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IMPORT RESTRICTIONS ON FROZEN CHICKEN AND DOMESTIC POULTRY PRODUCTION: THE CASE OF CAMEROON

Talla MU[1] and Y Kim[2]*

Youngjune Kim

Ulrich Mbidjiho Talla

*Correspondence author email: yjkim@kangwon.ac.kr

[1]Executive, Ministry of Livestock, Fisheries and Animal Industries, Yaounde, Republic of Cameroon

[2]Assistant Professor, Department of Agricultural and Resource Economics, Kangwon National University, Chuncheon 24341, Korea

ABSTRACT

The Cameroonian government implemented import restrictions in 2004 to protect the local poultry industry from low-priced frozen chicken imports that had been driving substantial financial losses and extensive job losses among small-scale producers. Prior to the ban, imported frozen chicken accounted for over 60 percent of urban poultry markets, undercutting domestic prices, eroding producer margins, and exacerbating concerns about food quality, food sovereignty, and rural livelihoods. This study investigated the policy's impact on annual domestic chicken production by applying the Synthetic Control Method (SCM) which is a counterfactual-based approach that constructs a weighted average of several other units to recreate the trajectory that chicken production would have followed in the absence of the intervention. The analysis draws on Food and Agriculture Organization Corporate Statistical Database (FAOSTAT) data from 1961 to 2022, focusing on a 1984–2003 pre-intervention window to secure a robust counterfactual, and assembling a donor pool of ten agricultural commodities, excluding crops with incomplete data or those affected by trade measures during the time frame of the analysis. Predictor variables include production levels, ensuring the synthetic control closely mirrors Cameroon's pre-2004 production trend. Between 2004 and 2008, observed output exceeded the synthetic counterfactual by an average of 23,880 tons per year, indicating a sizable policy-induced expansion. In major cities such as Yaounde and Douala, broiler prices respond to seasonal supply fluctuations: during shortages, prices for a 2kg bird rise to 3,500 Franc of the African Financial Community (FCFA), while in periods of surplus they fall to around 3,000 FCFA. National production is nearly fully absorbed by domestic demand, with no structural oversupply. Three Robustness checks: the placebo effects test, Root Mean Square Predictor Error (RMSPE) comparisons and leave one out tests confirm that the findings are robust. However, after 2008 volatility emerged due to the avian influenza shock and binding feed constraints (maize/soy), highlighting structural bottlenecks beyond border policy. These results support the infant-industry rationale for temporary protection but show that durable gains require complementary investments: input stabilization, veterinary and processing infrastructure, and market/quality systems aligned with World Trade Organization (WTO) consistent policy transitions. The SCM's applicability to agricultural trade policy in Africa was demonstrated and a replicable template for future evaluations provided. By doing that, this study offers concrete guidance for policymakers in designing sustainable agricultural trade policies.

Key words: Chicken production, frozen chicken, import restrictions, Cameroon, Synthetic Control Method

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INTRODUCTION

Government policies play a crucial role in shaping the agricultural sector's structure and performance through instruments such as subsidies, tax incentives, targeted research funding, and strategic infrastructure development. These interventions are designed to enhance agricultural productivity, ensure national food security, and support the resilience of rural economies [1]. Trade policies including tariffs, quotas, and import bans can either shield domestic industries from international competition or stimulate export growth, though their effects are often context-dependent. For instance, India's 2023 ban on non-Basmati rice exports triggered a surge in global prices while simultaneously depressing domestic ones, illustrating the multifaceted implications of trade restrictions [2]. Although generally prohibited under the World Trade Organization's framework, import bans may be justified under specific provisions, such as safeguarding mechanisms or public health concerns [3]. In West Africa, policymakers have employed import restrictions to promote self-sufficiency and mitigate disease outbreaks, though outcomes vary across national contexts. Restricting access to key inputs such as maize for poultry feed can elevate production costs and exert upward pressure on consumer prices [4]. A study compared the consequences of trade restrictions across European and sub-Saharan African regions, revealing that while both face trade-offs, the adverse effects of globalization tend to be more pronounced in developed economies, thereby underscoring the nuanced role of trade policy in developing contexts [5]. In Ghana, a partial poultry import ban yielded modest changes in import volumes, whereas a complete ban could potentially boost domestic production by up to 250%, albeit at the expense of tariff revenue and consumer welfare [6 ,7]. Senegal's ban contributed to job creation and reduced chicken prices, yet raised concerns regarding product diversity and food safety standards [8]. In contrast, Nigeria's comprehensive import ban led to diminished chicken consumption and market distortions, reflecting the complex interplay between protectionist policies and consumer behavior [4,9]. The theory of infant-industry protectionism supports such measures, suggesting that temporary protection allows emerging industries to develop economies of scale and compete globally. This process is driven by technological advancements and "learning by doing" [10,11]. Trade barriers can also generate positive output effects in the short run [12], while long-term impact of trade restrictions depends on sectoral dynamics, institutional context, and policy coherence [13]. Nonetheless, critics argue that protectionism may hinder allocative efficiency and distort market signals, while others underscore its potential to stimulate innovation, support domestic learning curves, and encourage strategic technology adoption under certain conditions [14]. In West Africa, persistently higher domestic chicken production costs underscore the need for carefully designed protective measures aimed at enhancing competitiveness, particularly in light of intensifying trade liberalization pressures and rising import volumes that threaten local industry viability [15]. At the same time, the broader debate surrounding agricultural policy interventions reflects deeper tensions in agronomic research and development priorities, especially when viewed through the lens of contested goals, methodological pluralism, and shifting paradigms in the Global South [16].

Cameroon's poultry sector, an infant industry, faces similar challenges, including high feed costs, insufficient infrastructures, and problems with the supply of day-old chicks. In 2004, the Cameroon government implemented import restrictions to protect local producers and address competition from low-quality imports, providing the sector time to grow and become competitive. However, the long-term benefits of such policies remain uncertain. Sustainable industry growth requires strategic investments in productivity, reduced production costs, and innovation to maintain competitiveness beyond temporary protections. Furthermore, market distortions may affect consumer welfare, highlighting concerns over accessibility and affordability. The risks of supply chain constraints, illegal trade, and the potential deterioration of trade partnerships further complicate the effectiveness of such policies. Without strategic support, the poultry sector may struggle to move from protection to sustainable expansion, making the long-term outcomes of these restrictions unpredictable. To address the potential endogeneity in estimating the impact of frozen chicken import restrictions, this study employed the Synthetic Control Method (SCM), a data-driven counterfactual approach that constructs a weighted combination of control units to approximate what chicken production in Cameroon would have been in the absence of the policy intervention. The analysis shows that the policy effectively boosts local production and supports the infant industry.

