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Licenciatura en Economía

Impact of front-of-package food labeling on cocoa consumption

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Abstract

This paper studies the impact of the incorporation of the Guideline Daily Amounts (GDA) regulation for food labeling on cocoa consumption in different countries. We implement a difference-in-differences model to measure the impact of adherence to the front-of-pack food labeling regulation and show different robustness checks to show the causal effect of this measure. We found a positive effect on cocoa consumption after ten years of the regulation.

Acknowledgments

This work concludes an important stage of my life at Universidad de San Andrés. I would like to deeply thank my mentor, Amelia, for supporting and teaching me in this final work. I owe this academic and personal achievement to my parents, Jorgelina and Gustavo, and my sister, Caterina, for their unconditional support. During this stage, I met very important people in my life to whom I am grateful for their assistance: Aisha, Tomás, and Federico. This final work is lovingly dedicated to my grandmother, Mercedes.

1. Introduction

Unhealthy eating habits and physical inactivity are patterns of behavior that have become more frequent in recent years, according to the World Health Organization (WHO). These trends are related to the appearance of multiple non-communicable chronic diseases currently causing death worldwide (WHO, accessed 18 September 2023). Consistently, governments have started to incorporate policies aimed at promoting healthier lifestyles. Among them is the introduction of front-of-pack food labeling (FOPL). Front labeling summarizes the nutritional information of a food item or a drink to provide simplified and at-a-glance facts to the end user.

Given that several countries have been enforcing this law for a considerable time, it is noteworthy to ask ourselves the following question: does front-of-pack food labeling encourage a decline in the consumption of unhealthy foodstuff? This paper will attempt to answer this question by evaluating the impact of specific front-of-pack labeling on cocoa consumption. To carry out this research, this paper will analyze data from different countries.

We analyze the Guideline Daily Amounts (GDA) labeling and any variant of this type of labeling. This group of front-of-pack food labeling is the oldest on the market. In our database, countries with this type of labeling date back to 1981. Therefore, the consumer has had time to come into contact with the labeling and to mature. This paper considers the medium-term effects of a particular group of labeling systems. The system aims to inform clearly and simply the main nutritional components of the food. In the following section, we detail and summarize the main types of front-end labeling in force. We also describe how they work and their purpose.

To assess the causal effect of Guideline Daily Amounts labeling on cocoa consumption, we estimated a staggered difference-in-differences model and found an increase in cocoa consumption after approximately ten years of the law. In addition, we estimated an alternative specification to be sure of this positive effect. A possible mechanism that may explain this result is the comparison of consumers between products that are considered "healthy" and those that are not. That is, when a consumer notices that a product he/she considers healthy contains high levels of a critical nutritional element, he/she will substitute it for a food with the same critical levels but which is even more preferred. Therefore, when faced with two foods with similar critical nutritional levels, the consumer will opt for the more preferred and possibly lower-quality food. The main observation is that the critical nutritional levels need to speak about the quality of the food itself. For example, a food rated as high in fat may be due to its high content of "good fats" (monounsaturated and polyunsaturated) or "bad fats" (saturated and trans fats). However, in the consumer's eyes, both products will be similar even if one is healthier. Furthermore, cocoa-based foods are preferred by consumers, which explains the increased consumption of cocoa- and sugar-based products.

2. Types of front-of-package food labeling

Different types of feature front labeling are grouped according to how they display information. It is important to understand their differences, functioning, and the purpose of each system. Table 1 shows a graphical example for each type of labeling described in this section.

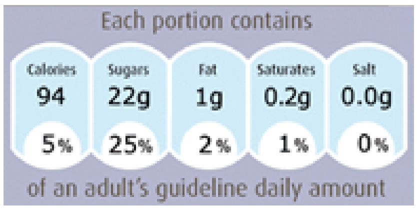
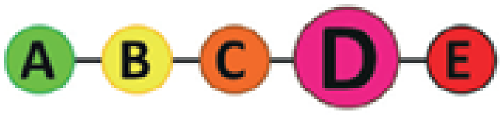
On the one hand, signaling systems summarize factual information on the nutritional composition of the food item in front of the package. This system provides information about calories, fat, saturated fat, sugars, and sometimes dietary fiber (Dagevos & Kleef, 2015). Within this category, the Guideline Daily Amounts (Table 1, row 1) system originated in the United Kingdom and presents information on the recommended daily intake for an average adult (Dagevos & Kleef, 2015). Similarly, the United States developed a daily intake rate (DI%) for essential nutrients that appear in front of the packages (Flood et al., 2008). These types of labeling are also called non-direct systems.

On the other hand, there are semi-direct systems that, in addition to indicating the essential nutrients, state whether each quantity value of a key ingredient is low, medium, or high in terms of the recommended levels of an average adult (Alcaire et al., 2017). These labels provide negative or positive information/data about the foodstuff according to a color code ranging from poor to good, passing through intermediate nuances. Each color represents the concentration in grams per hundred grams or milliliters of the product (Chantal et al., 2015).

Furthermore, different summary systems are in force in many countries that pursue the same purpose. Formats such as the Five Color Nutritional Label (5-CNL) (Table 1, 2) or the Guiding Stars System rank the product according to specific criteria. The first scheme is governed by categorizing five colors (green, yellow, orange, pink, and red) that indicate nutritional quality based on criteria established by the UK Food Standards Agency. The second scheme consists of a system of one to three stars, representing the food's nutritional quality, where three stars imply excellent nutritional value. Likewise, in recent years the Nutri-Score system (Table 1, 3) was introduced as a variation to 5-CNL, promoted by the French government (Chantal & Hercberg, 2017). This is regulated by a continuous rating scale indicating how healthy the product is, which is displayed on the package through a color (green to red) and letter (A to E) hierarchy to facilitate interpretation and avoid dichotomous classifications between "bad" or "good" foods (Chantal & Hercberg, 2017).

