Peru

Estimation of the pass-through and welfare effects of the tariff reduction for yellow corn in Peru between 2000 and 2011

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Abstract

Using non-parametric regressions, this study examines the welfare effects on households that are attributable to the reduction of the effective tariff on yellow corn between 2000 and 2011, through its impact on the reduction of chicken meat prices. The analysis focuses on Peru's coastal regions, which meet their yellow corn demand mainly through imports and where more than 90 per cent of the broiler production is located. The study calculates the welfare effect of the tariff change on consumers of yellow corn's main derivative product, chicken meat, which accounts for an important share in the household food expenditure basket. For this purpose, the study estimates the extent of the tariff pass-through to wholesale prices of yellow corn, and the price pass-through of yellow corn to retail prices of chicken meat. The results show that, on average, the reduction in chicken meat retail prices induced by the tariff reduction for yellow corn generates a welfare gain of 0.24 per cent for households in the coastal regions. Welfare gains are slightly higher in urban areas (0.24 per cent) than in rural areas (0.22 per cent). Finally, the induced effects of the yellow corn tariff reduction have a pro-poor bias: the poor households on the coast experience the highest welfare gain (0.29 per cent).

* The views expressed in this study are solely those of the authors and do not necessarily reflect, and should not be represented as, the views of the Ministry of Foreign Trade and Tourism of Peru.

1 Introduction

Yellow corn[1] is the third most important agricultural crop in Peru and the main input for the poultry industry. It is mainly used for the production of livestock compound feed and not for direct human consumption. The broiler industry that produces chicken meat and uses yellow corn as feed represents approximately 90 per cent of poultry meat production.[2]

Domestic production of yellow corn has not increased significantly in recent years. In fact, since 2004, domestic demand for yellow corn has mainly been met through imports. Due to small-scale operation and an informal sales market for local production, broiler firms depend highly on imports of yellow corn.

As the world price of yellow corn was increasing and national per capita consumption of chicken meat started to show significant growth, the government introduced new trade measures aimed at reducing the effective tariff applied to yellow corn: the tariff was cut from 33.3 per cent to zero between 2000 and 2011. However, during the same period, average domestic prices of yellow corn and chicken meat increased by 31.1 and 28.4 per cent, respectively. It is therefore of interest for policymakers concerned with international trade and social development to measure the degree of transmission of yellow corn tariff reductions to domestic prices of yellow corn and chicken meat, as well as their impact on household welfare.

As regards national demand for yellow corn, this study finds evidence of two purchasing patterns: Peru's coastal regions meet their yellow corn demand mainly through imports, while the highlands and jungle regions consume mostly domestically produced corn. Therefore, one would expect that trade policy measures aimed at reducing tariffs for yellow corn would have a more significant effect on the coast, especially if one takes into account that more than 90 per cent of the production of the broiler industry is concentrated there. For these reasons, this study estimates the tariff and price pass-through for the markets of yellow corn and chicken meat in the coastal regions of Peru.

On the one hand, the objective of this study is to estimate the extent of the tariff pass-through to domestic prices of yellow corn due to the reduction of tariffs between 2000 and 2011. On the other hand, given the importance of yellow corn as an input in the production of chicken meat and the

[1] A variety of hard yellow corn, known as *maíz amarillo duro* in Spanish.

[2] The production of duck and turkey meat represents the other 10 per cent (MINAG, 2012).

importance of chicken meat as an item in the Peruvian food expenditure basket,[3] the study measures the extent to which tariff reductions for yellow corn translated into changes in household welfare in the coastal regions through the consumption of chicken meat. This study is the first to address this question, and may therefore be used by policymakers as a starting point for further discussions about the effectiveness of unilateral tariff reductions implemented by the government of Peru in several sectors.

The study first estimates the tariff pass-through to wholesale prices of yellow corn and the price pass-through of yellow corn prices to retail prices of chicken meat. Then, using non-parametric regressions, it analyses the relationship between the level of livelihood and the welfare changes induced by the tariff reduction for yellow corn through its effect on chicken meat retail prices. This analysis is run across rural/urban areas and three income groups (extremely poor, poor and non-poor) on the coast of Peru.

The next section (Section 2) explains the rationale for the analysis, while Section 3 describes the main characteristics of the yellow corn and broiler industries in Peru. The study then explains the methodology for measuring the tariff and price pass-through and the welfare changes at the household level (Section 4). The final section outlines the conclusions of the study and proposes policy recommendations emanating from the analysis.

2 Statement of the problem

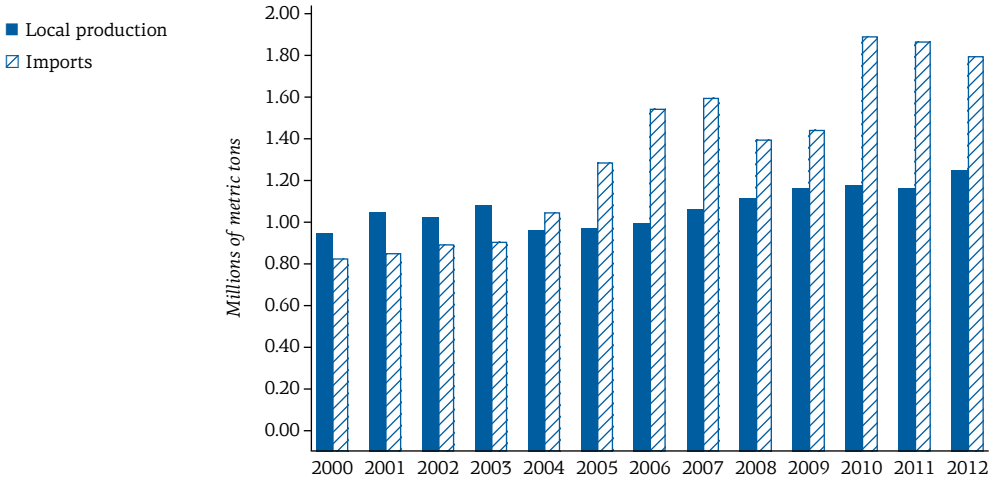
Yellow corn is the third most important agricultural crop in Peru and the main input for the production of chicken meat. Taken together, the production of yellow corn and chicken meat accounted for 23 per cent of agricultural gross domestic product (GDP) in 2012. Yellow corn is mainly used for the production of livestock compound feed for the broiler industry, but it is also required for industrial products such as starch (for beer) and vegetable oil.

Despite its importance, domestic production of yellow corn has not recorded significant growth in recent years. In fact, between 2000 and 2012, it only increased at an average annual rate of 3.2 per cent. In contrast, the volume of yellow corn imports rose by an average annual rate of 7 per cent,

[3] According to the methodology adopted by the National Institute of Statistics, food and beverages account for 26 per cent of the household expenditure basket. With a consumption share of 4.3 per cent in household expenditure (obtained from the 2011 National Household Survey), chicken meat represents about 15 per cent of the food expenditure basket.

from 0.85 million metric tons in 2000 to 1.83 million metric tons in 2012. As a consequence, since 2004, domestic demand for yellow corn has been covered mainly by imports (Figure 1).

Figure 1 Total supply of yellow corn – Domestic production and imports, 2000-2012 (millions of metric tons)



Source: Peruvian Customs Agency and Ministry of Agriculture.

The main reasons for the low levels of domestic yellow corn production are that most producers operate in the informal sector and do not work together in associations or cooperatives. According to the 2012 agricultural census, 68 per cent of local producers are smallholders (with less than five hectares (ha) of land). Due to the limited amount of land they cultivate, their negotiating power with intermediaries or wholesalers is very limited. At the same time, because the farmers work mainly in the informal sector, they do not have access to formal credit and thus have difficulty improving productivity through the acquisition of new equipment, fertilizers, and certified seeds. Consequently, they are unable to meet the broiler industry's demand for yellow corn.

