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Evolution of food and beverage prices after the front-of-package labelling regulations in Chile

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ABSTRACT

Introduction This study assesses the impact on prices of the 2016 Chilean comprehensive food policy package, centred around front-of-package warning labels for food and beverages high in saturated fats, sugars, calories and/or salt, on food and beverage prices, labelled or not.

Methods Data from Kantar WorldPanel Chile, from January 2014 to December 2017, were used. The methodology implemented was interrupted time series analyses with a control group on Laspeyres Price Indices on labelled food and beverage products.

Results After the regulations were implemented, prices among different categories of products (eg, high-in; reformulated but still high-in; reformulated and not high-in; not high-in) did not change with regulations relative to the control group. Specific price indices (relative to the control group) for households from different socioeconomic strata remained unchanged.

Conclusions Even where reformulation was extensive, we found no evidence that it was associated with price changes, at least during Chile's first year and a half of regulation implementation.

WHAT IS ALREADY KNOWN ON THIS TOPIC

⇒ It has been found that the availability of labelled products decreased after the law's implementation, consumption has changed and industry parameters, such as wage, employment or gross profit margins, have not changed significantly. However, more is needed to know how food and beverage prices change with these regulations.

WHAT THIS STUDY ADDS

⇒ Relative prices of labelled and unlabelled products mainly stayed the same during the first stage of implementing front-of-package food and beverage regulations in Chile, even in the presence of extensive product reformulation.

HOW THIS STUDY MIGHT AFFECT RESEARCH, PRACTICE OR POLICY

⇒ These findings suggest that any cost of reformulation was not passed to food and beverage prices.

INTRODUCTION

In 2016, 39.8% of the Chilean population was overweight, 31.2% were obese and 3.2% were morbidly obese.[1] One of the leading causes of overweight and obesity globally is the increased intake of energy-dense foods and beverages high in fat, sodium and sugar.[2] To counteract the alarming numbers, on 27 June 2016, Chile implemented the Food Labeling and Advertising Law or Law 20606. Figure 1 summarises graphically the different measures that were included in Law 20606, with their entry-into-force dates. This law mandated front-of-package labelling with visible black octagons on products high in sodium, sugar, calories and/or saturated fat (see Figure 1). Thresholds for these critical nutrients increased gradually over time, as explained elsewhere.[3 4] The law forbids selling foods and beverages with even one black octagon at schools or advertising them to children.

Several articles have documented the various impacts of such regulations. Taillie *et al* found that the volume of 'high-in' beverages purchased decreased by 23.7% after implementing Chile's law. High-education households had more significant relative reductions in high-in beverage purchases than low-education ones.[5] Using data from a supermarket chain, Barahona *et al* found that warning labels on breakfast cereals were associated with an 11.0% lower purchasing probability. In comparison, that figure was 24.0% for labelled juices.[6] The cereal reductions led to a 7.0% decrease in calorie and sugar intake and the juice reductions to a 9.0% decrease. Two studies used detailed firm-level employment and wage rate data to show that regulations implemented with Law 20606 did not cause reductions in sectoral or aggregate employment, real wages or gross profit margins.[3 7]

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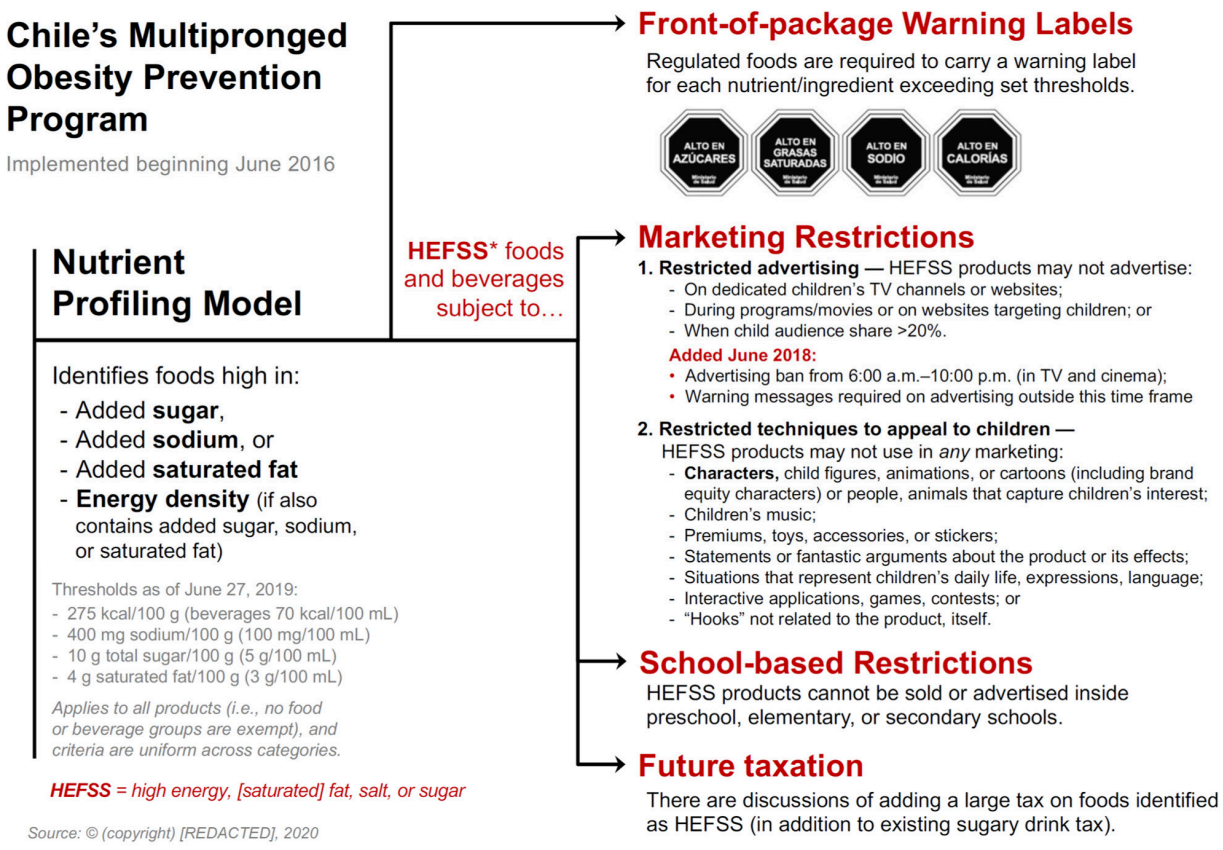