Direct systems highlight products that meet specific nutritional criteria. The best-known schemes include health logos such as Healthy Choice (Table 1, 4), Pick the Tick, and KeyHole (Table 1, 5) (Alcaire et al., 2017). These systems aim to signal positive features of the foodstuffs on a standard basis and warn about maximum amounts of added sugar, fat, and sodium. Thus, products are branded with a simple logo as a "seal of approval" or "quality seal" (Dagevos & Kleef, 2015). Likewise, logos have been proposed in warning formats (Table 1, row 6) that seek to alert about a high content of critical nutrients such as sugars, calories, saturated fat, and sodium. The proposal began in Chile and is supported by the Pan American Health Organization to reduce the consumption of ultra-processed foods (Alcaire et al., 2017). Very recently, other Latin American countries adopted the black octagons system such as Argentina, Peru and Colombia.

Table 1: Types of front-of-package food labeling

Non-direct Systems	**(1)** Guideline Daily Amounts (GDA)	
Semi-direct Systems	**(2)** Five Color Nutritional Label (5-CNL)	
	(3) Nutri-Score	

Direct systems	**(4)** Healthy Choice	
	(5) KeyHole	
Warning system	**(6)** Chilean System	

3. Background and previous literature

We will look at some background research on the topic. There are various forms of research on front-of-pack food labeling. From a general perspective, a study from Metcalf et al. (1986) investigate the impact of nutritional ingredient lists in supermarkets. This research concluded that the lists highlighting positive aspects of food, such as vitamins and minerals, did not significantly influence the consumers' attitudes. On the contrary, the lists of certain harmful elements, such as added sugar, implied a deviation in the purchase decision towards low-sugar foods. Concerning this finding, it was studied whether the front-of-pack labels (FOPL) attract more attention than the traditional nutritional labels on the back of the products (Alzahabi et al., 2016). The authors used the method called Flicker Change Detection, which consists of observing two practically identical images separated by a blank screen: "the blank screen interrupts the transitory movement that would call attention to the change in the image if the change were made during viewing constant" (Alzahabi et al., 2016, p. 91). The result shows that FOPLs are more effective than traditional nutritional labels to get the attention of the consumers towards the information on the food composition.

Based on the results, we observe a key finding regarding the utility of FOP labeling. Labeling is most effective when the consumer's attention is drawn to the nutritional information and the consumer highlights negative aspects of the product. All this has a significant influence on the purchasing decision. Additionally, there are studies aimed at analyzing FOP labeling grouped into two categories: objective formats and comparative systems. Newman, Howlett, and Burton (2014) evaluate the presence of frontal labeling in retail stores and the competitive advantage that FOP can generate. Labeling is grouped into two categories: reductive and evaluative. The first type consists of summarizing, on the label, the key components of the traditional nutritional table (for example, GDA), and the second type informs if the food meets a specific nutritional requirement based on an evaluative logo that guarantees a certain food quality (for example, Keyhole). Researchers analyze the purchase intention and the consumer's perception of how healthy the food is. As a result, the presence of both types of FOPLs increased the perception of healthy standards, although only reductive labeling had a positive effect on purchase intention. Likewise, the work indicates that the presence or absence of FOP labels influences the customer's perception of how healthy a product is. Also, how nutritional information is displayed influences the consumer's idea of the product (Burton et al., 2014, p. 18). Two years later, the authors decided to evaluate the comparative process between products with frontal labeling of the objective and evaluative types. They measure the specific cognitive cues received and the effort to compare foods. Objective signs in non-comparative contexts generate a greater consumer understanding of the labels. Instead, evaluative labels are helpful for comparative contexts. Consequently, from this research, the different labeling utilities arise depending on the context to which the consumer is subjected.

Meanwhile, a series of investigations evaluate the impact of certain types of front labeling on consumers. The work of Brug et al. (2010) assesses the effect of the Choices Foundation logo, which originated in the Netherlands, on the reformulation of products by suppliers to develop healthier compositions. Through an electronic questionnaire, they ask manufacturers whether newly developed products meet the requirements to carry the logo on their packaging and provide data on the composition of the products. Most of the reformulated products are soups, processed meats, and sandwiches with lower sodium content and higher fiber content. Also, dairy products have a lower content of added sugars and fats. This reflects the food industry's influence on the choice of products available and how they generally affect people's health.

Also, investigators focus on the effects of the 5-Colour Nutrition Label (5-CNL). Specifically, researchers Chantal et al. (2016) evaluate the impact of the 5-CNL system on the nutritional quality of individual purchases. The evaluation consists of exposing individuals to three situations within a supermarket in an experimental context: products without labeling (control group), products with 5-CNL, and products with labeling and consumer information on the use of labeling. As a result, individuals exposed to labeling made healthier purchasing decisions in the sweet biscuits category. Just as importantly, Chabanet et al. (2019) estimate the impact of the NutriScore system on the nutritional quality of snack choices between mother-child dyads. Mothers and children choose their snacks without labeling and then go through the same process but with the NutriScore mechanism. Also, they rate how healthy they perceive their choices to be. The results show that when foods are NutriScore-labeled, mothers and children tend to change their preferences for healthier products compared to product choices when they are not labeled at all.

There is another paper which studies the impact of the most recent type of front-end labeling of "warning formats". As mentioned, Chile pioneered in Latin America in applying this system through the Chilean Food Act of 2016. The work by Barahona et al. (2023) analyzes the equilibrium impact of labels on production decisions, prices, and consumer welfare through a model of firms' supply, demand, and nutritional choices. It finds that consumers substitute labeled products for unlabelled options. Also, the effect is driven by consumers' beliefs: those products that people already knew to be high in calories or sugars are slightly and temporarily lowered in demand. In contrast, those products considered low in calories or sugar and received a label saw a drop of up to 40% in demand. This suggests that food labels are most effective when consumers have misconceptions about product quality.

Much of the literature on which this article is based also compares labeling systems with each other without grouping them under any specific criteria. For example, in the study by Chantal et al. (2015), labeling systems such as GDA, Multiple Traffic Lights, 5-CNL, and Green Tick are evaluated through metrics such as acceptability of the participants (liking, attractiveness, and a load of cognitive effort) and also the understanding of this tool. Results show that 5-CNL labeling is the easiest way to identify and requires less cognitive work to understand. In comparison, GDA is the most challenging system to understand and quantify. In general, FOPs are adequate for classifying the nutritional quality of foods.

