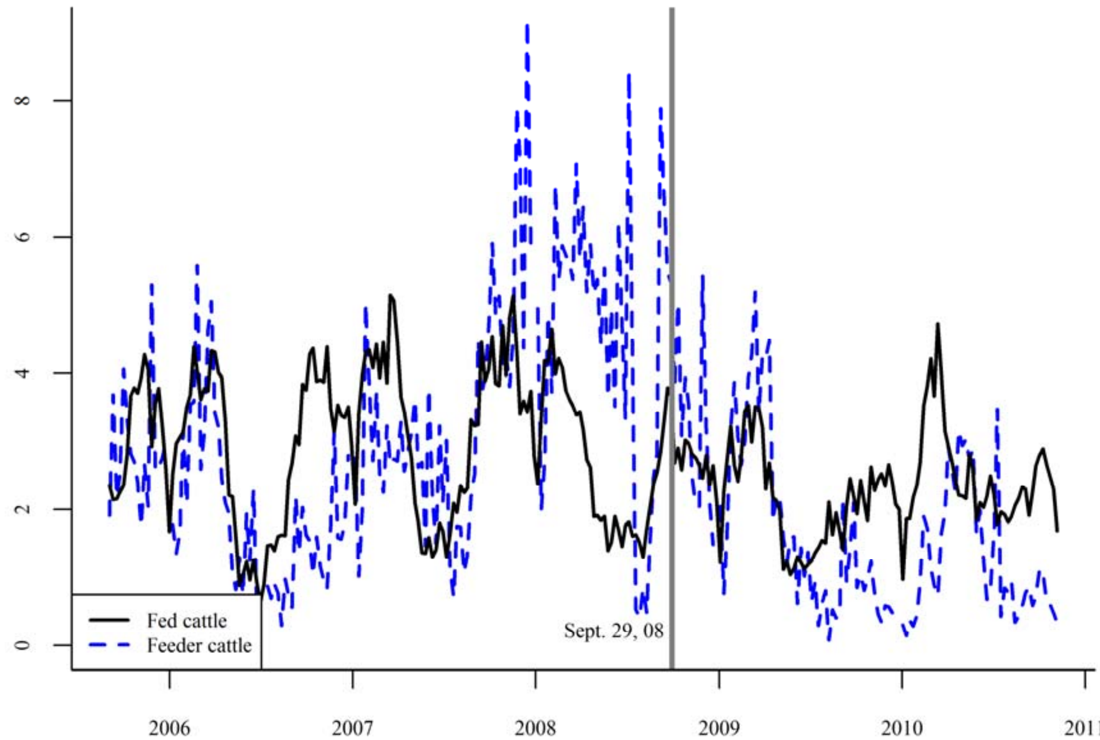

Figure 3: Ratios for fed cattle and feeder cattle