Sanctions and Imports of Essential Goods; A Closer Look at the Equipo Anova (2021) Results

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SANCTIONS AND IMPORTS OF ESSENTIAL GOODS:

A CLOSER LOOK AT THE EQUIPO ANOVA (2021) RESULTS

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Abstract: We revisit the results of Equipo Anova (2021), who claim to find evidence of an improvement in Venezuelan imports of food and medicines associated with the adoption of U.S. financial sanctions towards Venezuela in 2017. We show that their results are consequence of data coding errors and questionable methodological choices, including the use an unreasonable functional form that implies a counterfactual of negative imports in the absence of sanctions, the omission of data accounting for four-fifths of the country's food imports at the time of sanctions and incorrect application of regression discontinuity methods. Once these errors are corrected, the evidence of a significant improvement in the level and rate of change in imports of essentials disappears.

1. Introduction

How do economic sanctions affect living conditions in target countries? Concerns about the effects of sanctions on vulnerable populations have occupied a prominent place in the literature on economic statecraft. A growing literature has argued that sanctions have adverse effects on outcomes across a broad range of human development indicators ranging from per capita income (Neuenkirch and Neumeier, 2015; Spinter and Klomp, 2021), poverty (Neunenkirch and Neumeier, 2016), and inequality (Afersogbor and Mahadevan, 2016) to public health (Peksen, 2011; Petrescu, 2016; Allen and Letskian, 2012) and human rights (Wood, 2008; Peksen, 2011).

However, a recent study on Venezuela argues that restrictions on external financing imposed by the United States in 2017 are associated with an improvement in imports of essential goods (Equipo Anova, 2021). According to this study, the introduction of financial sanctions coincides with a discontinuous break in trend of key categories of imports of basic goods, leading to statistically significant increases in both the level and the rate of change of both food and medicines imports.

The findings of this study are remarkable in that they stand in stark contrast with those of the existing literature. Table 1 summarizes the results of 32 published studies that provide quantitative estimates of the effects of sanctions on living conditions in target countries. Of these, 30 studies find negative effects of sanctions on indicators of living standards in target countries and one finds ambiguous effects.[2] Equipo Anova (2021) provides a singular exception, reporting statistically significant improvements associated with the adoption of sanctions in a target country across all relevant indicators of living standards studied.[3] Furthermore, many of the country case studies written in the literature have emphasized restrictions on import capacity as being the key causal mechanism through which sanctions affect living conditions in target countries (Office of the UN Coordinator for Afghanistan, 2000; Kheirandish, Varahrami, Kebriaeezade and Cheraghali 2018; Oliveros, 2020; Rodríguez, 2021; Batmanghelidg, 2022; Carter Center 2022;), a channel of causation whose operation is directly contradicted by the results of the Equipo Anova (2021) study.

The purpose of this paper is to more closely examine the basis for the Equipo Anova (2021) result and to identify whether it effectively provides a counterexample to the existing literature. We focus on the sensitivity of the results to choices in functional form, definition of the dependent variable, and statistical methods used to test for the existence of discontinuities.

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[2] This table is a summary of Tables 1 and 2 of Rodríguez (2022b) which provides greater details on the methods and results of each of the studies. As discussed in that paper, some studies find a mixture of significant and insignificant results depending on the indicator and specification. Nevertheless, 30 of the published studies highlight the negative significant results as the main findings of their results, and one stresses the ambiguity of effects. The single exception is the Equipo Anova (2021) paper, in that it highlights as normatively significant only the indicators of imports of essential goods in which it finds positive effects.

[3] While Equipo Anova (2021) does find negative effects of sanctions on oil production, their discussion suggests that this effect can be disregarded due to their finding of improvement in imports of essentials: "even though the strategy of sanctions against [state-owned oil company] PDVSA could be responsable - only partial [sic]-of the decline observed in oil production and, with that, of the fiscal and external revenues of the Venezuelan economy, there is no evidence that sanctions have had a negative effect in the availability of basic humanitarian inputs."(2021, p. 2)

Table 1: Summary of cross-country panel data and country-level studies.