Similarly, another study compares the effects of Multiple Traffic Lights (MTL) labeling versus Facts Up Front (FuF), a summary system similar to Guideline Daily Amounts. The analysis aimed to examine the impact of labeling and signage in supermarket aisles that explain the healthiness of foods consumers choose through an experiment (Graham et al., 2017, p. 775). The hypothesis implies that consumers with access to MTL labeling will have healthier choices than those faced with the FuF system. Moreover, those who choose their foods without a labeling system will opt for products of lower nutritional quality compared to consumers who have access to some FOPL products. Overall, label use results in healthier choices for parents and children. In particular, there is no evidence that MTL performs better than FuF. However, with greater dietary education and using FOP, parents and children can be encouraged to choose healthier foods (Graham et al., 2017).

Finally, a recent investigation (Alcaire et al., 2017) compares the Chilean alert system with direct GDA labeling and indirect MTL. The study measures attention to nutrition labels by visually searching for the absence or presence of the label. Also, it measures the perceived level of food healthiness by the consumer. The most extended response times correspond to GDA. The faster response time corresponded to MTL systems and octagonal alerts. These buyers were the most capable of correctly identifying the healthiest option compared to the GDA system.

This said, our contribution to the literature will be to analyze the medium and long-term impact of the most established front-of-line food labeling systems in the market. In particular, we seek to understand whether this intervention has a causal effect on cocoa consumption in different countries.

4. Data

To investigate the effect of nutritional information labeling on the front of the package, we use data from the Food and Agriculture Organization of the United Nations (2020). The database contains a list of countries between 1961 and 2019, although not all countries provide the information in all the mentioned years. The cocoa consumption variable consists of the consumption of beans, paste, chocolate products, and powder cakes. As a result, we have cocoa consumption variability between countries and within time. We also incorporate the year in which a regulation of front-of-pack labeling was introduced in each country. The following table shows the year of incorporation in each country (Table 2):

Table 2: Year of GDA incorporation by country

País	Incorporación de GDA
Afghanistan	-
Arab Emirates	2019
Australia	2006
Belgium	1996
Bolivia	2016
Brazil	2001
Brunei	-
Bulgaria	2007
Canada	2005
Chile	2011
China	2011
Colombia	2011
Costa Rica	2011
Croatia	1996
Czechia	2011
Denmark	2009
Ecuador	-
France	1996
Germany	1996
Greece	1981
Hungary	1996
Iceland	1996
India	2008
Indonesia	-
Iran	2014
Ireland	1996
Israel	2011

País	Incorporación de GDA
Italy	1996
Lithuania	1996
Malaysia	2012
Mexico	2014
Netherlands	2009
New Zealand	2009
Nigeria	-
Norway	2011
Peru	2013
Philippines	2012
Portugal	1996
Romania	1996
Russia	2019
Slovenia	2009
South Africa	-
South Korea	1996
Spain	1996
Sweden	2009
Switzerland	2011
Taiwan	2018
Thailand	2007
Turkey	-
United Kingdom	1998
Uruguay	2018
USA	1994
Zimbabwe	2002

There is some difficulty in determining the year of treatment initiation in each country because there is no unified database that accounts for this. But, after an exhaustive search, we determined the year of enactment of the law for a part of the countries available in the database. The selection of countries for this study does not follow any specific pattern and can be said to be a good representation of the total sample. To illustrate this, we show a brief descriptive statistic on cocoa consumption (Table 3). In which, we can observe that the mean of the total sample is less than twice the value of the sample used, and they both have a similar standard deviation.

Table 3: Descriptive statistics

Variable	Observations	Mean	SD	Min	Max
Cocoa consumption: total sample	185	0.68	0.86	0	5.16
Cocoa consumption: sample used	53	1.02	0.90	0.01	3.39

4. Empirical strategy

4.1 Main results

In order to assess the impact of the introduction of front-of-pack nutrition labeling on cocoa consumption, we need to make some assumptions. The year of enactment of each law and the cocoa consumption in each country, allows us to exploit the panel variability. For this, we assume that regulation can be considered exogenous to cocoa consumption trends. Therefore, there is a source of variability that can be exploited to identify causal effects. Moreover, our identification assumption holds that the trend of the control group is a good counterfactual of how the treatment group trend would have been in the absence of treatment. The treatment is staggered, i.e., countries incorporate the regulations at different times, and we assume this staggering is random. We estimate the following staggered difference-in-differences model (DiD):

$$(1)\ Y_{it} = \beta T_{it} + \alpha_i + \mu_t + \varepsilon_{it}$$

where Y_{it} is per capita cocoa consumption in year t in country i, T_{it} is a dummy variable that takes the value 1 when the country enact the regulation in year t and thereafter, and 0 when the country does not have the law in force. α_i is a country fixed effect, μ_t is a year fixed effect, and ε_{it} is the usual error term clustered at country level. The parameter of interest is β. This parameter captures the effect of incorporating formal nutrition labeling on cocoa consumption. Year fixed effects capture any common time shocks across countries. Country fixed effects control for time-invariant countries characteristics . We deal with the possibility that a country's standard errors are correlated over time. For this, we cluster standard errors at the country level. This variance estimator has asymptotic properties and at least 50 clusters are needed, in this case we have 53 clusters. However, we also estimate model (1) using wild bootstrap standard errors. According to Cameron et al. (2008) this inference strategy fits well when the number of clusters is less than 50 without generating statistical power loss although it requires that there is little heterogeneity between clusters. In Table 3, we report the estimation of the model (1).