This paper contributes to the broader literature examining the effect of trade policy interventions on domestic industry performance, particularly in developing economies. Much of the existing research has focused on firm-level responses to non-tariff barriers [17], theoretical modeling of trade protection effects [12,18], and historical evidence of technology adoption under temporary protection [14]. Other studies have explored the infant-industry argument empirically, such as the review of trade policy impacts across sectors and regions [13]. In the African context, some studies [6,8] provided farm-level and Computable General Equilibrium (CGE)-based assessments of poultry import restrictions in Ghana and Senegal, respectively, while another examined the macroeconomic effects of trade protectionism in Nigeria using Autoregressive Distributed Lag (ARDL) Bounds testing, revealing a positive long-run relationship between tariff rates and Gross Domestic Product (GDP) growth [19].

The Synthetic Control Method (SCM) was applied to evaluate agricultural subsidies in the Czech Republic, demonstrating its utility for policy evaluation [20]. However, few studies offer causal, sector-wide empirical evidence on the impact of import bans in sub-Saharan Africa using SCM. This paper fills this gap by estimating the effect of Cameroon's 2004 frozen chicken import restrictions, revealing from the synthetic control analysis an average increase of 23 880 tons in domestic chicken production annually from 2004 to 2008 (see Results and Discussion section). By complementing firm-level and macroeconomic approaches with national-level causal analysis, the findings demonstrate that temporary protectionist policies can foster infant industry development particularly when paired with strategic investments and policy reforms to ensure long-term competitiveness.

BACKGROUND

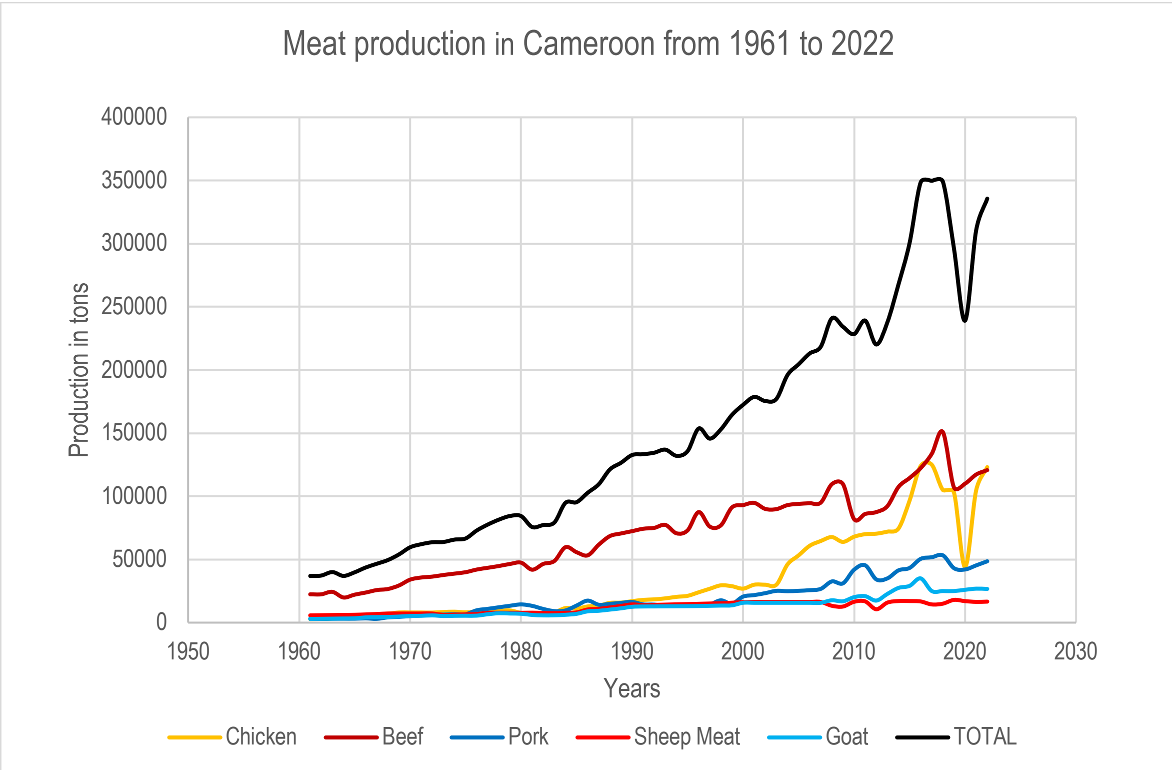

Figure 1: Meat production in Cameroon from 1961 to 2022. Source: FAOSTAT

In Cameroon, agriculture constitutes 17% of GDP, with the livestock sector contributing 13% [21]. Chicken play an essential role in the national diet, accounting for approximately 37% of total meat consumption in 2022, and its economic relevance is amplified by the short production cycles of broilers (mostly Cobb 500) and the rapid turnaround in egg output, which together enable frequent market engagement and income generation for smallholder producers [22,23]. These production dynamics place poultry as a strategic sub-sector within Cameroon's broader agricultural framework, particularly in light of rising consumer demand, evolving trade pressures, and ongoing efforts to strengthen food security and rural livelihoods.

Despite its importance, Cameroon's poultry sector has struggled against challenges such as the influx of frozen chicken imports following the 1996 World Trade Organization (WTO) agreements. Imported chicken, often cheaper than local production, led to a 60% decline in domestic poultry production and a 300% increase in imports by 2004 [24]. Concerns over microbiological contamination and unfair competition prompted protests, leading to the government's implementation of import restrictions in 2004, limiting frozen chicken imports and imposing protective tariffs [25]. While these restrictions aimed to support local producers and address job losses in the poultry industry, their effectiveness remains debatable. Critics argue that protectionist policies can hinder innovation and efficiency, despite their potential to nurture domestic industries [26].