In the late 1990s, in order to protect domestic production, the government of Peru introduced additional duties (specific and *ad valorem*) to the most-favoured-nation (MFN) tariff on imports of yellow corn. However, at the end of 2007, when world prices of yellow corn and per capita consumption of chicken meat started to rise, the government was concerned about

the effect of these duties on local prices of yellow corn and chicken meat, and consequently on household welfare. It therefore took steps to reduce local prices by reducing the effective protection applied to yellow corn. In fact, between 2000 and 2011, the effective tariff dropped from an annual average of 33.3 per cent to zero.

Meanwhile, during the same period, national wholesale prices of yellow corn rose by 31.1 per cent and retail prices of chicken meat increased by 28.4 per cent.[4] It is therefore important to find out whether and to what extent the tariff reduction was transmitted to domestic prices of yellow corn and chicken meat, as well as what impact the tariff reduction had on household welfare.

3 Peruvian yellow corn and chicken meat markets

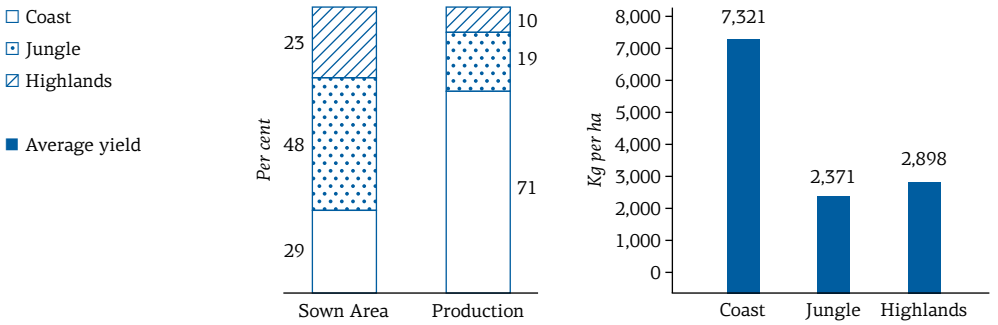
3.1 Domestic production of yellow corn

The 3.2 per cent annual increase in domestic production of yellow corn between 2000 and 2012 can be broken down into 3.4 per cent in coastal regions and lower rates of 2.5 and 2.6 per cent in the highlands and jungle regions, respectively. Farming units in the coastal regions have higher productivity due to more intensive use of new technologies and favourable weather conditions. Moreover, they have the advantage of being located near the largest broiler industry firms and feed mills that are the main buyers of yellow corn. In contrast, farming units in the highlands and jungle regions do not have access to modern machinery or production techniques, and are far away from the biggest centres of demand located on the coast. Significant infrastructure shortcomings in roads from the highlands and jungle regions to the coast increase transport costs, rendering producers in those regions unable to competitively supply buyers on the coast.

In 2012, coastal regions accounted for 71 per cent of total production of yellow corn in the country, while the highlands and jungle regions produced 19 per cent and 10 per cent, respectively, in spite of accounting for 71 per cent of the total area devoted to yellow corn (Figure 2). Half of the total production was concentrated in three coastal regions: La Libertad (22 per cent), Lima (19 per cent), and Lambayeque (11 per cent). Additionally, coastal regions were the most productive, with an average yield of 7,321 kilograms (kg) per hectare. The most productive were Lima (9,892 kg per ha), Ica (9,062 kg per ha), and La Libertad (8,981 kg per ha).

[4] Data from the National Institute of Statistics of Peru, average of regional prices for chicken meat.

Figure 2 Sown area, domestic production and average yield by region, 2012



Source: Ministry of Agriculture.

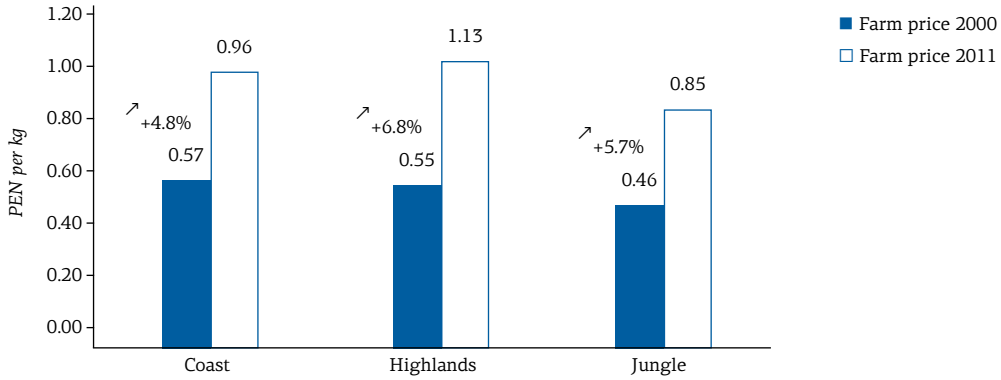
3.2 Domestic and international prices of yellow corn

Farm prices of yellow corn increased from Peruvian nuevos soles (PEN) 0.54 per kg in 2000 to PEN 1.00 in 2011 (with an average annual growth rate of 5.8 per cent). In the coastal regions, prices grew less than the national average (at a rate of 4.8 per cent). The regions with the lowest growth rates were Moquegua (2.77 per cent), Lambayeque (3.99 per cent), and Tacna (4.13 per cent). In contrast, in the highlands and jungle regions, prices increased more than the national rate, by 6.8 per cent and 5.7 per cent, respectively (Figure 3). The regions with the highest growth rates were Puno (9.18 per cent), Huancavelica (9.10 per cent) and San Martín (8.88 per cent).

It is important to highlight that in 2000, the difference between the highest and lowest price was only 11 cents, while in 2011 the difference was 17 cents.

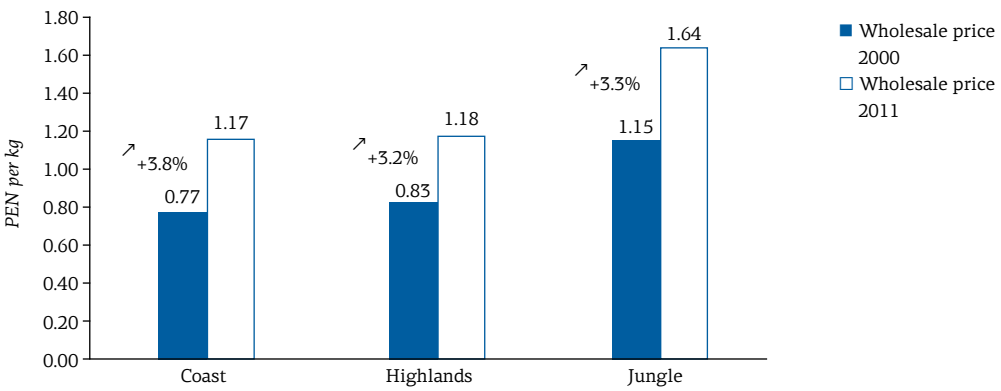
Between 2000 and 2011, wholesale prices of yellow corn increased at an average annual rate of 3.5 per cent. Coastal regions recorded a rate higher than the national average (3.8 per cent), while highlands and jungle regions had rates of 3.2 per cent and 3.3 per cent, respectively (Figure 4). In 2011, coastal and highlands prices only differed by 1 cent. In contrast, prices in jungle regions exceeded the other prices by approximately 40 per cent. The low supply of corn makes the prices higher in the jungle regions. However, buyers prefer to use local corn than to buy from the highlands or coastal regions in order to avoid paying extra transport costs.

Figure 3 Farm prices of yellow corn by region, 2000 and 2011 (PEN per kg)



Source: Ministry of Agriculture.
Note: Prices are expressed in nominal terms.