Authors	Outcome variable	Results	Data coverage	Authors	Outcome variable	Results	Data coverage
Hufbauer et al, (1985, 1990, 2007)	Economic cost to target countries	Average cost to target of comprehensive sanctions regimes is 4.2% of GDP	Cross-country	Dai et al (2021)	Trade flows between countries	The imposition of sanctions leads to a 77-82% decline in bilateral trade.	Cross-country
Wood (2008)	Human Rights Abuses	The most severe UN sanctions lead to an increase in the probability of repression from 5% to 25%; for U.S. sanctions the increase is to 16%.	Cross-country	Ha and Nam (2021)	Life expectancy	The imposition of economic sanctions reduces avarage life expectancy by 0.3 years. The effect is present only for trade and other sanctions. Countries with more developed financial systems and institutions are better able to alleviate the effect of sanctions on health.	Cross-country
Peksen (2009)	Physical integrity rights of citizens	Economic sanctions lead to significant increases in human rights violations in all measures of physical intergity considered as well as in aggregate indices	Cross-country	Splinter and Klomp (2021)	Growth collapses	The likelihood of experiencing a growth collapse rises by 9% in the first three years after sanctions are imposed	Cross-country
Peksen and Cooper (2010)	Democracy	Sanctions lead to a 7% reduction in the average Freedom House democracy score the year after sanctions are imposed, an effect that rises to 16% in the case of extensive sanctions	Cross-country	Gutmann et al. (2021)	The Economic Effects of International Sanctions: An Event Study	International sanctions slow GDP growth in the first (2.2 pp) and second (1.8 pp) years of a sanctions episode. The effect seems to be mostly caused by US unilateral sanctions and financial sanctions, and operates through a decline in Foreign direct investment, which drops by 39% in the first year of an episode of sanctions.	Cross-country
Peksen (2011)	Under-five child mortality rates	A one-standard deviation increase in the cost of sanctions leads to 4 percent increase in mortality. U.S. sanctions leads to a 35 percent increase in mortality.	Cross-country	Van Bergeijk (2015)	Political outcomes, GDP, oil and gas rents, government consumption, imports	Sanctions lead to a decline in GDP that is statistically significant only in the short term. Sanctions have no statistically significant effect on democracy either in the short nor long term.	Iran
Allen and Lektzian (2012)	Public health	Sanctions that have a large economic effect on target states can have severe public health consequences. These consequences are substantively similar to those associated with major military conflicts.	Cross-country	Farzanegan et al. (2016)	Macroeconomic Variables and Household welfare	Sanctions lead to a decline in total imports by 20%, total exports by 16.5%, private consumption by 3.9%, capital income by 3.8% and GDP by 2.2%	Iran
Choi and Lio (2013)	Incindents of international terrorism	The imposition of sanctions leads to a 93% increase in incidents of international terrorism	Cross-country	Warburton (2016)	GDP Growth, Exports/GDP, Inflation.	Sanctions detrimentally affect the target's macroeconomic performance	Iran, Liberia, Rwanda, Sierra Leone
Neuenkirch and Neumeier (2015)	Economic growth	UN sanctions cause 2.0% decline in growth at time of sanctions, rising to a cumulative 26% over 10 years. U.S. sanctions lower growth by 0.9% and cumulative 13%.	Cross-country	Gharehgozlia (2017)	Real GDP	Sanctions caused a 17.3 percent decline in real GDP in 3 years. The higest effect of the sanctions took place 2012, with a 12.0 percent drop.	Iran
Afesorgbor and Mahadevan (2016)	Income Inequality	A sanctions episode increases the Gini coefficient by 1.7 points, while each additional year of sanctions adds 0.3 points to the Gini	Cross-country	Parker et al. (2017)	Child mortality	The authors focused on sanctions designed to stop human rights violations through 3T mines in DRC. They found that infant mortality rates rose in villages that depend economically on armed groups. Also, they found that infant mortality rates increased in villages that depend economically on "conflict-free" minerals.	Five eastern Congo provinces
Lucena and Apolinário (2016)	Human Rights Abuses	Protection against loss of life and torture is 1.7 times more likely to worsen under targeted sanctions han under no sanctions. The effect of targeted sanctions is not different from that of conventional sanctions.	Cross-country	Kholodilin and Netšunajev (2018)	GDP Growth	Sanctions had a weak negative effect on the growth rate of Russian GDP.	Russia and euro area.
Petrescu (2016)	Weight, height and probability of death of children	Being exposed to sanctions during the whole duration of a pregnancy leads to a decrease of .07 standard deviations in a child's weight	Cross-country	Rodríguez (2019)	Venezuelan oil production	Financial sanctions are associated with losses in oil revenues of USD 16.9 billion per year	Venezuela
Neuenkirch and Neumeier (2016)	Poverty gap	U.S. sanctions lead to increases in the poverty gap by 3.8 % of GDP. The effect grows to 7.9% for most severe sanctions and is reinforced with multilateral support.	Cross-country	Felbermayr et al. (2020)	International trade	Sanctions reduce trade with the target, with an effect that is economically significant and heterogeneous across countries and sectors.	Iran
Gutmann et al. (2017)	Life expectancy for males and females	UN sanctions are associated with a decrease in life expectancy of 1.2 years for men and 1.4 years for women, while U.S. sanctions are associated with a smaller decline of 0.4 years for men and 0.5 years for women	Cross-country	Equipo ANOVA (2021)	Essential goods imports and oil production	Financial sanctions are associated with an improvement in imports of essential goods but an acceleration in the rate of decline in oil production.	Venezuela
Gutmann et al (2018)	Economic sanctions and human rights: Quantifying the legal proportionality principle	US economic sanctions are associated with a deterioration of political rights but an improvement in women's emancipatory rights. The effect on emancipatory rights comes from sanctions that are not targeted at human rights goals and that are imposed unilaterally by the US, while multilateral and human-rights targeted sanctions are not associated with improvements in women's rights but are associated with deteriorations in political rights.	Cross-country	Morteza (2021)	Real GDP	Sanctions caused a 12.5% fall in Iran's real GDP in the first year and a 19.1% decline 4 years after the application of the sanctions, while real GDP remained 5% lower than its counterfactual 2 years after the removal of sanctions.	Iran
Kim (2019)	HIV infections, aid-related deaths	Sanctions episodes lead to increase in the HIV infection rate of children by 2.5% and an increase in AIDS-related deaths by 1%.	Cross-country	Hejazi and Emamgholipour (2022)	Food prices, food security and dietary quality	Sanctions caused a significant increase in food prices. The share of urban and rural households that were prone to food insecurity increased from 8.8% and 25.2% to 11.2% and 29.2%, respectively, from 2017 to 2019.	Iran
Wen et al (2020)	Energy imports	Unilateral sanctions lead to increases in energy imports, as do U.S. sanctions, economic sanctions, and greater sanctions intensity. Plurilateral, EU and UN sanctions have no significant effects.	Cross-country	Rodríguez (2022)	Venezuelan oil output	Sanctions caused large losses in oil production among firms that had acces to finance prior to sanctions compared to a control group that lacked that access. The effect of sanctions explains around half of the output drop observed in those firms.	Venezuela