Table 4: Estimations

Variables	Cocoa Consumption
GDA	0.168
	(0.177)
	[0.176]
Observations	2,521
R-squared	0.273
Clusters	53
Confidence Interval	-0.186 - 0.523
Boottest	Prob>|t|=0.361

Note: Clustered standard errors at country level in parenthesis, standard errors using wild bootstrap at country level in brackets
*** p<0.01, ** p<0.05, * p<0.1

We can see that the parameter of interest is 0.168 so that cocoa consumption at per capita levels increases after the incorporation of GDA front labeling regulations, although this coefficient is not statistically significant and the p-value using wild bootstrap is similar to the p-value of traditional cluster estimation (p-value = 0.345). However, as we will see in the following sections, the value is consistently around -0.186 and 0.522.

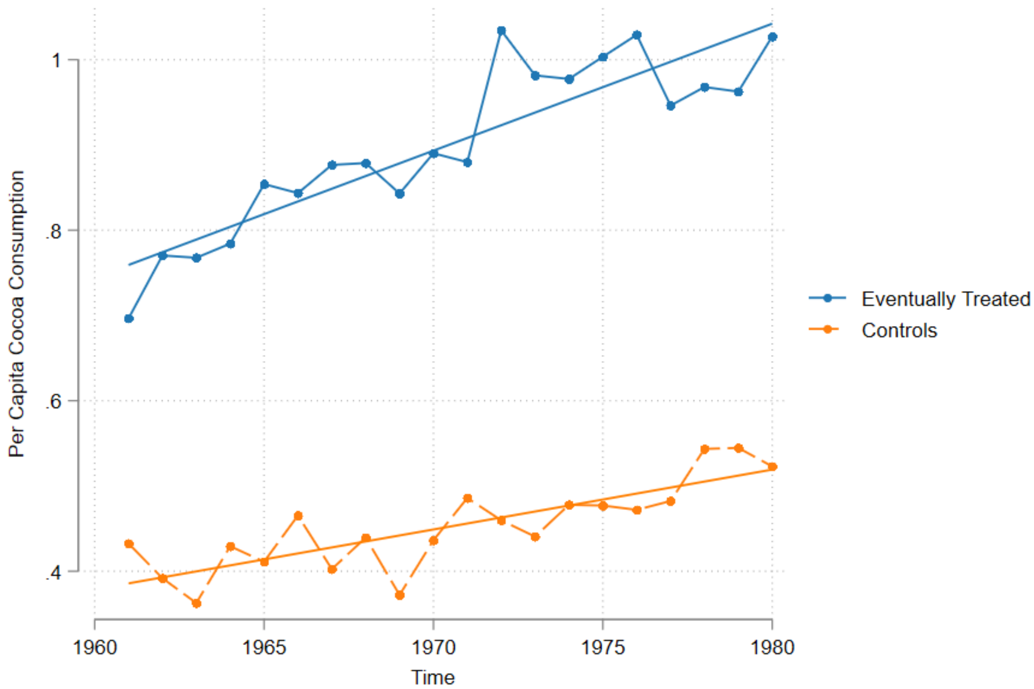
4.2 Validity of results

In this section, we discuss the validity of the result above. First, we check for parallel trends. Then, we check that the effect is not given by a particular treated country. Finally, we estimate an alternative specification to model (1).

Testing for parallel trends

The control units should be a good counterfactual of the treated units if the latter had not been treated. For this, we will evaluate how treated and untreated units behave before treatment. The concern here is that countries that adopt regulation might have different trends than those that have not adopted the regulation, which could bias our results. If the trends were parallel before the regulations started to be applied, it can be expected that the trends would continue to be parallel in the post-treatment period in the absence of treatment. First, we propose the following graph (Figure 1) showing the trends in per capita cocoa consumption before the first treatment started (year 1981). In general terms, the trends seem to be parallel, although we will retest this with an alternative specification in a subsequent subsection.

Figure 1: Pre-treatment trends

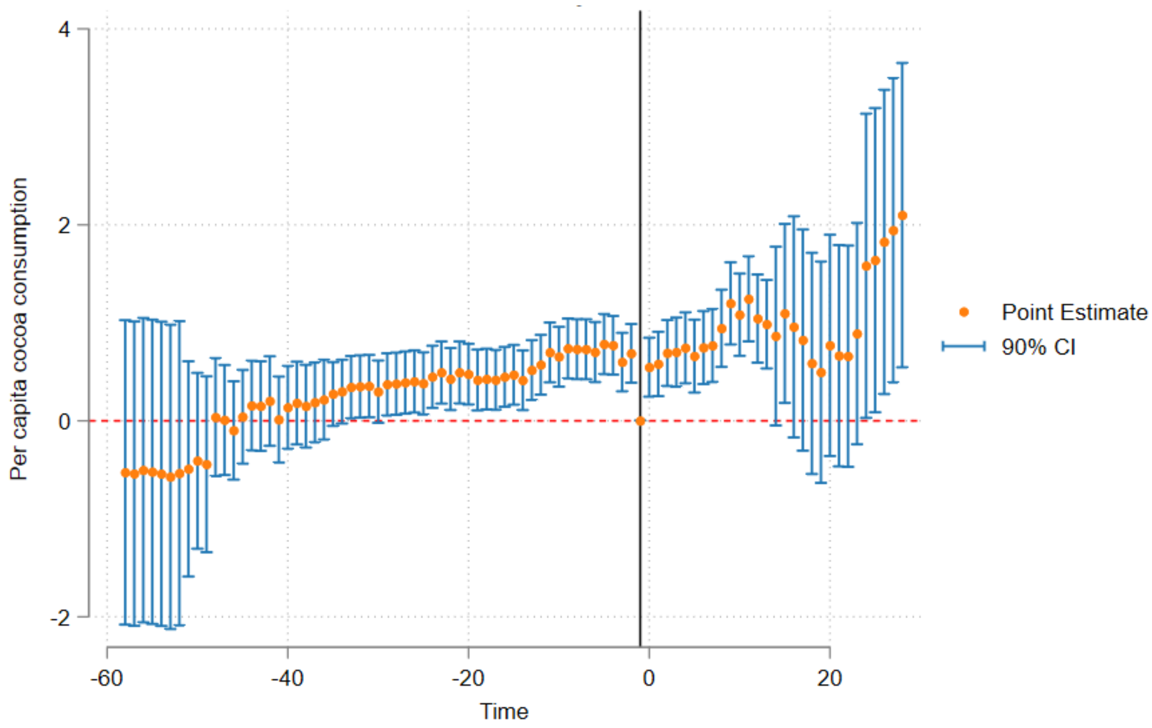


Now, we want to test parallel trends before treatment. In this case, since the treatment does not occur at the same point in time, we normalize it and estimate a leads-and-lags model:

$$(2)\ Y_{it} = \sum_{k=q-}^{q+} \beta^k T_{it}^{\ k} + \alpha_i + \mu_t + \varepsilon_{it}$$