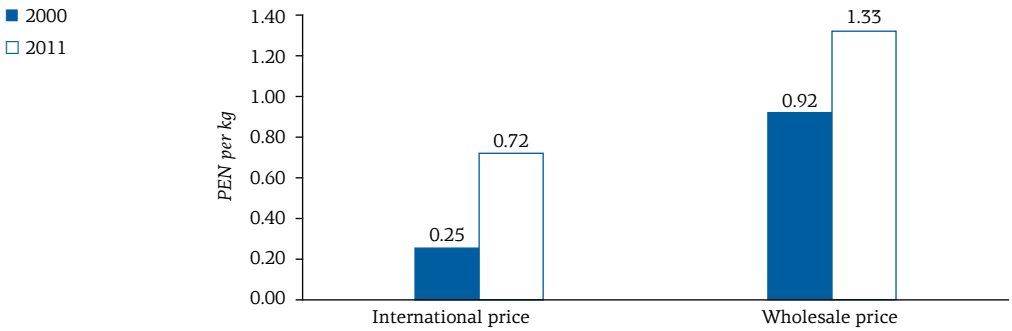
Figure 4 Wholesale prices of yellow corn by region, 2000 and 2011 (PEN per kg)



Source: Ministry of Agriculture.
Note: Prices are expressed in nominal terms.

The international price of yellow corn expressed in PEN increased by 186 per cent between 2000 and 2011 (from PEN 0.25 in 2000 to PEN 0.72 in 2011).[5] On average, the wholesale price was 3.6 times higher than the international price in 2000 and 1.8 times higher in 2011 (Figure 5). This difference may be due to internal transport costs and the presence of many intermediaries between farmers and wholesalers. This matter will be discussed in the following sections.

Figure 5 Wholesale and international prices of yellow corn, 2000 and 2011 (PEN per kg)



Source: Ministry of Agriculture.
Note: Prices are expressed in nominal terms.

3.3 Effective tariffs applied to yellow corn

To measure the effect of tariff changes on wholesale prices of yellow corn, we use the effective tariff rate for this product. Between 2000 and 2011, imports of yellow corn were subject to MFN *ad valorem* tariffs that are charged on the cost, insurance, and freight (CIF) value. In addition, there were a number of other special regimes that affected yellow corn, as detailed below.

3.3.1 Most-favoured-nation tariff

The MFN tariff is the tariff rate that World Trade Organization (WTO) members impose on imports from other members unless these countries are part of preferential trade agreements (such as a free trade area or a customs union). This means that, in practice, MFN rates are the highest (most restrictive) that the WTO members can charge one another.

[5] This increase in international prices of yellow corn can be attributed to, among other factors, growing demand from emerging economies such as Brazil, India, and China (corn as a food item), and from the United States (corn as an input to produce biofuels).

Between January 2000 and September 2007, the MFN tariff applied to Peruvian imports of yellow corn was 12 per cent. In the subsequent years, it was reduced to 9 per cent (October 2007), 6 per cent (January 2011), and zero (April 2011).

3.3.2 Additional tariff surcharge

In April 1997, the government added an *ad valorem* tariff of 5 per cent to the MFN tariff applied to yellow corn (Supreme Decree No. 035-97-EF). This policy was in force until June 2000.

3.3.3 Specific tariff

From August 1998 to May 2001, Peruvian importers of yellow corn had to pay a specific duty per metric ton that varied according to a free on board (FOB) reference price fixed by the central bank. The reference price changed every month and was an average of different market prices (USA 2YC-15.5 FOB Gulf and USA 3YC-15.5 FOB Pacific).[6] When the FOB price reached a ceiling value (also established by the central bank), importers paid no additional duty. On the contrary, the duties increased when the FOB reference prices were reduced. In June 2001, this mechanism was replaced by the Price Band System.

3.3.4 Price Band System

The Price Band System introduced in June 2001[7] increases or reduces the amount paid by importers resulting from the MFN tariff applied to yellow corn (and to other products such as milk, rice, and wheat). This amount is charged per metric ton – it can therefore be considered to be a specific tariff. It varies according to whether a CIF reference price is below (or above) a CIF floor price (or a CIF ceiling price):

- If the CIF reference price is below the floor, a specific duty per metric ton is added to the MFN *ad valorem* tariff.
- If the CIF reference price exceeds the ceiling, a specific duty per metric ton is detracted from the amount paid for the MFN *ad valorem* tariff. This reduction is applied up to a maximum of the MFN *ad valorem* tariff.

[6] Supreme Decree No. 083-1998-EF. Available at: *http://www.mef.gob.pe/index.php?option=com_docman&task=cat_view&gid=127&limit=15&limitstart=60&order=date&dir=ASC&Itemid=100602&lang=es.*

[7] The Price Band System, introduced by Supreme Decree No. 115-2001-EF in June 2000, aimed to protect national agriculture from price distortions caused by agricultural policies of the major producers.

The floor and ceiling prices, as well as the specific duties, are presented in a custom table established by the central bank. The table is published twice a year (1 January and 1 July) in the Official Gazette and includes a list of the CIF reference prices that will be in force during the coming semester. In addition, to establish which of the CIF prices listed in the custom table is applicable on a daily basis, the central bank fixes a reference CIF price every two weeks.

Table 1 summarizes the information from the custom table published on 1 July 2013. Using this information, we illustrate how to use the Price Band System. For instance, if a firm wants to import 10 metric tons of yellow corn on 5 August, it will have to search for the CIF reference price that is in force from 1 August to 15 August. In this case, the price is USD 239 per metric ton.[8] According to Table 1, the latter price is below the floor price (USD 294), thus the importer has to pay a specific tariff of USD 56 per metric ton. Considering that since April 2011 the MFN *ad valorem* tariff has been zero, the total amount paid by the importer will be USD 560, which is equivalent to an *ad valorem* tariff of 23 per cent.[9]

Table 1 Price Band System – Custom table, July–December 2013 (USD per metric ton)

CIF reference price USD 100-198	Additional or reduction specific tariff	CIF reference price USD 199-353	Additional or reduction specific tariff	CIF reference price USD 354-450	Additional or reduction specific tariff
100	200	199	98	354	-1
...	...	...	...	...	...
138	160	237	58	392	-40
139	159	238	57	393	-41
140	158	239	56	394	-42
141	157	240	55	395	-44
142	156	241	54	396	-45
143	155	242	53	397	-46
144	154	243	52	398	-47
145	153	244	51	399	-48
...	...	...	...	...	...
187	110	286	8	441	-91
188	109	287	7	442	-92
189	108	288	6	443	-93
190	107	289	5	444	-94
191	106	290	4	445	-95

[8] To see this and other two-week reference CIF prices, go to: *http://www.mef.gob.pe/index.php?option=com_docman&Itemid=100602.*

[9] Ratio of USD 560 to USD 2,390.

CIF reference price USD 100-198	Additional or reduction specific tariff	CIF reference price USD 199-353	Additional or reduction specific tariff	CIF reference price USD 354-450	Additional or reduction specific tariff
192	105	291	3	446	-96
193	104	292	2	447	-97
194	103	293	1	448	-98
195	102	294	0	449	-99
196	101	> 294 Floor Price	0	450	-100
197	100	< 353 Ceiling Price	0		
198	99	353	0		

Source: Central Reserve Bank of Peru.