2. Background

Over the past decade, several countries have imposed a broad array of sanctions on persons and entities associated with the government of Nicolás Maduro in Venezuela. While most countries, including the members of the European Union and Canada, have limited their actions to sanctions that target the economic transactions of specific actors associated with the Venezuelan government[4], the United States has imposed additional restrictions barring most types of financial and trade transactions that involve the Venezuelan government.

The U.S. first adopted sanctions against the Venezuelan government in August 2017, when the Trump administration barred the issuance of new debt and the transfer of dividends from offshore entities to the Venezuelan government. In January 2019, the U.S. designated the state-owned oil monopoly Petróleos de Venezuela (PDVSA) as a specially designated national entity (SDN), thus imposing an embargo on all oil trade with Venezuela. In the same month, it recognized then National Assembly president Juan Guaidó as interim president of Venezuela, transferring to his appointees the management of Venezuela's offshore assets and the legal capacity to represent the Venezuelan state before US courts. In February of 2020, the U.S. began imposing secondary sanctions on Russian and Mexican companies that had helped sell Venezuelan oil in non-U.S. markets.

Between 2012 and 2020, Venezuela underwent the largest economic contraction documented in Latin American economic history since 1950, with per capita income falling by 72% (Rodríguez, 2022a). The extent to which this decline is affected by sanctions is a matter of intense debate. Most studies recognize that poor economic policies played a significant role in the onset of the contraction, as they left the economy unprepared to deal with the negative economic shock of the 2014 decline in oil prices. There is some discussion as to whether the 2017 financial sanctions can be associated with the ensuing decline in oil production; some authors (Rodríguez, 2018; Oliveros, 2021) suggest that the beak in trend oil production at the time is indicative of a decline while others point to alternative potential explanations (Bahar et al., 2019; Hausmann and Muci, 2019). Rodríguez (2022c) shows that oil joint ventures with access to finance prior to the 2017 financial sanctions suffered stronger declines in output than those that had already lost access to finance.

The worsening of socioeconomic indicators appears to be strongly related to declines in import capacity, with indicators of living standards improving consistently during the period of rising oil revenues (2000-2012) and deteriorating rapidly with the decline in export revenues and imports (2012-2020) (Rodríguez, 2022c). This is consistent with prior research on the Venezuelan economy, which finds that its economic fluctuations are largely driven by changes in oil export revenues (Rodríguez and Sachs, 1999; Hausmann and Rigobón, 2002, Rodríguez and Hausmann, 2012) as well as an extensive literature that shows that there are strong links between per capita income and non-income components of well-being (Pritchett and Summers, 1996; Filmer and Pritchett, 1999; UNDP, 2010).

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[4] In this paper, we refer to the administration of Nicolás Maduro as the government of Venezuela. Some countries, however, recognize the interim government led by Juan Guaidó, president of the National Assembly elected in 2015, as the country's legitimate government since January of 2019. We follow the convention of referring to the authorities with *de facto* control of the territory as the government. This should not be interpreted as taking a position on the legitimacy of the claim to power of any of the parties involved.