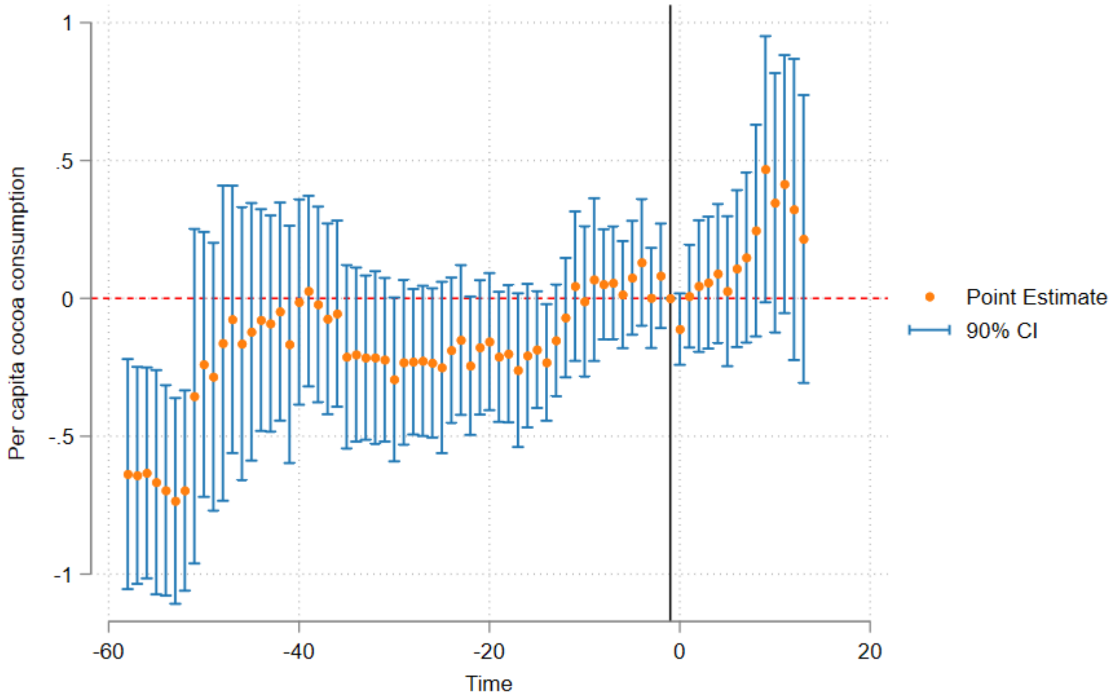
where $T_{it}^{\ k}$ is a dummy variable that takes the value of 1 for treated countries adopted k periods earlier, q^- is the most distant previous period and q^+ is the subsequent period further after the incorporation of the regulations. β^k measures the effect of each of the k periods after the regulation. If k is positive, β^k measures the effects of the k periods after the regulations. We can test whether the treated and controls behaved the same before treatment. Then, if we find that cocoa consumption is similar before treatment and then increases, we could conclude that the adoption of front-of-pack nutrition labeling increases cocoa consumption. We observe the results in Figure 2. We see that in the years furthest from the start of treatment, the differences between countries are significant, but from treatment up to fifty years back, the differences are no longer statistically significant. Then, from the beginning of treatment onwards, no immediate changes in consumption are observed. In the longer term, however, we see that differences start to become significant between treated and untreated countries.

Figure 2: Timeline β^k sequence of events



When we look at the country results for the last five years, we see that Greece, the United States and Ireland have a significant share of post-treatment outcomes. This is why we perform the same regression with leads and lags as a robustness check without those countries, which we see in Figure 3. The trends appear to remain parallel, although the effects after treatment, in the long term, are less extreme than in the previous case. However, we see that fifteen years after the start of treatment, there are significant differences between control and treated groups.

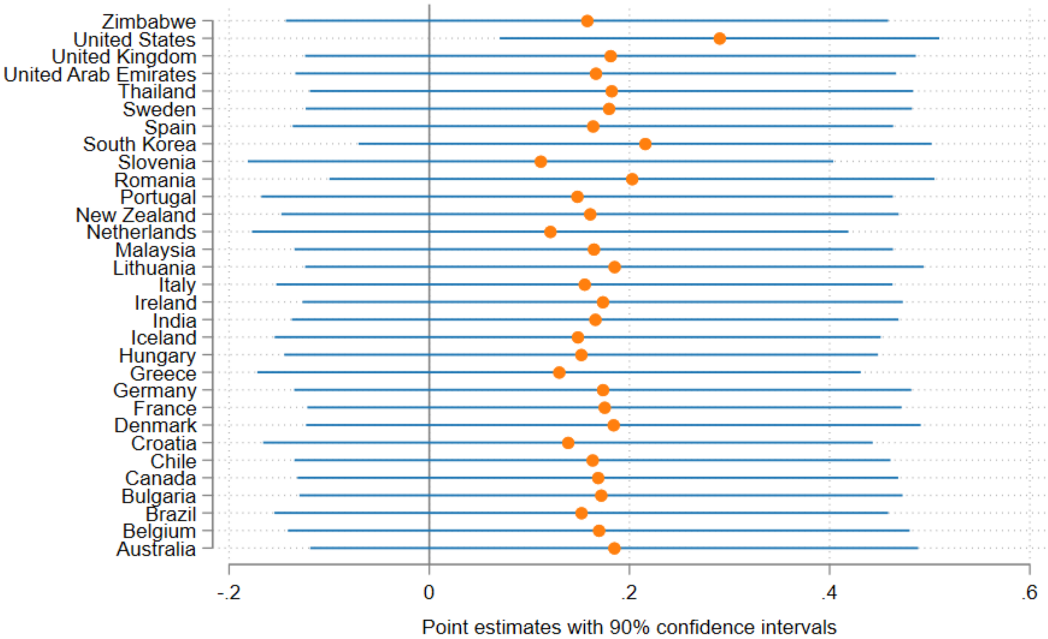
Figure 3: Timeline β^k sequence of events excluding Greece, Ireland, and the United States