3.3.5 Preferential tariffs

During the period covered by this study, Peru granted preferential tariffs to its main suppliers of yellow corn. In 2000, it offered a 100 per cent MFN reduction on its imports from Bolivia (under the Andean Agreement), and in 2006 it conceded a 15-year liberalization phase for Brazil and Argentina (under the Partial Preferential Agreement No. 58). In addition, in February 2009, the government granted the United States 100 per cent quota-free imports under the Trade Promotion Agreement.[10]

The effective tariff rate shown in Figure 6[11] is obtained as a ratio between the total amount of duties applied to imports of yellow corn and the total CIF imports of this crop:

$$Effective\ tariff\ rate_t = \frac{\sum Total\ duties\ on\ imports\ of\ yellow\ corn}{\sum Total\ imports\ of\ yellow\ corn} \qquad (1)$$

Figure 6 shows the monthly series (from January 2000 to December 2011) of the MFN *ad valorem* tariff rate and the effective tariff rate applied to Peruvian imports of yellow corn. There is an important difference between both series. Between January 2000 and November 2002, the effective tariff rate was higher than the MFN rate. In fact, during some months, the effective tariff exceeded the MFN rate by more than 30 percentage points.[12]

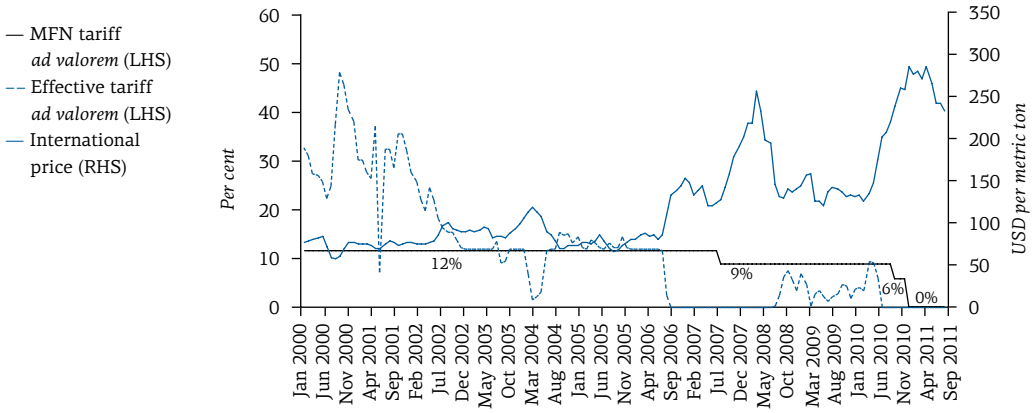
[10] If the volume imported from the United States does not exceed the quota established in the Agreement, importers do not have to pay duties. The Agreement established a duty-free tariff quota of initially 500,000 metric tons, with annual increases of 6 per cent and full duty-free access in 12 years.

[11] The effective tariff rate plotted in Figure 6 is an indicative measure of the protection applied, but it does not represent the official formula used by Peruvian customs authorities.

[12] The effective tariff cannot exceed the bound tariff to which Peru has committed under the WTO agreement (consolidated tariff), which is 68 per cent.

This difference is attributed to the specific tariffs paid by importers due to lower international prices of yellow corn. In contrast, when international prices increased significantly, the effective tariff was below the MFN tariff. For instance, from February 2007 to August 2008, the effective tariff paid by importers was zero due to high international prices.

Figure 6 Effective and MFN tariff rates, 2000–2011



Source: Peruvian Customs Agency.
Note: LHS stands for left-hand scale, RHS for right-hand scale.

3.4 Linkages between the yellow corn and broiler industries in Peru

Yellow corn is the main input for the production of chicken meat – the combined production of yellow corn and chicken meat accounted for 23 per cent of the country's agricultural GDP in 2012, with chicken meat taking a larger share of approximately 18 per cent. In 2012, the production of chicken meat (broiler industry) represented approximately 90 per cent of the production of the poultry industry,[13] which also includes turkey and duck meat. This study focuses only on the relationship between the yellow corn and broiler industries. Yellow corn accounts for about 45 per cent of the broiler industry production costs, while soybeans represent 15 per cent.[14] Other important expenditure items for the broiler production are baby chickens, vaccines, heating expenses, and labour costs.

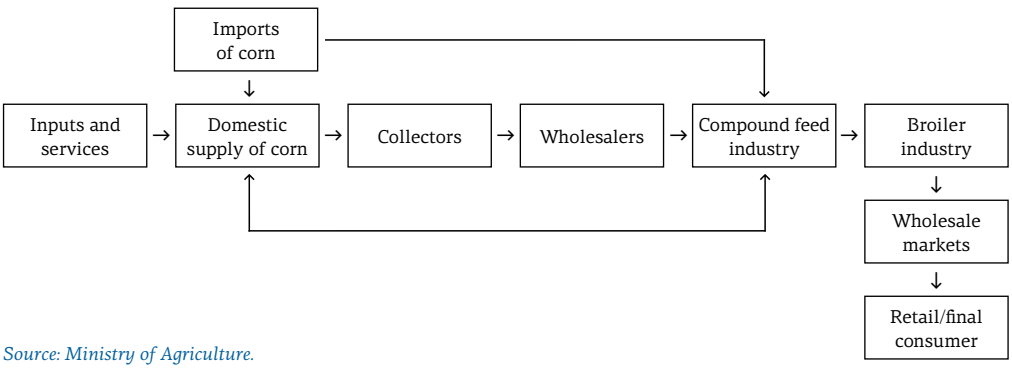
[13] According to the Ministry of Agriculture, the production of poultry meat was 1,168,951 metric tons. Using the percentage calculated by MINAG (2012) for the production in 2011, the production of chicken meat therefore was approximately 1,052,056 metric tons in 2012.

[14] Based on the rating report of Apoyo & Asociados (2012) on San Fernando, the largest company in the broiler industry.

[15] Sales represented 83 per cent of total production on the coast, 63 per cent in the highlands, and 75 per cent in the jungle regions.

In order to understand the tariff pass-through to yellow corn and chicken meat prices, Figure 7 describes the linkages between the yellow corn and broiler production.

Figure 7 Yellow corn – broiler production chain



Source: Ministry of Agriculture.

3.4.1 Farmers and wholesalers

Between 2000 and 2011, domestic production of yellow corn accounted for 47 per cent of the yellow corn commercialized on the Peruvian market. The 2012 agricultural census determined that 80 per cent of domestic production was sold, while the remainder was used by farmers to feed their own animals.[15] Most of the farmers do not issue invoices or pay taxes, so they cannot become suppliers to formal sector firms in the compound feed or broiler industries. In addition, they cannot supply the volumes of yellow corn demanded by those firms.

According to MINAG (2012), farmers sell their product to collectors directly from the farm. Occasionally, collectors provide working capital to farmers with a promise of purchase. In those cases, collectors have the power to fix farmer prices. Also, by consolidating their purchases from several farmers, collectors are able to reduce their provision/transaction costs. Otherwise, they would have to purchase corn from different farmers who are located far from one another.

Collectors sell the crop to wholesale markets or feed mills located in urban areas. According to MINAG (2012), wholesalers' clients are mainly informal or small-scale chicken farmers who require small quantities of yellow corn and usually produce their own compound feed.

3.4.2 Importers and the compound feed industry

Between 2000 and 2012, the volume of imports rose on average by 7 per cent annually, increasing from 0.85 million metric tons in 2000 to 1.83 million metric tons in 2012 (Table 2). Argentina was the major yellow corn supplier to Peru (70 per cent on average over 2000–2012). However, in 2012, its exports to Peru fell by 18 per cent; consequently, its share in the country's imports shrank from 80 per cent to 68 per cent. At the same time, imports from Paraguay and Brazil increased by 103 per cent and 38 per cent, respectively. Corn exports from the United States to Peru were almost nil in 2012 due to lower prices from other sources, limited production following the severe drought in the United States, and the fact that feed producers prefer Argentine or Peruvian corn because of its superior quality.