Figure 1 The Chilean law and accompanying regulations. TV, television.

The literature on the effects of regulations like those in Chile on prices of labelled versus unlabelled products is limited. Examining Vermont's labels on genetically modified food, Carter and Schaefer found about a 13.0% price reduction for beet sugar products (labelled) and about a 1.0% increase for sugar cane products (unlabelled).[8] The authors attribute these changes to food manufacturers' concerns about mandatory labelling causing them to adjust their ingredients. Pazuniak used triple difference models to compare Vermont's law to Oregon's similar law and found a general price premium of US$0.05 per ounce on unlabelled products and no changes on labelled goods. Pazuniak concluded that the labels did not impact short-term prices or sales.[9] Two studies in Chile that looked at price changes in the breakfast cereal market after the law's implementation reported mixed results. Barahona *et al* found that product labels increased prices of unlabelled products by 5.5% relative to labelled ones.[6] In contrast, Pachali *et al* found that labelled products' prices rose relative to unlabelled ones.[10] In both cases, the studies were conducted only with breakfast cereal purchase data.

To prevent the labelling of the products, some foods and beverages were reformulated; that is, the nutritional composition was changed to maintain ingredient levels under thresholds.[11] This reformulation of products after the implementation of Law 20606 could have impacted prices from a supply-side perspective (ie, the cost of reformulation drives prices of reformulated products up) and/or a demand-side perspective (ie, reformulation of high-in products to transform them into non-high-in ones, could have attracted consumers, increasing demand and driving their prices up).[3 7] For example, a study in Chile found that the proportion of available products with any high-in label decreased from 51% to 44% during the first 18 months after the law's initial implementation. The decrease was most common among products high in sodium and sugar, such as milk, breakfast cereals, sweet baked products, cheeses and sausages.[11] That study and others examining reformulation in reaction to sugar-sweetened beverage taxes based on sugar content did not consider price effects.[12 13]

The effectiveness of a labelling policy such as the one implemented in Chile can depend on how food and beverage prices respond to such a policy. Suppose that after implementing a policy aimed at diverting consumption from labelled products, such as the one implemented in Chile, the prices of these products decrease relative to unlabelled products. In that case, changes in consumption will be less than a priori expected or will not occur at all. Price changes can also have different socioeconomic patterns, which may also affect the effectiveness of the policy to change behaviour in certain groups of the population. To the best of our knowledge, there are no analyses of price changes after a labelling policy for either the general population or socioeconomic groups.

This study measures changes in levels and trends of absolute prices using the Laspeyres Price Index before

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and after the implementation of Law 20606, using the basket of products that were non-high-in the entire period as a control group for the rest of the products. In addition, we divided food and beverage products into baskets according to their labelling status and whether they had been reformulated. We also considered baskets of products for households of different socioeconomic levels to estimate specific price indices.

METHODS

Data sources

We used price data from Kantar WorldPanel Chile, a longitudinal database that contains monthly data on household packaged food and beverage purchases from January 2014 to December 2017. The database includes information on weekly purchases of solid foods and beverages by households in large cities (more than 20 000 inhabitants), representing 74% of the urban population and the Chilean urban population from the six regional groupings Kantar considered.

The Kantar database includes 2573 households and 1833 unique products (brands) grouped into 49 categories. Kantar interviewers visited the households weekly to collect data using a handheld barcode scanner. Unique stock-keeping units identify products (not only by type or category but by brand and presentation). The data collected include the number of units purchased, the price paid per unit and the volume or weight of a unit. Households are in the panel for a median time of 18 months; on average, 1936 households are present monthly. Kantar WorldPanel constructed a socioeconomic status variable based on household access to a list of goods (eg, television, cars, computers) and services (eg, telephone, internet, electricity) and the education level of the head of the household. The three socioeconomic groups are ABC1, the highest 10%; C2C3, the middle 80% and DE, the lowest 10%. This grouping is ad hoc and not income based, as incomes are not recorded as they are frequently subject to measurement errors and may be volatile, not reflecting the long-run socioeconomic status of households (contrary to educational variables and access to goods and services). This methodology has been widely used in household surveys by several international organisations conducting surveys in developing countries (eg, WHO, the World Bank, United Nations Development Programme).[14]

The set of products included in the Kantar WorldPanel represents about one-third (31.5%) of the food and beverage component of the Chilean Consumer Price Index (CPI) that the official statistical office, the Instituto Nacional de Estadísticas (INE), produces.[15] The Kantar WorldPanel considers packaged goods and does not include products that can be purchased by weight, such as meats, bread, fruits, vegetables and unpackaged sugars, which are not regulated by Law 20606. Online supplemental table A lists the foods and beverages in the Kantar WorldPanel.