Leave one out test

The effect on our outcome of interest may be driven by the fact that the treatment has an effect only in some countries. To deal with this concern, we estimate model (1) by excluding one by one the countries that were treated at some point in time. We see these results in Figure 4. The coefficients of the treated countries are between 0.1 and 0.3, with a mean of 0.172. This is consistent with what was estimated in the initial model, which leads us to believe that the result found with data from all countries (53) is not driven by an effect in any particular country.

Figure 4: Coefficients leaving each country out



Alternative specification

Model (1) estimates an effect based on staggered treatments since they enter at different points in time. Bacon's Decomposition Theorem (Goodman-Bacon, 2021) shows that the TWFE estimator is a weighted average of all combinations of estimators where the weights depend on the size of the groups and their variances. The theorem states that the more states adopt the law simultaneously, the greater their influence on the estimator. The variance of the within-group treatment effect is maximized when countries are treated in the middle of the panel. Then, the authors show that the estimated effect is biased when the treatment is staggered and heterogeneous.

In this sense, Callaway & Sant'Anna (2020) propose to estimate an Average Treated over Treated (ATT) for units treated at the same time, i.e., by cohort and time, which allows for identifying different treatment intensities. In particular, a post-treatment ATT is estimated for each cohort-time. In particular, the Callaway & Sant'Anna (2020) estimator estimates a propensity score using the pretreatment characteristics of each unit. Given that there are units in the treatment group and units in the control group, we must decide the criterion for comparison: never treated units or eventually treated units. Thus, ATT consistently estimates each of the group-time ATT. It does not use the pre-treatment trend as a counterfactual but as a base group. In this case, the control group is the not-yet-treated countries.

Four assumptions are required for identification. First, the data must have a panel structure. In addition, in the absence of treatment, the trends of the treatment and control groups must be parallel. Third, the treatment cannot be reversed once started. Finally, the treatment and control groups must have units with similar propensity scores.

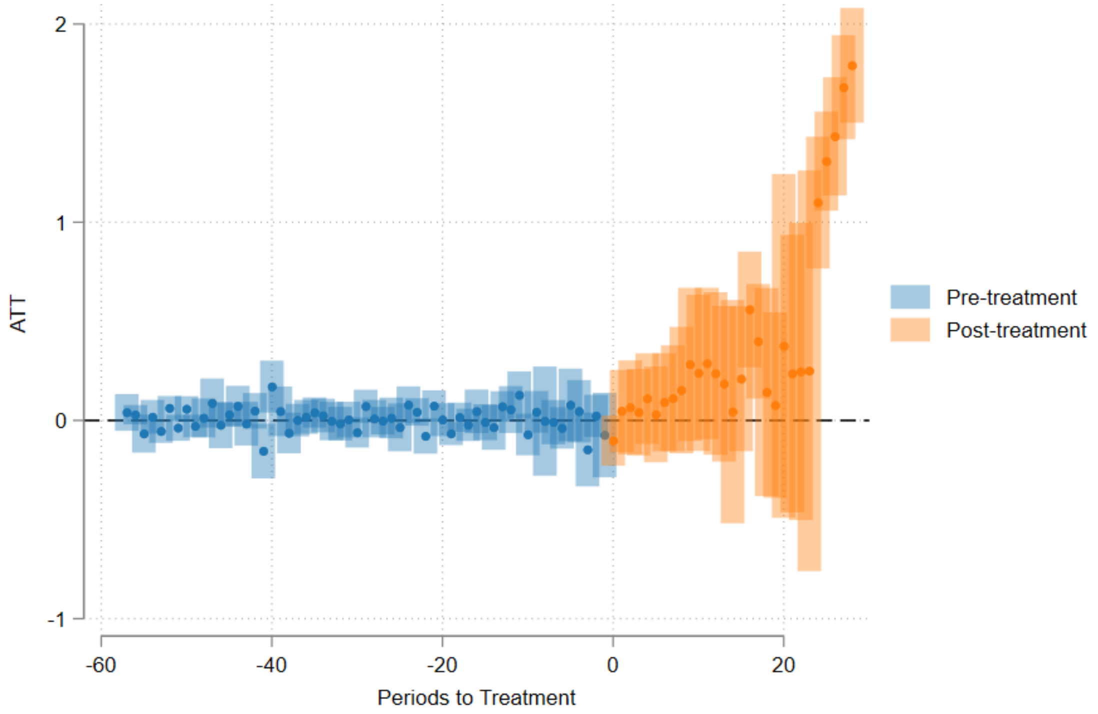
Therefore, we estimate the effect of the labeling regulation on cocoa consumption with the approach of Callaway & Sant'Anna (2020) shown in Table 4. We see that the ATT is 0.137 which indicates that, on average, the effect of regulation has a positive effect on cocoa consumption.