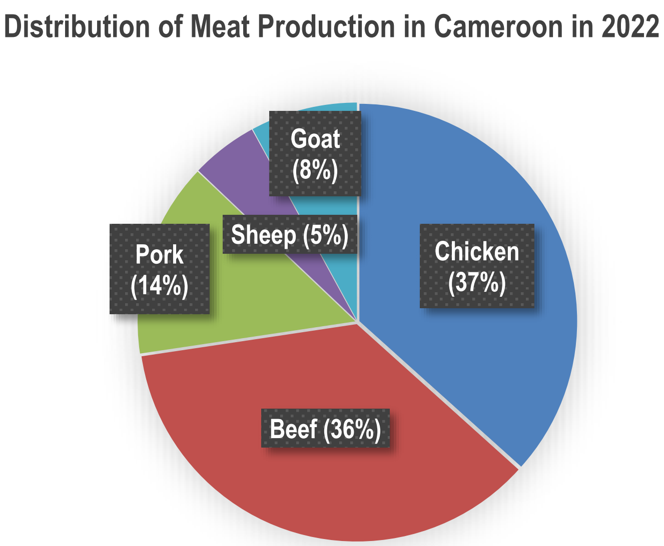

Figure 2: Distribution of meat production in Cameroon in 2022. Source: FAOSTAT

Before the restrictions, Cameroon allowed frozen chicken imports with minimal taxation, and domestic chicken production remained stagnant. Additionally, external factors such as consumer preferences, economic conditions, government subsidies, and infrastructure development may have contributed to the observed changes in production. By employing the SCM, this study aimed to isolate the causal impact of import restrictions on chicken production in Cameroon.

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MATERIALS AND METHODS

The Study Area

Cameroon is located in Central Africa. It shares borders with six countries including Tchad, Gabon, Equatorial Guinea and the Central African Republic, making it a strategic hub for regional poultry trade and informal exports. By implementing a ban on frozen chicken imports in 2004, the government created a clear intervention point for policy impact analysis. Cameroon's poultry sector is characterized by a mix of smallholder and commercial producers, with strong demand concentrated in urban centers such as Yaounde and Douala. These structural features combined with the sector's partial dependence on imported inputs like day-old chicks and feed grains make Cameroon a compelling case for evaluating the effects of trade restrictions using synthetic control methods.

The Synthetic Control Method

To identify the effects of frozen chicken import restrictions on chicken production, the synthetic control method developed in previous studies were used [27,28]. In practical terms, the Synthetic Control Method (SCM) was applied by constructing a 'synthetic chicken production' unit from weighted combinations of other Cameroonian agricultural commodities. The weights were chosen so that the synthetic unit closely matched Cameroon's actual chicken production trend during the pre-intervention period (1984–2003). This allowed to estimate what chicken production would have looked like in the absence of the 2004 import restriction. The difference between observed production and the synthetic counterfactual in the post-intervention years represents the estimated policy effect. Robustness was assessed through placebo tests, Root Mean Square Prediction Error (RMSPE) ratios, and leave-one-out analysis, ensuring that the results are not driven by chance or by any single commodity in the donor pool.

The objective was to estimate the effect of the intervention on the treated unit:

$$\alpha_{1t} = Y_{1t}^{I} - Y_{1t}^{N} = Y_{1t} - Y_{1t}^{N} \quad (1)$$

where α_{1t} is the observed effect of the import restriction policy, Y_{1t} is the treated unit or potential outcome under restrictions policy which is observed, and Y_{1t}^{N} is the outcome in the absence of restrictions policy which is the counterfactual or synthetic chicken production.

Y_{1t} is the already observed outcome, then to be able to estimate, Y_{1t}^{N} is to find. For the post-intervention period t, using an ideal linear combination of selected units (donor pool) as synthetic control, the synthetic control estimator reveals how the

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policy intervention affected the treatment group. The synthetic control measures the causal effect as follows:

$$\alpha_{1t} = Y_{1t} - \sum_{j=2}^{j+1} W_j^* Y_{jt} \quad (2)$$

Where W_j^* Is a vector of optimal chosen weights. In previous studies [27,28], the authors chose the optimal weights by minimizing

$$||X_1 - X_0W|| = \sqrt{(X_1 - X_0W)'V(X_1 - X_0W)} \quad (3)$$

Where X_1 = vector of pre-intervention of chicken, X_0 = vector of the post-intervention of other agricultural commodities, W = weight allocated to the donor pool's control units in order to determine which combination of weights, when applied to the control units, most closely resembles the features of the treated unit prior to the intervention. V Is some (k*k) semidefinite matrix which is positive and symmetric. With the predictor X_1, X_2,…, X_k, the V-matrix is V=diag (v_1,v_2,…, v_k).

Macroeconomic variables were not included, as they may be direct outcomes of the ban. Including such variables could bias the estimated effect of the ban. Therefore, following previous studies [29,30], pre-treatment outcomes were used as covariates to estimate the optimal weights.

For the inference, the placebo analysis was conducted. The "placebo effects" in the context of SCM analysis refer to a method to evaluate the predicted treatment effect's significance. The model was created on small sample inference for SCM [28]. By reassigning the treatment to the donor pool units iteratively and estimating "placebo effects" in each iteration, a mode of inference based on permutation techniques may be achieved. The logic behind the placebo tests consists of producing a number of artificial controls for units that were not really treated and then these placebo units are compared to the outcome of the treated unit; it provides evidence that the treatment effect is not due to chance. In the context of placebo tests, the significance of the treatment effect and the evaluation of how well the synthetic control fits is done by employing the Root Mean Square Prediction Error (RMSPE). If the pre-treatment RMSPE of a placebo is significantly higher than the one of the treated units, it shows that the placebo is a poor match and may not provide a good comparison. Commodities with pretreatment RMSPE five times greater than the one of the treated were dropped. By doing this, only the most comparable units are included into the analysis. A higher RMSPE in the post-treatment period for the treated unit than the placebo RMSPEs of the other units indicates a significant treatment effect. The RMSPE is defined as follows:

$$RMSPE = \sqrt{\frac{1}{T_0}\sum_{t=1}^{T_0}(Y_{1t} - \hat{Y}_{1t})^2} \tag{4}$$

Where:

- T_0 is the duration of the pre-treatment period
- Y_{1t} is the treatment unit's observed result at time t
- $\hat{Y}_{1t}$ is the outcome predicted by the synthetic control

A histogram was plotted giving the density and the pre/post RMSPE ratio. The largest ratio means that the commodity stands out as having the most significant deviation between pre- and post-treatment periods in comparison to other commodities. Moreover, to test the sensitivity of the results to the donors in the synthetic that was constructed, the leave-one-out tests were conducted. The logic behind it is that each donor in the synthetic chicken that had a non-zero weight is iteratively removed and the estimation is made to check if the results remain.