Using the Kantar WorldPanel data on purchases, our team of trained nutritionists reviewed the nutritional information on the food labels of products that households purchased in January 2014–June 2016, before the implementation of Law 20606, and categorised them according to the Law's definition as high in sugar, sodium or saturated fat if they exceeded the calorie threshold.[16 17] After the implementation of the law, the nutritionists recorded the actual high-in labels of products purchased by households (from January to February 2017).[11] The resulting unique data set catalogued comparable information before and after the law's implementation.

Statistical analysis

Using the Laspeyres Price Index, we constructed price indices to consider price changes over time. The Chilean INE, the US Bureau of Labor Statistics, and other official statistical institutions frequently use this method to construct and measure the CPI.[15 18] The index maintains the initial quantities of a basket of selected products constant over time to weigh price changes. However, it does not reflect the consequent quantity reaction of the households in response to price variations over time.[19] To account for this limitation, we conducted sensitivity analyses using other price indices methods, such as the Paasche and the Fisher. A short discussion on them and the results of the main analyses using them can be found in online supplemental material.

Let i denotes categories of products (eg, 'carbonated drinks' or any of the 49 categories of online supplemental table A), and K is one of the four mutually exclusive baskets: (1) products that were high-in during the entire period and were not reformulated or if they were reformulated still had the same high-in labels, (2) products that were reformulated after the intervention and lost at least one high-in label, but were still high-in after reformulation, (3) products that were reformulated after the intervention and became not high-in after reformulation and (4) products that were not high-in during the entire period. Thus, the Laspeyres Price Index has its usual simple form:

$$LPI_t^K = \frac{\sum_{i=1}^{49} P_t^i Q_0^i}{\sum_{i=1}^{49} P_0^i Q_0^i} = \sum_{i=1}^{49} \left(\frac{P_t^i}{P_0^i}\right) s_0^i \qquad (1)$$

where LPI_t^K is the Laspeyres Price Index for the K basket of products at month t; P_t^i is the price of each category i of basket K at month t; and Q_t^i is the quantity purchased of each category i of basket K at month t in grams for solid foods and in millilitres for beverages. The base period is denoted by 0. The weighing parameter s_0^i is equal to:

$$s_0^i = \frac{P_0^i Q_0^i}{\sum_{i=1}^{49} P_0^i Q_0^i}$$

Thus the weight of each category is equal to the budget share of each category in the base period.

Given that several similar products may be included in each of the 49 categories of products potentially in basket K, a weighted average within each category is considered to estimate prices for categories. Hence for each of the i (49) categories, the total purchases in monetary terms for each of the J goods belonging to each category are added together and divided by the total physical quantity

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(in grams for solid foods and in millilitres for beverages) purchased in products of that category at month t. Equation (1) becomes:

$$LPI_t^K = \sum_{i=1}^{49} \left(\frac{\frac{\sum_{j=1}^{J} p_t^j q_t^j}{\sum_{j=1}^{J} q_t^j}}{\frac{\sum_{j=1}^{J} p_0^j q_0^j}{\sum_{j=1}^{J} q_0^j}} \right) s_0^i \quad (2)$$

The base period considered to weigh price changes can be a month or several months to avoid seasonal effects. In this case, the base period is the year 2014. Hence, we estimated average purchases in physical units (grams or milligrams) for each of the J categories for the year 2014 (Q_0^j) and also estimated average prices for purchases for that year $\left(\frac{\sum_{j=1}^{J} p_0^j q_0^j}{\sum_{j=1}^{J} q_0^j} \right)$. We also considered an alternative base year (2015) with no significant differences in the main analyses (results in online supplemental material).

Let us assume that, for instance, the basket of solid food products that have been not high-in in any critical nutrient for the entire period contains X products over Y categories. In that case, we averaged purchases in physical units (grams) of all products belonging to each Y category for the entire sample of households for 2014.

We used a multiple-group interrupted time series analysis (ITSA) with a control group to estimate the effect of Law 20606 on the price index.[20] This method is used widely to assess the impact and evaluate the effectiveness of interventions applied in specific moments.[21–24] ITSA uses multiple and consecutive moments in time, preintervention and postintervention, allowing us to view the evolution of the time series and test the assumption of parallel trends preintervention (ie, that treated and control groups have the same statistical characteristics—level and trend—during the preintervention period).[25] When using ITSA with a control group, as is done in this study, the postintervention statistical differences between control and treated groups (if any) both in levels and trends can be directly attributed to the intervention (eg, the enactment of Law 20606). In this sense, this method allows us to determine causality using a quasi-experimental setting.[25]

As said before, the mutually exclusive baskets considered in the analyses are (1) products that were high-in during the entire period and were not reformulated or if they were reformulated still had the same high-in labels, (2) products that were reformulated after the intervention and lost at least one high-in label, but were still high-in after reformulation, (3) products that were reformulated after the intervention and became not high-in after reformulation and (4) products that were not high-in during the entire period. This grouping is instrumental and reflects two things: (A) baskets are mutually exclusive and products should not change baskets because intra-basket weights would not add to 1; and (B) baskets reflect all the possibilities regarding reformulation or, more generally, changes in labels.