Table 4: Alternative estimation

Specification	Coef.	SE	Z	P-value
Calleway and Santana: ATT	0.137	0.1098	1.25	0.211

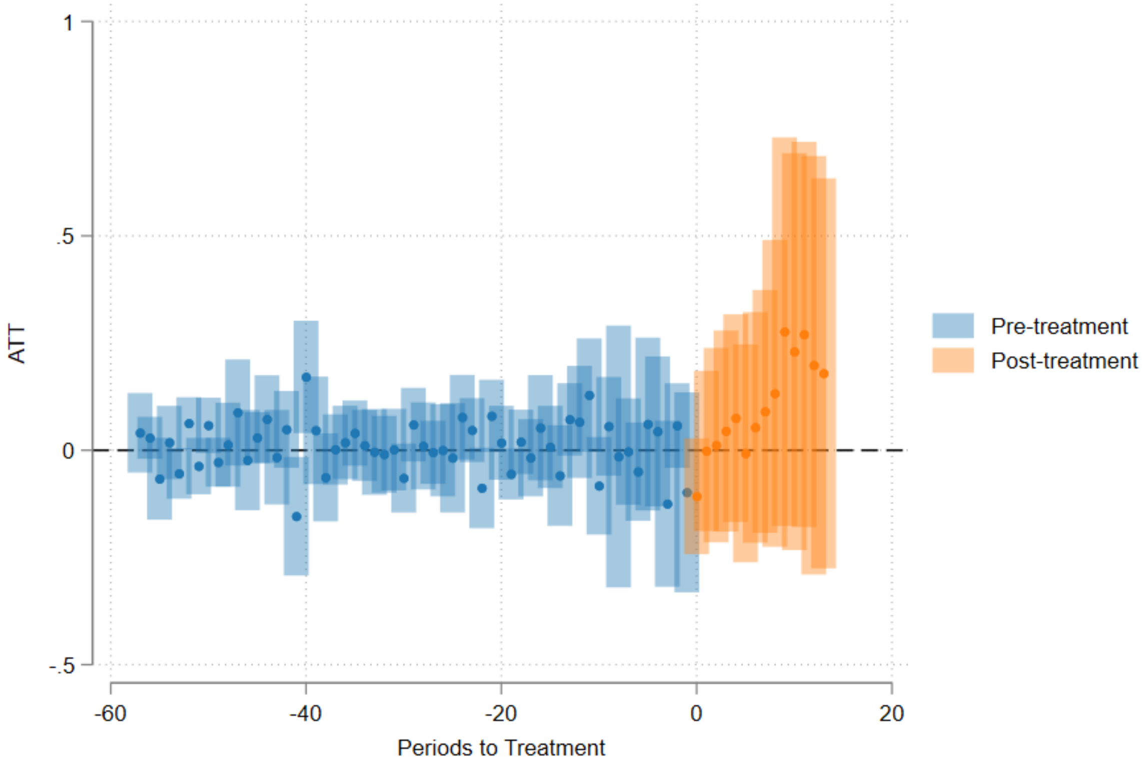
Again, we test parallel trends through an event study with Callaway & Sant'Anna (2020) specification. In Figure 5, we find a similar pattern to the previous one. The trends of the control and treatment groups are not significantly different. In turn, a positive difference between the control and treatment groups is observed 20 years after the start of treatment, confirming the previous estimate.

Figure 5: Timeline β^k sequence of events by Callaway & Sant'Anna



We then perform the same procedure by removing Greece, Ireland, and the United States from our database, as shown in Figure 6. We observe that there are significant differences in cocoa consumption in the long run but in a smaller proportion than in the previous case. The effect is still positive, although the estimator is not statistically significant. In other words, we see that despite the estimator being biased when the regular difference in difference model is run because of the staggered treatment, the effect is positive: there is an increase in cocoa consumption at per capita levels after the incorporation of the GDA food labeling regulation both for the case of all countries and also when excluding Greece, Ireland, and the United States.

Figure 6: Timeline β^k sequence of events by Callaway & Sant'Anna excluding Greece, Ireland, and the United States



Dynamic effects

The Callaway & Sant'Anna (2020) approach allows ATTs to be grouped together to have a clearer picture of the impact of the treatment. We observe the dynamic effects by groups according to the application of the treatment. In Figure 7, we show four different years where several countries were starting with legislation: 1981, 1996, 2007, and 2009[1]. In all cases, pre-treatment trends also appear to be parallel. Also, for the countries treated in years 1981, 2009, and 2011, the differences in the long run are positive.

Moreover, this approach provides insight into treatment intensities by group or cohort. In Figure 8, we see an ATT for each year after the first year of treatment (1981), and it is positive in most years, especially in the long term, although the results may be noisy given that few countries are treated in each particular year.

[1] Countries that passed the law by year. 1981: Greece. 1996: Belgium, Croatia, France, Germany, Hungary, Iceland, Ireland, Italy, Lithuania, Portugal, Romania, South Korea and Spain. 2007: Bulgaria and Thailand 2009: Denmark, Netherlands, New Zealand, Slovenia and Sweden.