Table 2 Total imports of yellow corn by main suppliers, 2000–2012

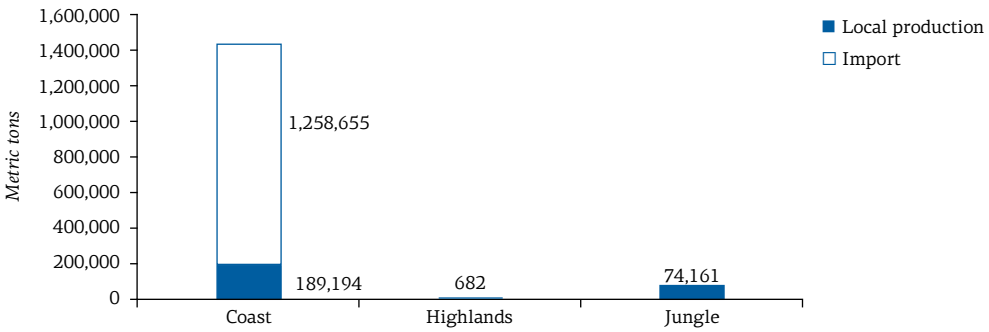
Country	2000	2002	2004	2006	2008	2010	2011	2012	Variation 2011–2012
Argentina	562.9 66.5	719.4 78.6	815.3 75.0	954.1 64.2	1,070.6 76.9	1,059.7 55.7	1,515.1 79.8	1,242.3 67.8	–18
Paraguay	0 0	0 0	35.2 3.2	128.5 8.6	44.8 3.2	156.3 8.2	156.5 8.2	318.0 17.4	103
Brazil	0 0	0.1 0.0	0.6 0.1	0.7 0.0	54.0 3.9	58.9 3.1	163.0 8.6	225.7 12.3	38
Bolivia	0.6 0.1	1.5 0.2	5.6 0.5	25.1 1.7	8.2 0.6	2.3 0.1	0 0	45.3 2.5	
United States	282.5 33.4	191.9 21.0	230.2 21.2	378.6 25.5	214.6 15.4	626.4 32.9	63.1 3.3	0 0	–100
Other	0.4 0.0	2.0 0.2	0 0	0 0	0 0	0 0	0 0	0 0	
Total metric tons	846.4	915.0	1,087.0	1,486.9	1,392.2	1,903.5	1,897.8	1,831.3	–4

Source: Peruvian Customs Agency.
Note: The imports of yellow corn are shown in thousands of metric tons (first line), and as a share of every country in Peruvian imports (second line, in per cent). The variation (the far right column) is expressed in per cent.

As mentioned earlier, domestic farmers cultivating yellow corn are not in a position to supply the volumes required by formal firms in the compound feed industry. For this reason, the industry mostly satisfies its requirements through imports, and complements those imports with domestically produced corn purchased from collectors. In fact, in 2011, the compound

feed industry mainly used imports for its production (83 per cent of its needs, or 1.2 million metric tons). As shown in Figure 8, imports were concentrated in the coastal regions (about 60 per cent), while the highlands and jungle regions mainly purchased the domestic variety.

Figure 8 Demand for yellow corn by the compound feed industry, by source and region, 2011 (metric tons)



Source: Ministry of Agriculture.

The largest importer of yellow corn is the largest firm in the broiler sector (San Fernando), which accounted for 26 per cent of total imports during 2000–2011. In fact, San Fernando and the other leading firms, which are located on the coast, purchase mainly the imported variety. These firms are vertically integrated and thus also produce their own compound feed.[16]

In addition to the first type of buyers of yellow corn described above – large or medium-size formal firms in the compound feed and broiler industries located mainly in coastal regions – there is a second type of buyers. These buyers are small firms or informal producers of chicken meat that are not able to import themselves or require small amounts of yellow corn. These buyers are concentrated in the highlands and jungle regions.

3.4.3 The broiler industry

The production of chicken meat increased by 113 per cent during 2000–2011 (average annual growth of 7.3 per cent) and per capita consumption grew from 19 kg in 2000 to 37 kg in 2011. According to Shimizu (2011),

[16] The vertical integration in the broiler industry might affect the transmission of yellow corn tariff reductions to retail prices of chicken meat. This issue will be discussed in the next section.

increases in the production of chicken meat are due to the introduction of new technologies (i.e. breeding, nutrition, medicine, and equipment) and to the tendency towards vertical integration in the broiler industry.

The broiler industry is composed of about 30 large and medium-sized firms that account for 90 per cent of domestic production. The leading firms in 2012 were San Fernando (36 per cent of total sales), Redondos (19 per cent), Ganadera Santa Elena (12 per cent) and San Luis (4 per cent). Additionally, there are between 200 and 300 small firms, many of them subcontractors to the industry leaders. The main producing areas are located in the coastal regions: in 2012, Lima accounted for 55 per cent of domestic production, followed by La Libertad (20 per cent), Arequipa (9 per cent), and Ica (4 per cent).[17] The firms are close to the coast because most of the facilities of the broiler industry (such as breeding farms, hatchery plants, feed mills, grow-out farms, slaughtering plants, and processing plants) are located there. Moreover, they are close to the Ports of Callao (Lima), Pisco (Ica), and Salaverry (La Libertad), the main points of entry for imported corn.

The most important characteristic of the Peruvian broiler industry is related to its distribution process. In developed countries, almost all broilers are slaughtered and processed before they are distributed to wholesalers. In Peru, by contrast, around 80 per cent of broilers are distributed alive to wholesalers (Shimizu, 2011), and according to MINAG (2012) approximately 65 per cent are sold in Lima.

4 Methodology and results

4.1 Tariff and price pass-through estimation

The previous section identified two patterns of yellow corn demand: the coast meets its demand mainly through imports, while the highlands and jungle regions consume mostly domestically produced corn. Therefore, one would expect that trade policy measures that reduce tariffs on yellow corn would have a more significant effect on the coast.

In this context, the objective of this study is to estimate the extent of the tariff pass-through to domestic prices in the coastal regions of Peru due to the reduction in yellow corn tariffs between 2000 and 2011. Given the importance of yellow corn as an input for the production of chicken meat and, in turn, the importance of chicken meat in the Peruvian food expenditure

[17] Data from the Ministry of Agriculture.

basket, we also measure the extent to which tariff reductions on yellow corn have translated into changes in household welfare in the coastal regions through the consumption of chicken meat.[18]

This section first estimates the tariff pass-through to wholesale prices of yellow corn and then examines the price pass-through of yellow corn to retail prices of chicken meat.

Following the theoretical framework applied in Nicita (2009), we start with the estimation of the tariff pass-through coefficient in the yellow corn market, for which it is assumed there are no differences between imported and domestic varieties of yellow corn. However, given that yellow corn is not consumed directly by households, but used as a production input for the chicken meat (broiler) industry, we will use wholesale prices of yellow corn instead of retail prices as our dependent variable. We will model yellow corn wholesale prices (pd_{it}) as a function of yellow corn producer prices (pp_{it}), yellow corn international prices in domestic currency ($p*_t$) , trade costs (trc_t),[19] an index of market concentration ($mrkc_t$), effective tariffs (et_t), and a trend variable ($year$).[20] This can be expressed in logarithms as:

$$\ln pd_{it} = \beta_1 + \beta_2 \ln pp_{it} + \beta_3 \ln p*_t + \beta_4 \ln trc_t + \beta_5 \ln mrkc_t + \gamma \ln(1 + et_t) + \theta\, year_t + \varepsilon_{it} \qquad (2)$$

where i is the subscript associated with regions and t is the subscript associated with monthly periods.