In this case, the control group is the last basket, products that were not high-in during the whole period, and the treated groups are 1–3.

The multiple group ITSA models we estimated have the following form:

$$Y_{t,K} = \beta_0 + \beta_1 T_{t,K} + \beta_2 X_{t,K} + \beta_3 X_{t,K} T_{t,K} + \beta_4 Z_{t,K} + \beta_5 Z_{t,K} T_{t,K} + \beta_6 Z_{t,K} X_{t,K} + \beta_7 Z_{t,K} X_{t,K} T_{t,K} + \sum_{u=1}^{11} \delta_u D_{ut,K} + \epsilon_t$$

where $Y_{t,K}$ is the outcome variable (the Laspeyres Price Index for the two baskets estimated in each model, where K equals 1 for the high-in basket or one of the two baskets of reformulated products; and K equals 2 for the control group), $T_{t,K}$ is a time variable, $X_{t,K}$ is a dichotomous variable that identifies the treatment period (July 2016–December 2017), $Z_{t,K}$ is a dichotomous variable identifying the treated group (0 corresponds to the control group), and $D_{ut,K}$ is a set of dichotomous variables for calendar months (to adjust for seasonality).

The parameter β_1 is the preintervention trend for the control group, β_2 is the change in the level after the intervention for the control group and β_3 is the change in the trend after the intervention for the control group. β_4 is the preintervention difference in levels between the treated and the control groups, and β_5 is the preintervention difference in trends between the treated and the control groups. We used β_4 and β_5 to test the preintervention parallel assumption: If both parameters are statistically non-significant, the treated and the control groups had similar behaviours in the preintervention period. β_6 is the postintervention difference in levels between the treated and the control groups, and β_7 is the postintervention difference in trends between the treated and the control groups. These last two parameters measure the effect of the intervention on the treated group relative to the control group.[20]

In addition to the multiple group ITSA models, we estimated a set of single ITSA models on price indices for groups 1–4. In these models, parameters $\beta_4 - \beta_7$ are set to 0, as there is no control group. The models show before-and-after changes in level (parameter β_2) and trend (parameter β_3). We added a dichotomous variable (equal to one from March 2016 onward) to account for an unusual increase in price indices in March 2016. That increase does not seem to be related to the implementation of Law 20606 at the end of June 2016.

After dividing the sample by the socioeconomic status described above, we estimated the multiple-group ITSA models for each socioeconomic group. In this case, we constructed specific price indices for each socioeconomic group. In other words, we considered a basket of products for each socioeconomic status (the base year is 2014) and assessed the price evolution of each basket using equation (2). In this context, comparing the statistical evolution of the price indices of the treated and control groups preintervention and postintervention is equivalent to comparing the change in those periods of the relative price indices of each treated group to the control group. Stata V.17 was used in the analysis.

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Table 1 Households' average monthly expenditures in UF on all products, high-in products, not high-in products and reformulated products and mean difference tests by socioeconomic level

	All	High-in	Not high-in	Reformulated high-in	Reformulated not high-in
Overall population					
Preintervention	1.67100	0.49640	0.95770	0.07480	0.21670
	(0.85240)†	(0.30700)	(0.51170)	(0.03710)	(0.14660)
Postintervention	1.62830	0.48890	0.92640	0.07850	0.21450
	(0.82070)	(0.30080)	(0.49620)	(0.04150)	(0.14210)
Difference preintervention versus postintervention	0.04270*	0.00760	0.03130**	–0.00360***	0.00220
SE	0.02490	0.00900	0.01500	0.00120	0.00430
ABC1					
Preintervention	2.03534	0.53095	1.22474	0.09560	0.26246
	(0.98480)	(0.29519)	(0.60912)	(0.04227)	(0.18692)
Postintervention	1.90240	0.49218	1.15298	0.09710	0.24847
	(0.92652)	(0.27217)	(0.58893)	(0.04725)	(0.17648)
Difference preintervention versus postintervention	0.13294*	0.03877*	0.07175	–0.00150	0.01399
SE	0.07353	0.02184	0.04605	0.00352	0.01400
C2C3					
Preintervention	1.71215	0.50712	0.98539	0.07669	0.21816
	(0.87143)	(0.30435)	(0.51611)	(0.03680)	(0.15203)
Postintervention	1.67520	0.50004	0.95370	0.07983	0.21891
	(0.84013)	(0.30265)	(0.49943)	(0.04112)	(0.15075)
Difference preintervention versus postintervention	0.03695	0.00707	0.03169	–0.00310*	–0.00080*
SE	0.03530	0.01251	0.02095	0.00164	0.00625
DE					
Preintervention	1.45418	0.46480	0.80480	0.06242	0.19411
	(0.69252)	(0.31506)	(0.39955)	(0.03110)	(0.10689)
Postintervention	1.43531	0.47029	0.78420	0.06727	0.19255
	(0.68608)	(0.30939)	(0.39142)	(0.03518)	(0.10238)
Difference preintervention versus postintervention	0.01887	–0.00550	0.02061	–0.00490*	0.00156
SE	0.03518	0.01594	0.02020	0.00180	0.00537

*p<0.1, **p<0.05, ***p<0.01.
†SEs are in parentheses.
UF, Unidad de Fomento.