Data

This study used FAOSTAT's annual country-level production data for Cameroon's livestock and crop commodities from 1961 to 2022. Other agricultural commodities were selected for the donor pool to construct a credible counterfactual for Cameroon's poultry production in the absence of the 2004 import ban. The selected commodities had relatively complete and consistent data from 1984 to 2003. By choosing commodities within the same national context subject to similar macroeconomic conditions, policy environments, and market dynamics, the Synthetic Control Method could better isolate the effect of the poultry import ban from broader agricultural trends. This approach also ensures that the donor units share structural similarities with the treated unit, thereby improving the validity of the estimated treatment effect. The donor pool includes Avocado, Banana, Beans, Bee wax, Beef meat, Cassava, Chicken, Cocoa beans, Coconut, Green coffee, Cow milk, Goat meat, Goat milk, Groundnuts, Cattle hides and skins, Honey, Horse Meat, Kola Nuts, Maize, Millet, Natural Rubber, Oil palm fruit, Pepper, Pineapples, Plantains, Pomelos and grapefruits, Potatoes, Rice, Seed cotton, Sesame, Sheep meat, Sheep milk, Sorghum, Sugarcane, Sweet potatoes, Tea leaves, Tomatoes, Wheat, and Yams. For each commodity, the focus is on the quantity produced (measured in metric tons), covering all products available for consumption or processing.

Table 1 reports the summary statistics for all variables. The average value of the outcome variable, chicken production, is 34,156 metric tons. Specifically, during the pre-ban period, the annual output averaged 13,517 tons. In the post-ban period (2004–2022), mean production increased to 80,866 tons, as reported in Table 1.

To maintain consistent weights over time in the synthetic chicken for the synthetic control analysis, only commodities with data covering the entire timeframe of the research period in the dataset were used; then the commodities lacking data before 1984 were dropped. Any item subject to import restrictions during the study period were dropped. This yields a 20-year pre-intervention window (1984–2003) for creating a robust counterfactual of chicken production.

RESULTS AND DISCUSSION

Table 2 displays the donor-pool weights used to construct the synthetic chicken which is what chicken production would have been without policy intervention. The matrix is sparse: beans, goat milk, honey, maize, natural rubber, pineapples, sweet potatoes, pomelos and grapefruits, and yams received nonzero weights; all other commodities were excluded. Table 3 compares the pre-treatment outcomes of actual chicken with those of the synthetic chicken. The results show that the pre-treatment outcomes of actual chicken closely align with those of the synthetic counterpart, which confirms the model's validity before the 2004 intervention.

Next, Figure 3 illustrates actual versus synthetic chicken output (tons) over time. The X-axis represents the years, while the Y-axis denotes production levels in tons. The solid line tracks observed production; the dashed line shows the synthetic estimate in absence of frozen chicken import restrictions. The vertical 2004 marker pinpoints the policy implementation. Prior to 2004, the synthetic chicken closely mirrors the observed production, demonstrating a strong fit.

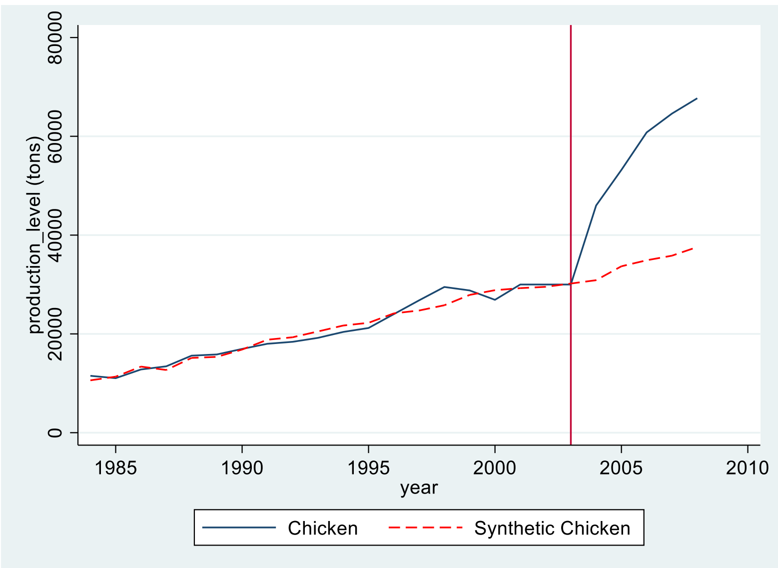

Figure 3: Chicken production in Cameroon versus synthetic chicken. Source: calculation using stata

After 2004, actual production diverges upward from the synthetic counterfactual, illustrating how the intervention affected chicken production. The gap indicates that import restrictions led to a rise in domestic output, as Cameroonian producers increased supply in response to reduced competition.

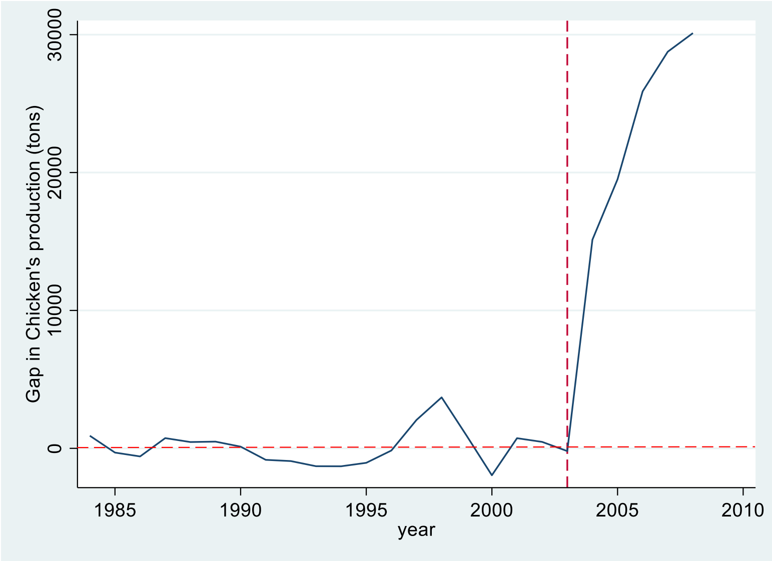

Figure 4: Treatment effects over time. Source: calculation using stata

Figure 4 plots the difference between chicken production and the synthetic estimates over time. The X-axis represents years, when the Y-axis measures the difference (in tons). The solid line depicts actual chicken production when the horizontal dashed line represents the estimated synthetic chicken production, serving as a baseline projection of what production might have been without the intervention. As shown in table 4, the results indicate an average annual increase of 23 880 tons in domestic chicken production from 2004 to 2008.