The tariff pass-through elasticity is represented by γ, the percentage increase in local prices derived from a 1 per cent increase in the tariff. In order to estimate the tariff pass-through for yellow corn, we will use monthly data[21] from January 2000 to April 2011 for eight coastal regions of Peru where most of the production of and demand for yellow corn are concentrated.[22] Our panel database is balanced. Wholesale and producer (farm)

[18] Originally we also intended to measure the impact on producer welfare on the coast. However, there were no households/units of production of corn/chicken meat represented in the 2011 Household Survey for the coastal regions that reported income resulting from the sale of these items. Therefore, we only focused on the analysis of the impact on consumer welfare.

[19] Trade costs are assumed to affect only imported goods.

[20] To capture the effect of a trending factor common to all coastal regions (such as the influence of demand preferences and agricultural policies).

[21] A description of our statistical sources is presented in the Annex.

[22] Lambayeque, La Libertad, Ancash, Lima, Ica, Arequipa, Moquegua, and Tacna. Two regions on the coast (Tumbes, Piura) were excluded due to the fact that they registered few observations of the dependent variable.

prices of yellow corn are available by region. The international price of yellow corn corresponds to the closing spot price of yellow corn number 2 on the Chicago Commodities Exchange, expressed in local currency (PEN). The effective tariff includes the MFN tariff and specific/additional tariffs that were in force during the period covered by this analysis. Trade costs are measured as monthly averages of freight and insurance costs per unit (kg) of Peruvian imports of yellow corn. The index of market concentration is the C4 market share[23] of yellow corn importing firms in Peru.

We estimate two panel data specifications to explain the behaviour of the dependent variable (wholesale yellow corn prices) using fixed- and random-effects estimation.[24] Due to the fact that we are working with different regions on the coast of Peru, it seems reasonable to assume that there is a component of time-invariant unobserved heterogeneity across entities, which could be correlated with some explanatory variables (e.g. differences in productivity and entrepreneurial behaviour may be correlated with producer prices). Therefore, to allow for arbitrary correlation between regional unobserved heterogeneity and the predictor variables, we estimate a fixed-effects model, whose results will then be compared with those of a random-effects model through a Hausman test.

Given that a reverse causality relationship exists between yellow corn producer prices and wholesale prices (endogeneity), contemporary producer prices in both models are instrumented by their four-month lag, using two-stage least squares.

In both models, all coefficients are significant at the 1 per cent confidence level and with the expected signs (all positive). According to the results of the Hausman test, the null hypothesis of no systematic differences between fixed- and random-effects estimators cannot be rejected, so we should take the coefficients from the random-effects model[25] to estimate the welfare effects on households on the coast of Peru derived from the tariff changes in yellow corn (and the changes in chicken meat prices that those changes induce).

As shown in Table 3, our tariff pass-through coefficient for wholesale prices of yellow corn is 0.74, which suggests a moderate to high transmission

[23] The aggregated market share of the four biggest importers.

[24] We do not estimate our panel by ordinary least squares because the necessary assumption of zero correlation between the error term and the explanatory variables would be violated.

[25] In this context, this model provides consistent, more efficient results than fixed-effects estimation.

of tariffs to domestic prices in the yellow corn market, consistent with the fact that most of the yellow corn demand on the coast of Peru destined for compound feed production is met by foreign producers (on average, imports cover more than 60 per cent of total supply).

Our results are also consistent with previous studies of the tariff pass-through of agricultural/food products in other Latin American countries,[26] which find an incomplete adjustment of the wholesale/retail price of the product to changes in its border price.

Table 3 Tariff pass-through dependent variable – Yellow corn wholesale price

	Model 1	**Model 2**
Variable	Fixed effects with instrumental variable estimation (2SLS)	Random effects with instrumental variable estimation (G2SLS)
Constant	–45.06*** (5.99)	–45.05*** (5.97)
Yellow corn producer price	0.47*** (0.05)	0.47*** (0.05)
Yellow corn world price	0.24*** (0.03)	0.24*** (0.03)
Trade costs	0.02*** (0.01)	0.02*** (0.01)
Market concentration	0.10*** (0.04)	0.10*** (0.04)
Tariff	0.74*** (0.09)	0.74*** (0.09)
Year	0.00*** (0.00)	0.00*** (0.00)

Source: Authors' estimations.
*Note: All variables are in logs. Standard errors, computed using default variance estimator in STATA, are shown in brackets. Significance levels of 1, 5, and 10 per cent are marked with ***, **, and *, respectively. 2SLS stands for two-stage least squares; G2SLS stands for generalized two-stage least squares.*

[26] Nicita (2009) finds that the tariff pass-through coefficient in Mexico is about 0.33 for an aggregate of agricultural products. Duran and LaFleur (2011) find a tariff pass-through coefficient of 0.08 for an aggregate of food products.

Had the movement in the wholesale price of yellow corn been determined exclusively by the effective tariff cut, the wholesale price would have experienced a reduction of 24.68 per cent (Table 5), which is obtained as the result of multiplying the tariff reduction (–33.3 per cent) by the tariff pass-through coefficient (0.74) estimated over the period 2000–2011.

We next address the pass-through between wholesale prices of yellow corn (as a production input) and retail prices of chicken meat, given that we want to measure the welfare effects on coastal households derived from the consumption of chicken meat, which is an important item in the food expenditure basket.

For this estimation, we also use monthly data[27] from January 2000 to April 2011 from the most representative coastal region (Lima).[28] Here we use the retail price of chicken meat as the dependent variable, and include as explanatory variables the wholesale price of yellow corn and the international price of soybeans (both production inputs for the compound feed used by the broiler industry),[29] as well as the retail price of fish meat (to allow for the possibility of substitution between chicken and fish in household demand).[30]

As shown in Table 4, we obtained a price pass-through coefficient from yellow corn to chicken meat of 0.22, which is significant at the 1 per cent confidence level and has the expected sign. Despite the fact that yellow corn accounts for more than 60 per cent of compound feed production costs on the coast, the magnitude of the price pass-through coefficient is consistent with the fact that there is evidence of a relatively high concentration in the broiler industry (in 2012, the market share of the four biggest firms in Lima was 70 per cent). Moreover, there is vertical integration in the firms that are both the biggest importers of yellow corn and the major producers of chicken meat, which suggests that limitations in competition may have hindered the transmission of the tariff reduction to the prices of yellow corn and chicken meat for consumers on the coast.

[27] A description of our statistical sources is presented in the Annex.

[28] According to MINAG (2012), 65 per cent of chicken meat sales take place in Lima.

[29] Compound feed costs account for approximately 75 per cent of production costs in the broiler industry.

[30] We also included the retail prices of red meat and pork, gasoline prices, and an index of wholesale price inflation in the estimation, but they were rendered insignificant.

Table 4 Price pass-through dependent variable – Chicken meat retail price

	Model 1
Variable	Ordinary least squares
Constant	1.49*** (0.07)
Yellow corn wholesale price	0.22*** (0.07)
Soybean world price	0.10*** (0.04)
Fish retail price	0.20*** (0.04)

Source: Authors' estimations.
*Note: All variables are in logs. Standard errors, computed using default variance estimator in STATA, are shown in brackets. Significance levels of 1, 5, and 10 per cent are marked with ***, **, and *, respectively.*

For the estimation of household welfare changes, we use a retail price change for chicken meat induced by the tariff reduction in yellow corn equal to –5.5 per cent. It is obtained by multiplying the tariff change[31] between 2000 and 2011 (–33.28 per cent, as shown in Figure 9) by both the tariff pass-through rate (0.74) and the price pass-through rate from yellow corn to chicken meat (0.22).