Patient and public involvement

No patients were involved in this study. Households of Kantar WorldPanel Chile are anonymous (at least to the researchers).

RESULTS

Table 1 shows the preintervention and postintervention monthly average expenditures for the different baskets of products in Unidad de Fomento (UF), real account units widely used in Chile to index contracts, wages and mortgages. It also shows mean difference tests between preintervention and postintervention real expenditures.

The overall population's real expenditures on packaged foods and beverages marginally decreased (p<0.1) after the intervention (Law 20606), though the decrease is entirely explained by the ABC1 group's decline in those expenditures. The other socioeconomic groups show no statistical differences in real preintervention and postintervention expenditures.

The overall population exhibited a statistically significant decrease (p<0.05) in real expenditures on not high-in products after the intervention and a statistically significant increase (p<0.01) in real spending on reformulated but still high-in products after the intervention.

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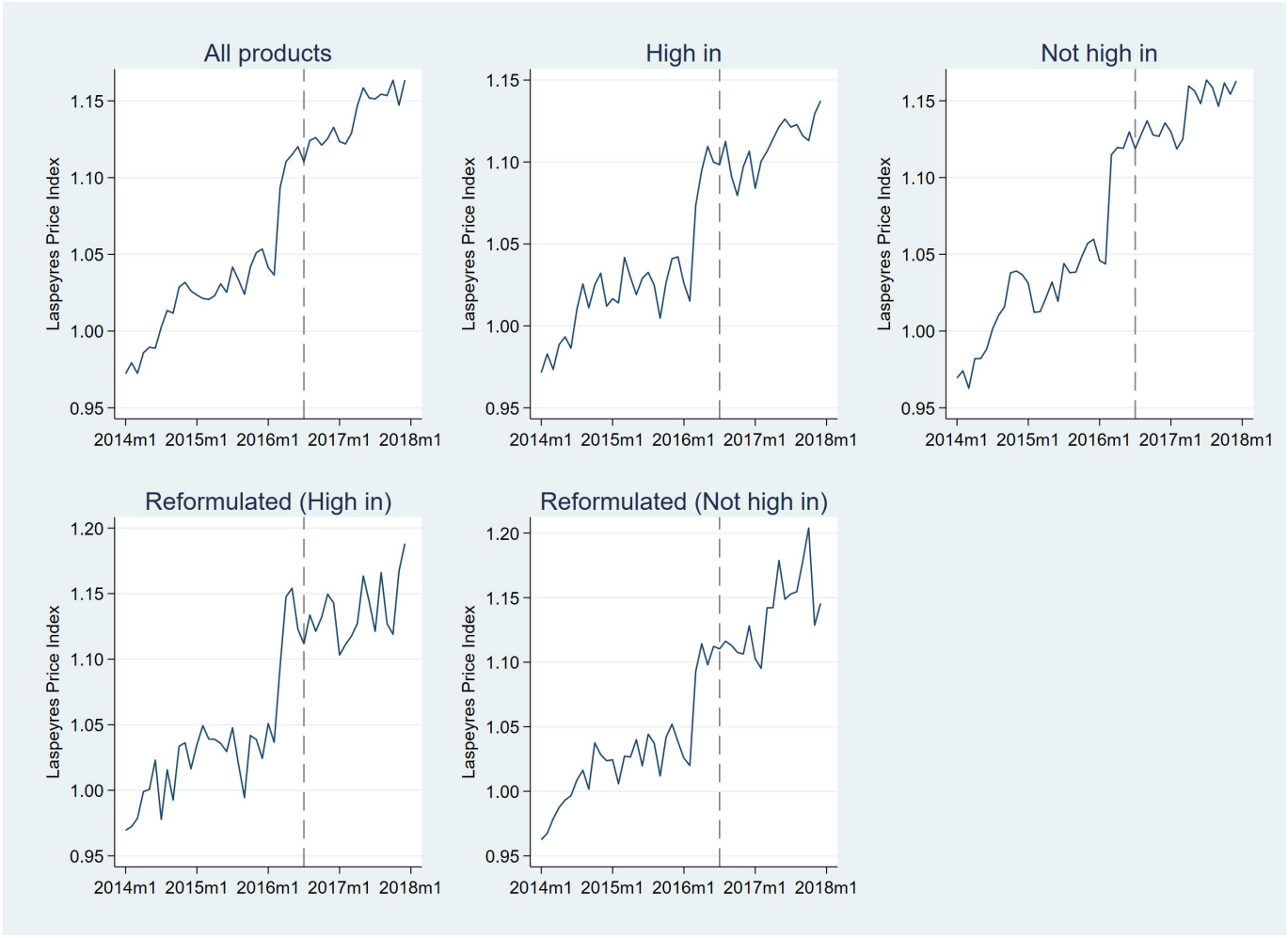

Figure 2 Laspeyres price indices for all products, high-in products, not high-in products and reformulated products (2014=1). The intervention is marked with a vertical dashed line.

However, in both cases, the differences are minor. In the first case, the decrease in real expenditures is only 3.1% of the preintervention real spending, and in the second case, the increase is 4.8% of the preintervention real expenditures. Among the socioeconomic levels, C2C3 and DE real expenditures on reformulated products, both high-in and not high-in, increased, though the increases were small and of marginal statistical significance ($p<0.1$).