Figure 7: Dynamic effects by groups

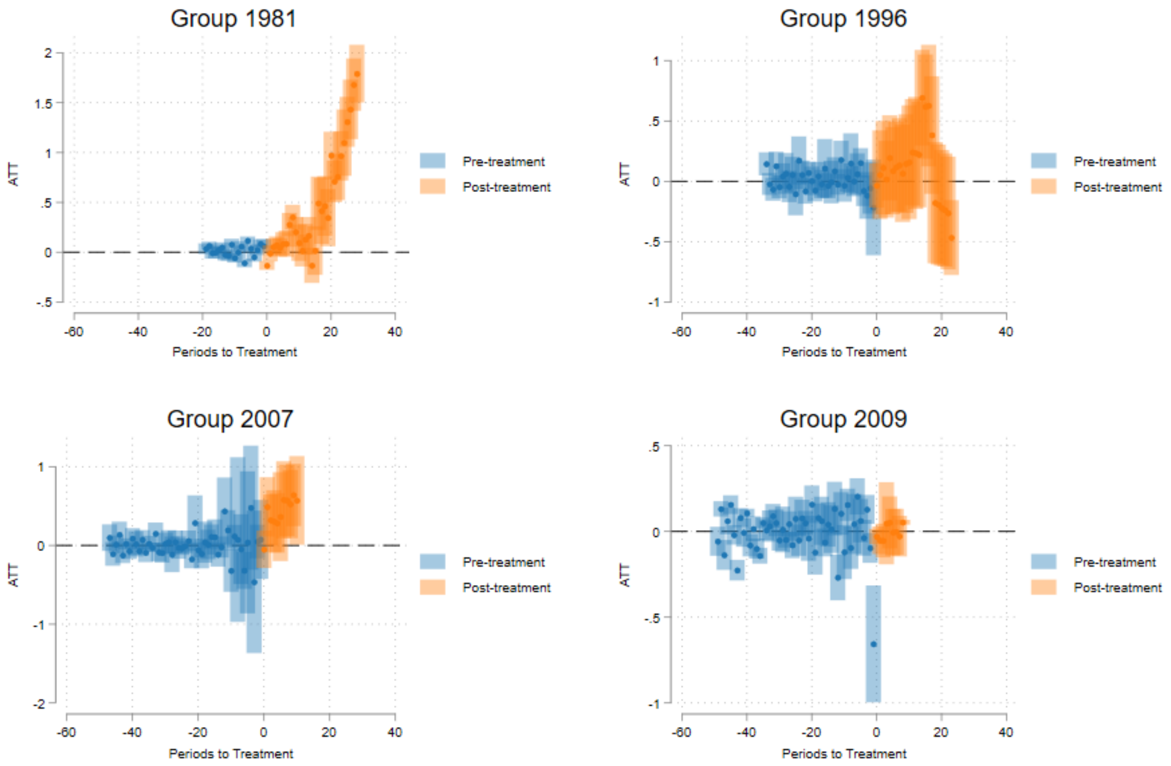
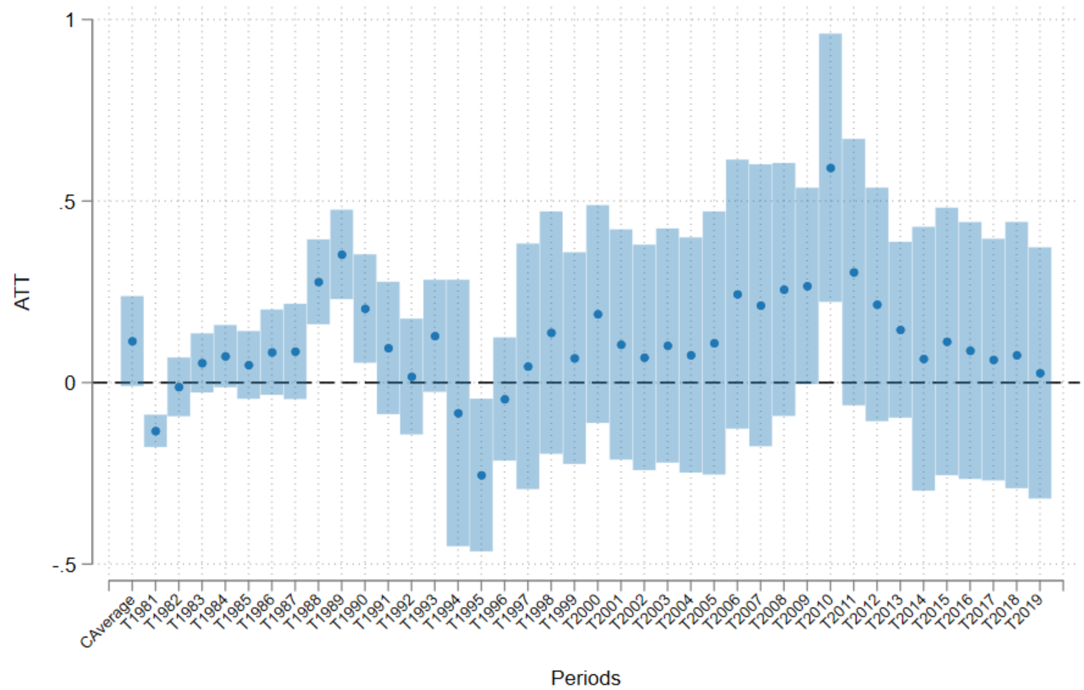


Figure 8: Effects by year



4. Concluding remarks

Recently, regulations on front-of-package food labeling have been implemented in many countries to improve society's eating habits. According to the literature, the most recent labeling systems, like semi-direct systems, show high effectiveness in their function, at least in the short term. However, the GDA front-of-package labeling scheme is the oldest in society, allowing an analysis of its medium and long-term impact.

This paper analyzes the causal effect of the Guideline Daily Amounts front-end labeling regulation on the consumption of cocoa-based foods. For this purpose, we use a difference-in-differences econometric model. The identification assumption in this model holds that the trend of the control group is a good counterfactual of how the treatment group trend would have been in the absence of treatment. Therefore, we focus on the validity of the strategy so that we show that the identification assumption appears to hold. As a result, we observe a positive effect on cocoa consumption more than ten years after the start of treatment. The validity of causality in the long run may be weakened because other events may affect the outcome of interest. However, we focused on checking the robustness of this result, and it appears to be consistent over time, although not statistically significant.

It is relevant to consider this result to analyze consumer behavior in depth. Although the literature shows a behavioral change towards healthier foods after the intervention of semi-direct labeling, these are results observed in an experimental or very short-term context. This implies the need to study whether the effect of such types of labeling shows satisfactory results even after many years of implementation.

For this particular case, we need to consider the mechanisms behind the observed result. The work of Barahona et al. (2023) found a reduction in the consumption of foods with low health warning labels only for those considered healthy before regulation. Those products regarded as unhealthy, such as chocolates or biscuits, did not show a sustained drop in demand. Along the same lines as this work, our long-term analysis shows an increase in the consumption of cocoa-based foods, generally of low nutritional quality. So, in the long term, people choose the more preferred option (in general, less healthy) when faced with two foods with similar critical nutritional levels, such as calories or fat, without analyzing the nutritional quality of the latter. For this reason, we consider it relevant to study the impact of different types of food labeling in the short and long term. This way, we can think of effective policies to improve consumers' food choices.

5. References

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