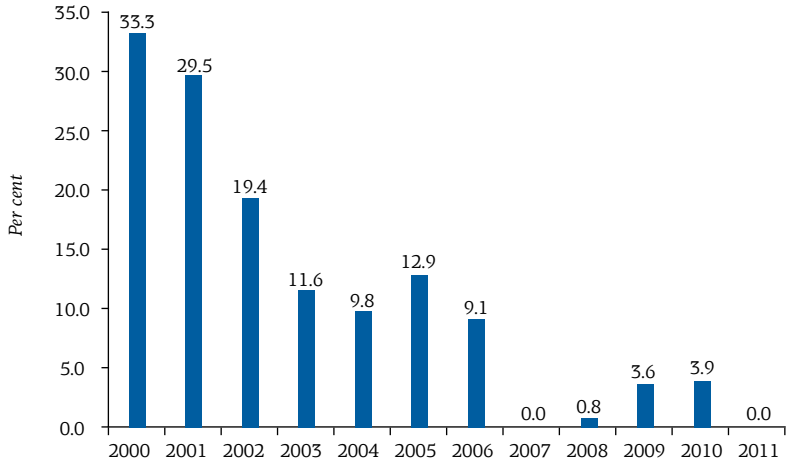
Table 5 Chicken meat price changes induced by yellow corn tariff changes

Product	**Yellow corn tariff change (per cent)**	**Tariff pass-through rate (fraction)**	**Price pass-through rate from yellow corn to chicken meat (fraction)**	**Price change attributed to yellow corn tariff change (per cent)**
Yellow corn	–33.28	0.74		–24.68
Chicken meat	–33.28	0.74	0.22	–5.50

Source: Authors' estimations.
Note: The changes were estimated for the 2000–2011 period. The tariff pass-through rate was taken from the estimation results for the tariff variable in Table 3 (Model 1). The price pass-through rate from yellow corn to chicken meat was taken from the estimation results for the yellow corn wholesale price variable in Table 4. The price changes in the last column are the result of multiplying the factors in each row.

[31] Obtained by subtracting the average effective tariff in 2011 from the average effective tariff in 2000.

Figure 9 Effective tariff for yellow corn, annual average, 2000–2011 (per cent)



Source: Peruvian Customs Authority.

As mentioned previously, despite the reduction in the tariff applied to yellow corn during 2000–2011, wholesale yellow corn prices rose by 31.1 per cent and retail prices of chicken meat rose by 28.4 per cent during the same period. Nevertheless, our estimation results suggest a reduction of 24.68 per cent in yellow corn prices and 5.5 per cent in chicken meat prices induced by the yellow corn tariff reduction (see Table 5). A counterfactual interpretation of these results implies that, if the tariffs had not been reduced, local prices of yellow corn and chicken meat would have risen by 55.78 per cent and 33.9 per cent, respectively. This shows that the measures adopted mitigated increases in local prices that would otherwise have been observed.

4.2 Estimation of welfare changes

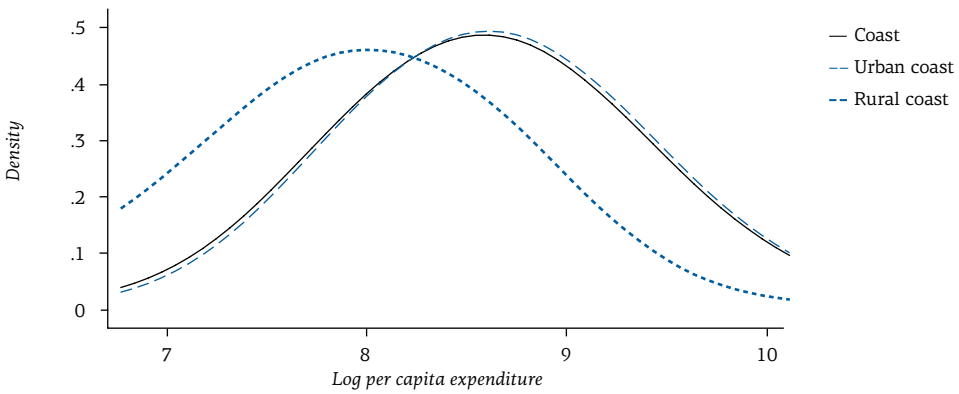
This section measures the extent to which tariff reductions in yellow corn have affected household welfare through consumption of chicken meat, considering only first-order consumption effects.

First, using non-parametric regression methods, we analyse the relationship between per capita expenditure of the households located on the coast of Peru and the welfare effects derived from the changes in retail prices of chicken meat induced by the tariff reduction in yellow corn. This analysis is conducted according to two criteria: (a) rural/urban location, and (b) poverty characteristics in terms of monetary poverty (i.e. non-poor, poor, and extremely poor households).

We work with data from the 2011 National Household Survey in Peru, which included 9,561 households on the coast. Eighty-six per cent (8,262) of surveyed households on the coast were in urban areas. The number of households that recorded a non-zero consumption share of chicken meat was 7,270.[32] Even though the majority of chicken meat production units are located on the coast of Peru, these firms are not represented in the household survey, which implies that we are only able to measure the welfare changes on the consumption side.

Following Deaton (1989), we use a kernel density estimator to characterize a smooth density function of log of per capita expenditure.[33] As shown in Figure 10, urban areas present higher levels of expenditure than rural areas.

Figure 10 Kernel density estimation of per capita expenditure



Source: Authors' estimations, based on the 2011 National Household Survey.

As shown in Table 6, chicken meat accounts on average for 4.28 per cent of household expenditure on the coast. On average, consumption shares of chicken meat are higher in urban than in rural areas on the coast, with the highest share in the capital (Metropolitan Lima). In addition, poor households show a higher consumption share of chicken meat than non-poor households, while extremely poor households have the lowest expenditure share, as it is likely that inferior goods have the highest shares in their food consumption basket.[34]

[32] According to the survey, 2,291 households recorded a zero consumption share of chicken meat.

[33] We use Epanechnikov kernel and bandwidth = 0.5.

[34] Inferior goods refer to such products as potatoes, rice, entrails and offal, among others.

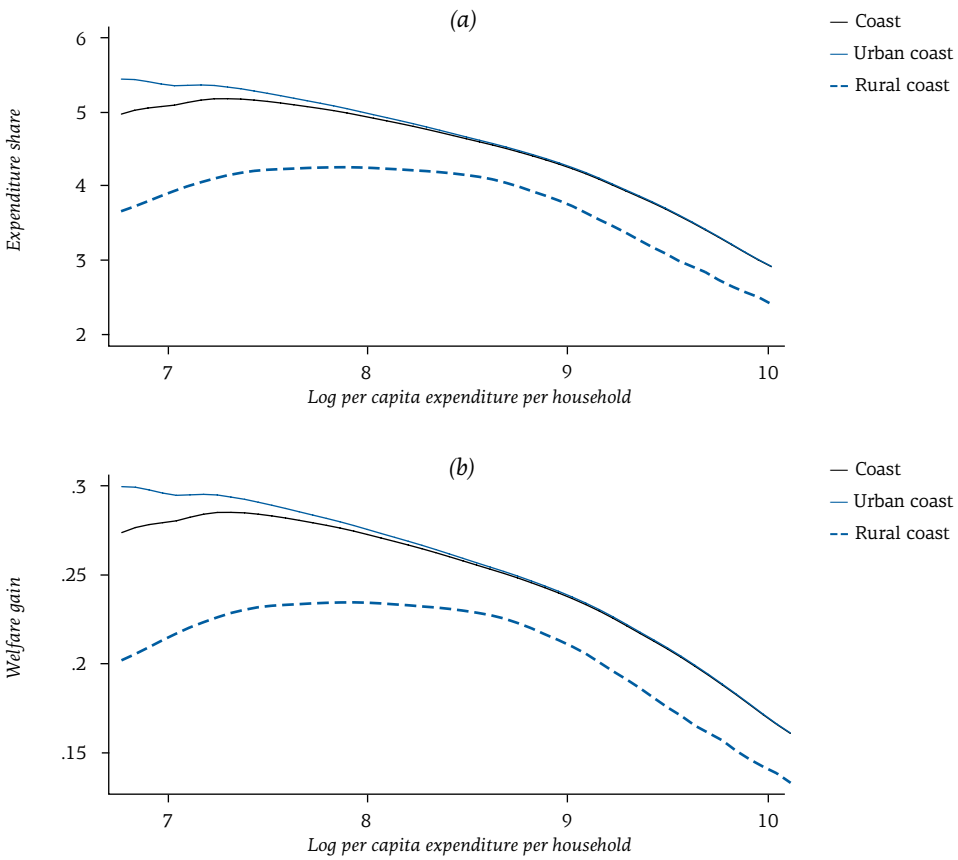
In panel (a) of Figure 11, we plot expenditure shares of chicken meat against per capita expenditure in the household, while in panel (b), we plot the welfare changes obtained against household per capita expenditure. When analysing the plots in panel (a), it can be seen that in urban areas on the coast, household consumption shares of chicken meat decrease almost monotonically with per capita expenditure. However, in rural areas, consumption shares of chicken meat increase with household per capita expenditure up to middle levels of this variable, only to decrease later.