All product baskets exhibited a sudden price increase in March 2016, well before the intervention, that cannot be attributed to the intervention (figure 2 shows the evolution of the Laspeyres Price Index for the different product baskets). Though the official general CPI that the INE estimated also indicates an increase in that month, it is not of the magnitude reflected in the Kantar WorldPanel data. That increase has no satisfying explanation and does not affect our statistical analyses. Regarding absolute price increases, the single group ITSA models in online supplemental table B show that prices did not significantly change their previous evolution with the implementation of Law 20606.

Table 2 shows the results of the multiple ITSA on products that were high-in during the entire period, products that were reformulated but remained high-in, and products that were reformulated and became not high-in. The control group is the products that were not high-in during the entire period.

Table 2 shows that the control group's statistical behaviour during the preintervention period is similar to that of the three other product baskets in levels (β_4) and trends (β_5). In all cases, these parameters are non-significant, showing that the control group is suitable. The postintervention behaviours of the price indices of the three product baskets were similar to the control group. The difference in levels (β_6) immediately after the intervention is non-significant for all three product baskets compared with the control group. The differences in trends (β_7) are also non-significant except in the reformulated not high-in basket, where it is significant only at 10%. This relative analysis implies that the high-in and reformulated products baskets reacted similarly to the not-high basket. To clarify the direction of the effect, online supplemental table B shows that price indices for each basket of products continued to increase after the intervention.

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Table 2 Multiple ITSA for the Laspeyres Price Indices of high-in and reformulated products

	High-in	Reformulated high-in	Reformulated not high- in
Control preintervention trend (β_1)	0.0044***	0.0043***	0.0044***
	(0.0006)†	(0.0006)	(0.0005)
Change in level control postintervention (β_2)	0.0211*	0.0247**	0.0208*
	(0.0124)	(0.0117)	(0.0111)
Change in trend control postintervention (β_3)	−0.0020***	−0.0022***	−0.0020***
	(0.0006)	(0.0007)	(0.0006)
Preintervention difference in level between treated and control (β_4)	0.0111	0.0064	0.0069
	(0.0111)	(0.0126)	(0.0098)
Preintervention difference in trend between treated and control (β_5)	−0.0013	−0.0004	−0.0008
	(0.0008)	(0.0011)	(0.0007)
Difference in change in level treated vs control postintervention (β_6)	−0.0027	0.0014	−0.0005
	(0.0183)	(0.0252)	(0.0167)
Difference in change in trend treated vs control postintervention (β_7)	0.0011	0.0001	0.0023*
	(0.0010)	(0.0014)	(0.0013)

*p<0.1, **p<0.05, ***p<0.01
†SEs are in parentheses.
ITSA, interrupted time series analysis.

Still, such an increase was not statistically different from the preintervention trend they had (figures 2 and 3 show this evolution).

Table 3 presents the results of the multiple ITSA for the highest socioeconomic group, ABC1. In all cases, the control group is suitable, as in the preintervention period, the control group does not show any statistical differences with the three treated groups (parameters β_4 and β_5 are statistically non-significant). Postintervention, no statistically significant differences between the control and treated groups emerge in levels (β_6) or trends (β_7). In other words, the intervention did not change the preintervention relative price behaviours.

Table 4 shows similar results for the price indices of products C2C3 households purchased. No statistically significant differences in prices emerge between the control and the treated groups' preintervention or postintervention. Again the relevant price indices did not change their previous behaviours with intervention.

Table 5 shows the results for the DE group. Like the other socioeconomic groups, no statistically significant differences emerge between the levels and trends of the price indices of the control and treated groups preintervention or postintervention.

Sensitivity analysis using different price indices (eg, the Paasche or the Fisher) or considering a different base year (eg, 2015) show no significant differences in the primary analyses. These results are included in online supplemental material.

DISCUSSION

Chile's Law 20606 had two primary objectives: to inform consumers about critical levels of certain nutrients in foods and beverages and to restrict minors' contact with labelled products at school and in advertising and marketing. A third goal is to promote industry reformulation and the development of healthier products. Changing relative prices of labelled foods and beverages was not a direct target and would have involved taxing labelled products and/or subsidising healthier ones.

Firms could have changed the relative prices of their products for several a priori reasons. Considering that the Chilean food and beverage sector is dominated by a few multinational firms that manage large portfolio product categories, firms may face little opposition to changing prices to maximise total profits.[26] A dwindling demand for labelled products in a category could generate a price change in a unlabelled product in the same or a similar category.