To strengthen credibility of the results, a placebo-effects test was conducted (Figure 5). The X-axis represents time, while the Y-axis measures the deviation in production estimates across different commodities. The black solid line (chicken) shows a pronounced post-2004 divergence compared to the red lines (other commodities). This unique shift suggests the impact on chicken is statistically distinguishable from random fluctuations in the control group.

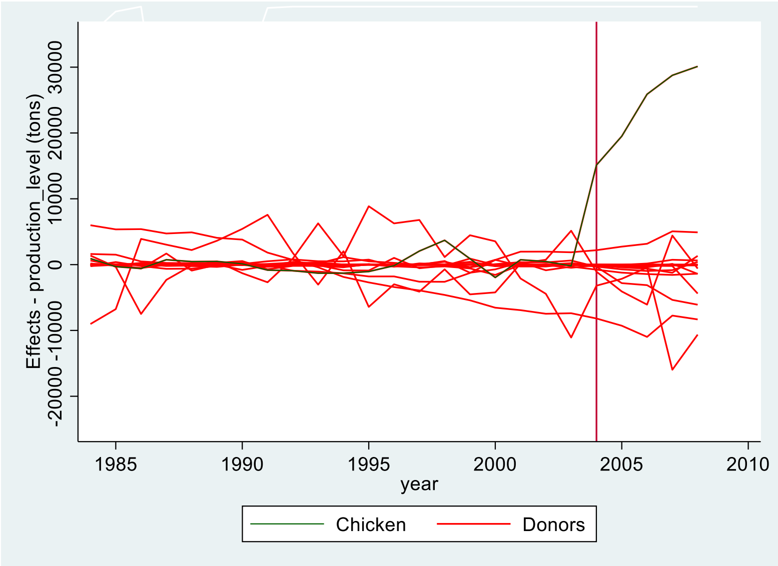

Figure 5: Placebo test results. Source: calculation using stata

Figure 6 reports post-to-pre-intervention RMSPE ratios (root mean squared prediction error) for chicken and other control commodities. Chicken exhibits the highest ratio, reinforcing that the observed increase was attributable to the import ban rather random fluctuations or other common factors.

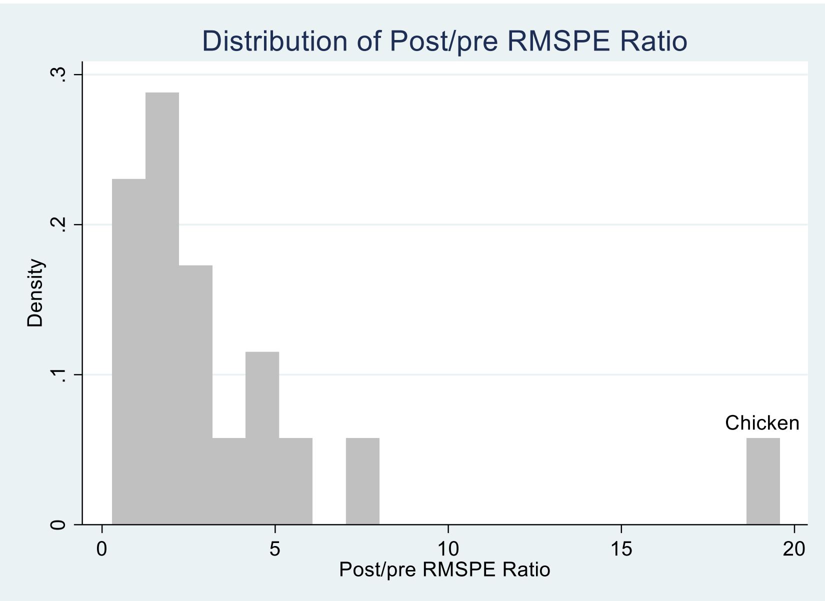

Figure 6: Distribution of Post/Pre RMSPE-ratio

Figure 7 shows results of the Leave-one-out tests that were conducted for the nine donor commodities that received non-zero weights in the initial synthetic control. The estimated treatment effect measured as the average increase in chicken production from 2004 to 2008 was 23,880 tons in the baseline model. Across eight of the nine