Now, recalling the results in the previous section, we obtain that the reduction in the effective tariff of yellow corn induced a *ceteris paribus* reduction in the retail price of chicken meat of 5.5 per cent. To measure the effect that this price reduction has had on household welfare through the consumption of chicken meat, we calculate for each household the welfare gain derived from the induced change in retail prices of chicken meat. In order to do that, we multiply the price reduction (–5.5 per cent) by the household expenditure share of chicken meat.[35] This procedure is run for all households, and then the results are averaged across two criteria: (a) urban/rural location, and (b) poverty classification (i.e. non-poor, poor, and extremely poor households).[36] As shown in panel (b) of Figure 11, for the poorest households on the coast (black line), welfare gains first increase with per capita expenditure, but then decrease monotonically. Rural areas on the coast show smaller welfare gains than urban areas, and these gains tend to be steady among middle levels of income. On the other hand, the poorest households in urban areas obtain the biggest welfare gains, which, however, decrease with per capita expenditure.

[35] The expenditure share of chicken meat is calculated as the ratio between chicken meat expenditure and total household expenditure. The numerator of the ratio considers only products that were purchased in the market.

[36] Defined according to the following expenditure ceilings for a five-member household: PEN 1,420 for poor households, and PEN 755 for extremely poor households. These references are the standard established by the National Institute of Statistics of Peru.

Figure 11 Expenditure shares and welfare changes due to the impact of yellow corn tariff reductions on consumption of chicken meat



Source: Authors' estimations, based on the 2011 National Household Survey.

The results in Table 6 show that the reduction in chicken meat retail prices induced by the tariff reduction for yellow corn generates an average welfare gain of 0.24 per cent. Due to the fact that urban areas show a higher consumption share of chicken meat than rural areas, welfare gains are slightly higher in the former (0.24 per cent versus 0.22 per cent). Also, it can be seen that the induced effects of yellow corn tariff reductions have a pro-poor bias. Poor households on the coast get the highest welfare gain of 0.29 per cent, compared to the non-poor group (0.23 per cent).

Table 6 Average welfare changes due to the impact of yellow corn tariff reductions on consumption of chicken meat (per cent)

Coastal areas	Average expenditure share of chicken meat	Average welfare gain
Center	4.38	0.24
North	4.19	0.23
South	3.75	0.21
Metropolitan Lima	4.59	0.25
Urban	4.32	0.24
Rural	4.02	0.22
Non-poor	4.15	0.23
Extremely poor	3.48	0.19
Poor	5.19	0.29
Total coast	**4.28**	**0.24**

Source: Authors' estimations.

5 Conclusions and policy recommendations

In recent years, the effectiveness of tariff reductions applied to yellow corn imports in Peru has come under scrutiny because their expected benefits do not seem to have been significantly transferred to buyers of yellow corn and of its main derivative product, chicken meat. While the effective tariff of yellow corn was reduced by 33.3 percentage points between 2000 and 2011, average prices of yellow corn and chicken meat increased by 31.1 per cent and 28.4 per cent, respectively.

This study used two approaches to try to provide a tentative explanation to this apparent mismatch between the reduction of tariffs and the increase of domestic prices by undertaking: (a) estimations of the tariff pass-through to domestic prices of yellow corn and chicken meat; and (b) estimations of the first-order household welfare effects – excluding effects on wages – induced by the tariff reduction for yellow corn.

First, the estimation results show that the tariff reduction for yellow corn helped mitigate increases in local prices of yellow corn and chicken meat that otherwise would have occurred. In fact, a counterfactual interpretation of these results implies that if the tariffs had not been reduced, local prices of yellow corn and chicken meat would have risen by 55.78 per cent and 33.90 per cent, respectively.

Second, the findings show that the reduction in chicken meat retail prices induced by the tariff reduction for yellow corn would have generated an

average welfare gain of 0.24 per cent on the coast of Peru. Slightly higher welfare gains would have been obtained in urban areas (0.24 per cent) as opposed to rural areas (0.22 per cent). The estimated effect of yellow corn tariff reductions would have had a pro-poor bias, with poor households obtaining the highest welfare gain (0.29 per cent), compared to the non-poor group (0.23 per cent).

However, the results suggest that the benefits of the tariff reduction may not have been fully transmitted to consumers, and it could be the case that they have mostly been captured by the firms importing yellow corn and by the largest broiler producers, which are vertically integrated firms.

As regards the effects on producer welfare, we were not able to capture them because no income resulting from the sales of yellow corn and chicken meat was reported in the household survey for coastal regions. However, as the theory suggests, we would expect that net producers of yellow corn and derived products would have incurred welfare losses as a result of the tariff reduction.

In line with previous findings in the applied literature on trade policy transmission to household welfare, this study showed that when designing tariff policies that should mostly benefit consumers, special attention needs to be paid to the design of complementary policies aimed at encouraging a greater degree of competition in the relevant market. In this case, while there is some evidence that the yellow corn market in Peru is moderately competitive, the opposite happens to be true in the broiler industry, where the four biggest producers account for 70 per cent of total sales in Lima, and the major players are vertically integrated.

In addition, different patterns of yellow corn demand by the broiler industry on the coast (met mainly through imports) versus the highlands and jungle regions (which mostly use locally produced corn) suggest a low degree of integration in the national yellow corn market. This is also reflected in the significant differences in wholesale prices of yellow corn across regions. Therefore, trade policy measures aimed at altering tariffs for yellow corn would have had a more significant effect on the coast and a marginal effect on the highlands and jungle regions. This result highlights the importance of furthering market integration as a means of extending the benefits of trade policy, particularly to the poorest groups in the highlands and jungle regions. In sum, the effectiveness of tariff reductions such as those in the Peruvian yellow corn market should be increased through port and highway infrastructure development in order to enhance market integration.

Annex

Table A1 Data sources

Variable	Primary sources
Yellow corn wholesale prices	Ministry of Agriculture, National Institute of Statistics
Yellow corn producer prices	Ministry of Agriculture, National Institute of Statistics
Yellow corn world prices (yellow corn no. 2 – Chicago Commodities Exchange)	Reuters/Bloomberg
Trade costs (average freight and insurance costs per kg of Peruvian imports of yellow corn)	Peruvian Customs Agency – calculated by the authors
Market concentration (C4 market shares of yellow corn importing firms in Peru)	Peruvian Customs Agency – calculated by the authors
Effective tariffs on yellow corn	Peruvian Customs Agency
Chicken meat retail prices	National Institute of Statistics
Soybean world prices	Reuters/Bloomberg
Fish meat retail prices	National Institute of Statistics
Nominal exchange rates (USD/PEN)	Central Reserve Bank of Peru

Source: Authors' estimations.

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