Little literature has examined the effects of similar regulations on relative prices, and none is conclusive. Most of the evidence pertains to small markets rather than a country's food and beverage market. One study reported that regulations for specific products, breakfast cereals, triggered an average of 5.5% higher prices of unlabelled products than labelled products.[6] Another found that among the same commodities, prices of labelled products increased relative to those of unlabelled products.[10]

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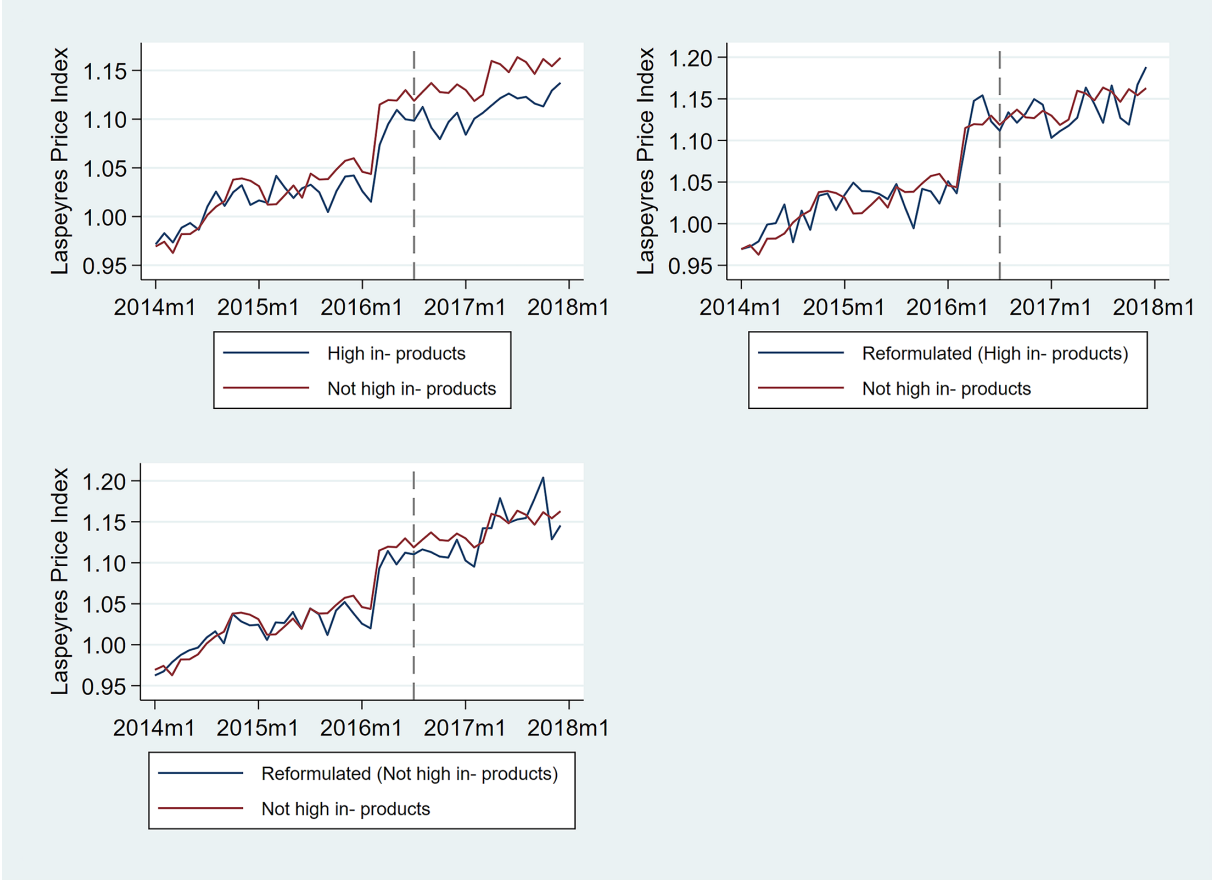

Figure 3 Laspeyres price indices for high-in, not high-in and reformulated products (2014=1). The intervention is marked with a vertical dashed line.

Table 3 Multiple ITSA for Laspeyres Price Indices of high-in and reformulated products that ABC1 households purchased

ABC1	High-in	Reformulated high-in	Reformulated not high-in
Control preintervention trend (β_1)	0.0038***	0.0037***	0.0038***
	(0.0007)†	(0.0008)	(0.0007)
Change in level control postintervention (β_2)	0.0493***	0.0521***	0.0498**
	(0.0184)	(0.0192)	(0.0200)
Change in trend control postintervention (β_3)	−0.0019*	−0.0020**	−0.0020*
	(0.0010)	(0.0009)	(0.0011)
Preintervention difference in level between treated and control (β_4)	0.0129	0.0110	0.0039
	(0.0133)	(0.0162)	(0.0125)
Preintervention difference in trend between treated and control (β_5)	−0.0011	.0001	−0.0006
	(0.0010)	(0.0012)	(0.0011)
Difference in change in level treated vs control postintervention (β_6)	0.0021	−0.0164	0.0106
	(0.0261)	(0.0302)	(0.0316)
Difference in change in trend treated vs controls postintervention (β_7)	−0.0001	0.0005	0.0027
	(0.0014)	(0.0019)	(0.0025)

*p<0.1, **p<0.05, ***p<0.01.
†SEs are in parentheses.
ITSA, interrupted time series analysis.

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Table 4 Multiple ITSA for Laspeyres Price Indices of high-in and reformulated products that C2C3 households purchased

C2C3	High-in	Reformulated high-in	Reformulated not high-in
Control preintervention trend (β_1)	0.0048***	0.0048***	0.0048***
	(0.0006)†	(0.0005)	(0.0005)
Change in level control postintervention (β_2)	0.0190	0.0228**	0.0184*
	(0.0117)	(0.0099)	(0.0107)
Change in trend control postintervention (β_3)	−0.0024***	−0.0025***	−0.0024***
	(0.0006)	(0.0007)	(0.0006)
Preintervention difference in level between treated and control (β_4)	0.0084	0.0083	0.0038
	(0.0121)	(0.0125)	(0.0104)
Preintervention difference in trend between treated and control (β_5)	−0.0012	−0.0009	−0.0006
	(0.0009)	(0.0011)	(0.0008)
Difference in change in level treated vs control postintervention (β_6)	−0.0114	0.0026	−0.0117
	(0.0202)	(0.0274)	(0.0198)
Difference in change in trend treated vs control postintervention (β_7)	0.0017	0.0016	0.0034*
	(0.0013)	(0.0019)	(0.0017)

*p<0.1, **p<0.05, ***p<0.01.
†SEs are in parentheses.
ITSA, interrupted time series analysis.