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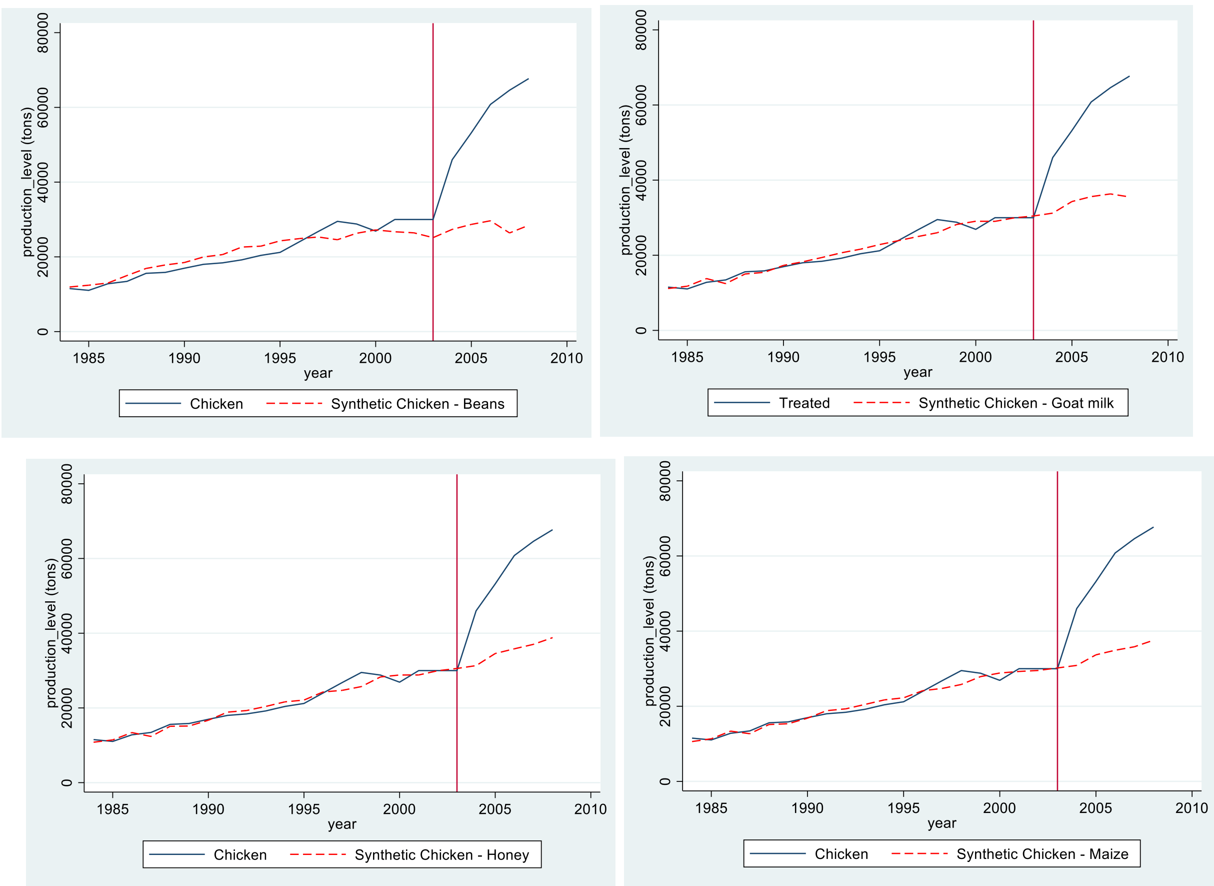
leave-one-out iterations, this effect remained remarkably stable, ranging from 22,947 tons (when honey was excluded) to 23,928 tons (when natural rubber was excluded). Excluding goat milk yielded 23,865 tons, while removing pomelos and grapefruits resulted in 23,702 tons. Notably, excluding maize, pineapples, sweet potatoes, or yams produced no change at all, with the effect remaining exactly 23,880 tons indicating that these commodities had minimal influence on the synthetic trajectory.

However, excluding beans which had a modest initial weight of 2.8% led to a significantly larger estimated effect of 30,349 tons. This suggests that beans exerted a non-negligible influence on the synthetic control, likely due to its post-treatment trajectory dampening the estimated gap. These findings underscore the sensitivity of SCM to donor pool composition and highlight the importance of robustness checks. The overall consistency across most donor exclusions reinforces the credibility of the main results and supports the validity of the estimated policy impact.



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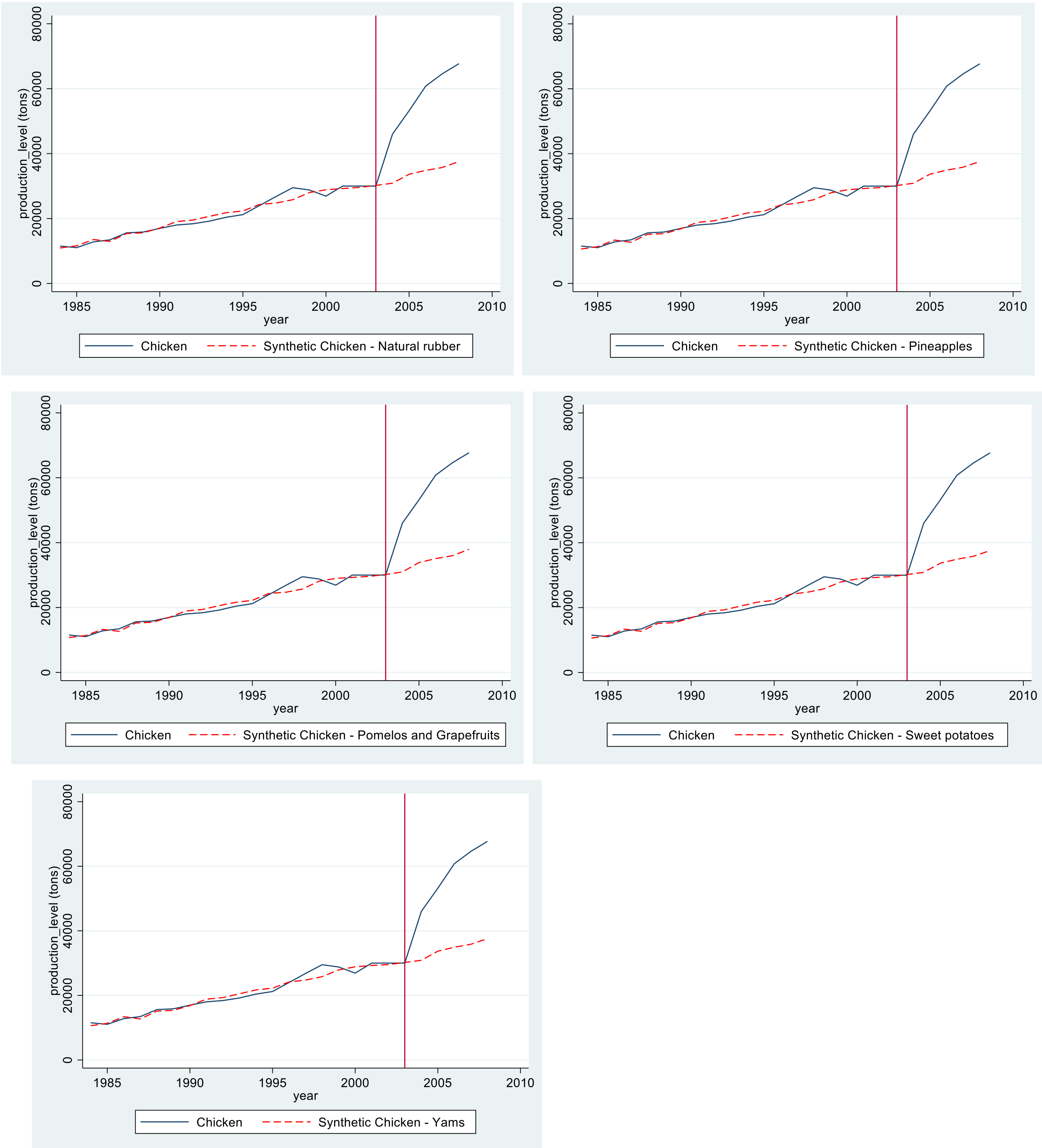

Figure 7: Leave one out test results. Source: calculation using stata

Altogether, these findings support the protection of the Cameroon's infant-poultry industry through temporary trade restrictions. While some studies find that agricultural liberalization can boost productivity and value-addition in developing countries [31,32], others caution that emerging sectors often need a period of protection to grow competitive. They warn that relying too heavily on trade may expose producers to unstable prices and discourage long-term investment [26]. The

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results align with this latter view, demonstrating significant gains from the 2004 import ban.