Our results show no change in the relative prices of labelled and unlabelled products in general and no changes in the products that different socioeconomic levels preferred. However, this does not mean that absolute/nominal prices remained unchanged after the implementation of Law 20606. Instead, either prices continued with the same trend established before the regulation, or prices of all products, labelled or not, changed similarly.

Table 5 Multiple ITSA for Laspeyres Price Indices of high-in and reformulated products that DE households purchased

DE	High-in	Reformulated high-in	Reformulated not high-in
Control preintervention trend (β_1)	0.0041***	0.0040***	0.0041***
	(0.0004)†	(0.0005)	(0.0004)
Change in level control postintervention (β_2)	0.0124	0.0175	0.0119
	(0.0104)	(0.0142)	(0.0102)
Change in trend control postintervention (β_3)	−0.0012*	−0.0015	−0.0011
	(0.0007)	(0.0011)	(0.0007)
Preintervention difference in level between treated and control (β_4)	0.0098	0.0036	0.0152*
	(0.0088)	(0.0138)	(0.0089)
Preintervention difference in trend between treated and control (β_5)	−0.0007	−0.0002	−0.0008
	(0.0006)	(0.0009)	(0.0007)
Difference in change in level treated versus control postintervention (β_6)	0.0019	0.0167	−0.0126
	(0.0142)	(0.0279)	(0.0198)
Difference in change in trend treated versus control postintervention (β_7)	−0.0002	−0.0029	0.0018
	(0.0010)	(0.0023)	(0.0018)

*p<0.1, **p<0.05, ***p<0.01.
†SEs are in parentheses.
ITSA, interrupted time series analysis.

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These findings have deep implications. Food and beverage regulations led to profound changes in the nutritional content of certain products due to reformulation. The proportion of products high in sugar and sodium in several categories, especially milk-based beverages, breakfast cereals, savoury spreads, cheeses, soups and sausages, significantly decreased.[11] No study has reported direct evidence of how reformulation affected production costs, and as we stated above, proof of the effects of reformulation on prices is negligible and mixed. Our results indicate that for large food and beverage groups, neither absolute nor prices those relative to the control group changed significantly with the regulations compared with their preregulation trends. This implies that, at least during the first 18 months of Law 20606's implementation, if firms had reformulation costs, they did not pass them on through prices. Reformulation and potentially higher costs for firms did not change gross profit margins for the entire food and beverage sector compared with the non-affected control group.[7] These results cast doubt on a common belief that food and beverage regulations increase firms' costs and prevent them from reformulating their products.[6 27]

Moreover, other authors have studied Laspeyres Price Indices estimated for only breakfast cereals with mixed results.[6 10] In our examination, the price indices of reformulated cereals did not change relative to their preintervention trends. However, we found that prices of unlabelled non-reformulated products increased immediately after the implementation of Law 20606 relative to the other three product baskets we examined. (These results are not shown but are available from the authors.) Since these products were not high-in during the preintervention or the postintervention period, this could indicate that prices increased not because of reformulation but because the intervention triggered an increase in their demand.

This study has some limitations that need to be considered. First, Laspeyres Price Indices have a well-documented upward bias, as they tend to overestimate price changes.[28 29] As relative prices increase, individuals substitute to cheaper products, a process not captured by a fixed-basket index such as the Laspeyres index. This is one of the reasons those baskets are refreshed periodically. Despite this limitation, we chose the Laspeyres index because it is the one the Chile INE uses to estimate the CPI (as do most countries).[15] Using other price indices did not change the primary results obtained with the Laspeyres.

Second, the products available for our analyses are about one-third of the total food and beverage products the INE considers for the CPI. Our set does not include unpackaged products that can be sold by unit or weight, such as fruits, vegetables, meats and bread. Chile's regulations could have led to an increased demand for healthier products, such as fruits and vegetables, and even to an increase in other, not necessarily healthier, products, such as bread and meats. Not having the price evolutions of these products is a significant limitation. However, baskets of products are fixed according to preintervention consumption patterns, which eases this restriction on the data. Keeping them constant during the preintervention period allowed us to consider price changes in relation to that period and assumes that consumption of products not in the basket is also constant. Since this study does not assess consumers' welfare changes after implementing Law 20606, the lack of price data for almost two-thirds of consumers' consumption basket is not considered crucial.

CONCLUSIONS

A common feature in food industry discourse is that regulations are pricey for producers and cost the economy jobs and wages, even when the evidence is scarce or non-existent.[7 30] This study examined changes in the prices of different food and beverage product baskets according to their exposures to regulations and reformulation. Even where reformulation was extensive, we found no evidence that it was associated with price changes, at least during Chile's first year and a half of regulation implementation. An association between higher costs and food regulations like those in Chile is not demonstrated.

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