However, Cameroon's broiler supply remains unstable. The market has faced repeated shortages, especially during festive seasons and feed crises. This is largely because the country depends on imports for day-old chicks and key feed ingredients like maize and soybean. Finding reliable suppliers is also difficult due to avian flu outbreaks in Europe, which limit import options. In major cities like Yaounde and Douala, broiler prices follow the basic supply and demand curve: prices rise when supply is low and fall when there's oversupply. Feed costs also influence final prices, which vary across regions. Most of the chicken produced are consumed locally, with exports representing less than 1% of total output. In 2022, poultry exports amounted to $82000, mainly to the Central African Republic, with smaller volumes to Gabon and Equatorial Guinea [33].

Given these feed-related constraints, alternative protein sources have been explored to improve poultry performance. For instance, the use of vermi meal under free-range systems examined, though results showed limited impact on growth and profitability [34]. This highlights the need for careful evaluation of feed innovations before large-scale adoption. Similarly, it was demonstrated that native pigs fed with kitchen leftovers, *Trichantera gigantea*, and taro achieved comparable growth and profitability to those fed commercial diets, pointing to the potential of low-cost, locally available feed options in livestock systems [35].

Beyond feed, the sector's resilience also depends on veterinary systems and technological upgrades. The 2024 Yaounde International Poultry Exhibition emphasized the urgent need to shift from live bird sales to processed poultry products, highlighting the role of biosecurity protocols, cold chain infrastructure, and veterinary surveillance in modernizing the industry. Moreover, Gesellschaft für Internationale Zusammenarbeit's (GIZ) policy brief on poultry production in Cameroon underscores the importance of veterinary extension services and disease monitoring systems to reduce vulnerability to outbreaks like avian flu [23]. These systems are critical not only for safeguarding animal health but also for maintaining consumer confidence and export potential.

Technological upgrades in housing systems also play a role. The adoption of layer and broiler cage systems can improve hygiene and biosecurity, reduce mortality, and enhance productivity in commercial farms [36]. These innovations can support better feed conversion ratios and allow for more efficient use of space and labor. However, their uptake remains limited outside urban centers, pointing to the need for targeted extension programs and financing mechanisms to support smallholder adoption.

These patterns highlight the need to pair trade protection with stronger domestic production systems, better feed supply chains, and regional market coordination to ensure stable prices and sustainable growth. However, certain limitations of this study must be noted. The results are statistically significant only up to 2008, as shown by the standardized p-values from the placebo effects tests, which are no longer zero after that year. This decline in significance is partly due to the avian flu outbreak in Cameroon in 2008, which disrupted chicken production and introduced external shocks not captured by the synthetic control model.

CONCLUSION AND RECOMMENDATIONS FOR DEVELOPMENT

This study aimed to understand how the import restrictions on frozen chicken have affected chicken production in Cameroon and what would have been the production without the intervention. Cameroon is a member of the World Trade Organization, and therefore the poultry import ban introduced in 2004 cannot be maintained indefinitely. The temporary protection of the poultry sector was intended to give producers time to adapt, improve, and become competitive. While the intervention initially proved beneficial, leading to a short-term production increase between 2004 and 2008, the sector remained fragile. After 2008, chicken production fluctuated significantly due to the avian flu outbreak, persistent feed constraints, and Cameroon's continued reliance on imported hatching eggs for day-old chicks. These factors highlight that, despite the gains from protectionist measures, the industry still faces challenges in meeting growing domestic demand.

To ensure a stable and competitive poultry sector under WTO compliance, additional measures are required. These include subsidies, investment in infrastructure, innovation and technological advancements, and improved quality standards to meet international benchmarks. Furthermore, diversifying export opportunities and strengthening the poultry value chain can bolster the sector's resilience and growth. Continuous monitoring and evaluation of trade policies will be essential to guarantee that Cameroon's poultry industry transitions successfully from temporary protection to long-term competitiveness in both domestic and international markets.

Future research could extend the analysis to other countries to compare the impact of similar policies. Investigating the broader economic effects of import restrictions such as effects on employment, prices, consumer welfare, and overall economic growth, and exploring these policies long-term sustainability and effectiveness in supporting domestic industries are also important. Investigating the entire poultry supply chain, including feed production, processing, distribution, and retail, could identify bottlenecks and opportunities for improvement. Moreover, it would be valuable to explore the measures taken by the Cameroonian government to enhance productivity and their effectiveness in supporting the poultry sector. Finally, understanding changes in consumer behavior and market dynamics in response to import restrictions can provide insights into demand patterns and potential areas for market development.

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Conflict of interest

The authors of this paper declare no conflicts of interest in relation to the publication of this manuscript.

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Table 1: Summary statistics of agricultural commodities

	Unit	Mean	Standard deviation	Minimum	Maximum
Chicken	metric tons	34156	35132	2800	125006
Bee Wax	metric tons	258	41	185	308
Sheep Milk	metric tons	13885	5252	6360	20086
Goat Milk	metric tons	31737	19470	5000	59966
Cow Milk	metric tons	121133	65569	21250	266000
Honey	metric tons	2969	970	1850	4757
Cattle Hide and Skin	metric tons	10193	4763	2896	21968
Sheep Meat	metric tons	11829	4286	5724	18000
Beef Meat	metric tons	69979	32700	19880	150826
Goat Meat	metric tons	12721	7940	2940	35000
Pork	metric tons	19765	14746	3000	53250
Avocado	metric tons	40309	21062	12000	74946
Banana	metric tons	691685	376275	130000	1600231
Beans	metric tons	161146	125467	25840	396059
Cabbages	metric tons	26467	23922	0	65107
Cassava	metric tons	2152716	1658358	580000	6267574
Chillies and Peppers	metric tons	12754	19583	0	58903
Cocoa Beans	metric tons	157731	76652	75100	344752
Coconut	metric tons	3647	1101	1700	5710
Coffee green	metric tons	73402	30305	26322	137900
Dates	metric tons	245	220	0	600
Eggplants	metric tons	784	872	0	2227
Ginger	metric tons	12566	19526	0	56322
Groundnuts	metric tons	273388	202172	74766	801632
Kola Nuts	metric tons	31227	12665	5000	49197
Maize	metric tons	884603	652705	309752	2398637
Millet	metric tons	76837	19347	17810	104000

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Natural Rubber	metric tons	35222	18726	8800	61736
Oil Palm Fruit	metric tons	1156871	707703	398000	3000000
Papayas	metric tons	14	17	0	48
Pepper	metric tons	67	22	20	105
Pineapples	metric tons	78896	92501	2000	312968
Plantains	metric tons	1755149	1310915	524797	4667344
Plums and Sloes	metric tons	235	240	0	650
Pomelos and Grapefruits	metric tons	46	39	8	129
Potatoes	metric tons	109266	110787	12000	377912
Rice	metric tons	88820	93193	3583	343103
Seed Coton	metric tons	167717	128207	25100	600000
Sesame	metric tons	16847	24191	1571	80302
Sorghum	metric tons	553071	368546	203232	1260000
Soya Beans	metric tons	11946	24430	0	110043
Sugarcane	metric tons	986498	509925	38508	1770000
Sweet Potatoes	metric tons	203361	127528	91018	579883
Tea Leaves	metric tons	3107	1792	83	6000
Tomatoes	metric tons	330701	393666	25000	1219046
Watermelons	metric tons	22305	28953	0	96484
Wheat	metric tons	522	386	0	1548
Yams	metric tons	282542	165751	53480	618136
Pre-ban Chicken	metric tons	13517	8526	2800	30000
Post-ban Chicken	metric tons	80866	26312	43999	125006

Note: All quantities are expressed in metric tons. Data sourced from FAOSTAT, covering the period 1961–2022. The reported standard deviation reflects variability in annual production across the study period. “Pre-ban Chicken” and “Post-ban Chicken” represents the mean production level over the years before and following the 2004 import restriction, respectively

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Table 2: Agricultural commodities weights in synthetic Chicken

Agricultural commodity	Weight (%)
Avocado	0
Banana	0
Beans	2.8
Bee Wax	0
Beef Meat	0
Cassava	0
Cocoa Beans	0
Green coffee	0
Cow Milk	0
Goat Meat	0
Goat Milk	8.7
Groundnuts	0
Hide and Cattle Skin	0
Honey	36.2
Horse Meat	0
Kola Nuts	0
Maize	1.1
Millet	0
Natural Rubber	7.2
Oil Palm Fruit	0
Pepper	0
Pineapples	0.3
Plantains	0
Pomelos and Grapefruits	41.2
Potatoes	0
Rice	0
Seed Coton	0
Sesame	0
Sheep Meat	0
Sheep Milk	0
Sorghum	0

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Sugarcane	0
Sweet Potatoes	1
Tea Leaves	0
Tomatoes	0
Wheat	0
Yams	1.4

Note: Weight values were calculated using the Synthetic Control Method (SCM) implemented in Stata 17. All weights represent the relative contribution of each commodity to the synthetic chicken unit constructed from the donor pool

Table 3: Predictor balance

	Chicken	Synthetic Chicken
Production level (2003)	30000	29987.51
Production level (2002)	30000	29451.43
Production level (2001)	30000	28152.06
Production level (2000)	26900	28219.35
Production level (1999)	28800	28271.45
Production level (1998)	29500	27102.41
Production level (1997)	26800	25053.45
Production level (1996)	24000	24102.05
Production level (1995)	21200	21855.49
Production level (1994)	20400	20281.6
Production level (1993)	19200	19326.59
Production level (1992)	18400	18752.2
Production level (1991)	18000	18200.11
Production level (1990)	16960	16364.7
Production level (1989)	15840	14878.03
Production level (1988)	15600	14647.08
Production level (1987)	13440	13898.06
Production level (1986)	12800	13630.25
Production level (1985)	11040	10857.89
Production level (1984)	11520	11561.5

Note: Values of chicken and Synthetic chicken are expressed in metric tons. Predictor balance was calculated using the Synthetic Control Method (SCM) implemented in Stata 17.

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Table 4: Post-treatment results; Effects, p-values, standardized p-values up to 2012

Year	estimates	pvals	pvals_std
2004	15129.65	0.058824	0
2005	19508.56	0.058824	0
2006	25888.07	0.058824	0
2007	28762.97	0.058824	0
2008	30112.62	0.058824	0
2009	21603.92	0.058824	0.117647
2010	24224.56	0.058824	0.058824
2011	24720.93	0.117647	0.235294
2012	25939	0.117647	0.294118

Note: Estimates are expressed in metric tons. Post-treatment effects, p-values, and standardized p-values were calculated using the Synthetic Control Method (SCM) implemented in Stata 17

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Table 5: Root Mean Square Predictor Error ratio

Donors	pre_rmspe	post_rmspe	rmspe_ratio
Avocado	687.01	4086.23	5.95
Beans	78372.76	189223.80	2.41
Bee Wax	10.17	26.85	2.64
Chicken	1254.07	24551.01	19.58
Goat Meat	233.37	877.18	3.76
Goat Milk	4503.60	3860.81	0.86
Hide and Skin Cattle	489.89	692.34	1.41
Honey	279.06	1300.74	4.66
Horse Meat	34.04	146.09	4.29
Kola Nuts	4812.99	8976.92	1.87
Natural Rubber	4788.79	8753.33	1.83
Pepper	6.82	11.47	1.68
Pomelos and Grapefruits	33.79	12.86	0.38
Sesame	1459.83	3796.48	2.60
Sheep Meat	269.69	1971.85	7.31
Sheep Milk	558.61	677.86	1.21
Tea Leaves	233.00	442.58	1.90
Wheat	50.11	14.73	0.29

Note: RMSPE = Root Mean Square Predictor Error. Values were calculated using the Synthetic Control Method (SCM) implemented in Stata 17. The RMSPE ratio compares post-treatment predictive error to pre-treatment error for each donor unit

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