3. The Equipo Anova (2021) study

A study published in January of 2021 by Venezuelan consultancy firm Anova (Equipo Anova, 2021) contends that the 2017 financial sanctions could have led to an increase and stabilization of imports of food and medicines. The argument is based on the finding of a break in trend in food and medicines imports at the time of the August 2017 sanctions. In the words of the study's lead author, "there is a strong temporal association between the start of the first economic sanctions in 2021 and the recovery of imports of humanitarian goods, in particular food and medicines" (Zambrano, 2022). In its conclusions, the report states that "it is possible to argue that the change in policy orientation of the government, which finally led to the flexibilization of the web of controls, was also an immediate consequence of the hardening of financial sanctions on PDVSA." (Equipo Anova, p. 3)

The Equipo Anova study has been widely reported in the local press and is often invoked in the country's policy debate (Amaya, 2021, Méndez, 2021, Polítika UCAB, 2021, Iturbe, 2021). The idea that sanctions have had a myriad of positive effects on the economy, particularly by forcing the government to enact policy reforms, is also often echoed by political actors. Opposition leader Juan Guaidó, who claims to be the country's legitimate president, said in a recent interview that sanctions had allowed the economy to experience a "dead cat bounce" in economic activity; in a recent speech, he added that "thanks to the sanctions today the [U.S.] dollar is used in Venezuela", alluding to the Maduro government's flexibilization of restrictions on the use of foreign currency in domestic transactions (Guaidó, 2022a, b). Legislator Armando Armas, who served as president of the Foreign Relations Committee of the opposition-controlled National Assembly elected in 2015, wrote that "to those who think the country is improving…I'll remind you that this is due to the policy of international sanctions on the regime and its collaborators." (Armas, 2022).

Let us consider in more detail the estimates presented by Equipo Anova. Formally, they estimate a simple linear trend model on a time series of Venezuelan import data ranging from April 2015 to December 2019:

$$Imports = \alpha_0 + \alpha_1 D + \alpha_2 t + \alpha_3 tD \tag{1}$$

where t denotes a time trend and D is an indicator variable taking the value 1 on and after the adoption of sanctions on August 2017 and 0 before that date. Normalizing the time at the adoption of sanctions, t_c, to zero, they estimate equation (1) on medicines and food imports separately. They then test the hypotheses that $\alpha_1 = 0$ and $\alpha_3 = 0$ to evaluate respectively the change in level and rate of change of imports at the time of adoption of sanctions.

It is worth highlighting that Equipo Anova labels this research design as a regression discontinuity in time (RDiT) approach, using the term used to refer to time-series variants of the regression discontinuity design (RDD) framework (Hausman and Rapson, 2018). However, equation (1) differs significantly from what is typically understood in the literature as an RDD estimate. RDD estimation relies on the use of nonparametric regressions methods to estimate treatment effects on a subset of the data in the vicinity of a cutoff (Imbens and Lemieux, 2008; Lee and Lemieux, 2010; Hahn, Todd and Van der Klaauw, 2011 Lee, 2016). Typically, RDD studies use a variety of methods to select a window of data around the intervention of interest – also called a bandwidth – and use data inside that window, typically weighted by its proximity to the intervention date, to estimate treatment

effects. Its implementation generally requires large data sets that contain many observations both before and after the intervention being evaluated.[5]

In contrast, Equipo Anova preselect a sample of 28 months before and after sanctions to carry out parametric estimation of (1) via ordinary least squares, presenting no argument as to why this would be an appropriate bandwidth choice. This choice is problematic because a key assumption of RDD is that the bandwidth is small enough to preclude major changes in other determinants of the dependent variable.[6] Yet the period over which Equipo Anova estimate regression (1) was also one during which major events with significant economic impacts took place, including a collapse in the price of the economy's main export, the overhaul of government food policies, reforms in price and exchange control regulations, the imposition of additional oil sanctions at periods different from the cutoff, and the holding of parliamentary, regional, constitutional and presidential elections, to name just a few potential confounding events.[7]

Aside from the debatable choice of estimation method and its interpretation, there are two additional major problems with the Equipo Anova estimates. One is their choice to use as a dependent variable a measure of import levels in US dollars, instead of the standard logarithmic specification used in the literature on macroeconomic time series. The other one is the omission of several import categories accounting for around four-fifths of the economy's food imports at the time of sanctions. We discuss each of these in turn.

When estimating equation (1), Equipo Anova specify their dependent variable as the level of imports measured in current US dollars. This implies that the pre- and post-sanctions parameters α_2 and α_3 will measure the change in absolute dollar amounts per period of time. In other words, a constant rate of decline in the Equipo Anova setup will not mean a constant rate of percentage decline, but rather a continued decline of *a specific amount of dollars per year*. Even if the percentage rate of change were to remain constant, changes in absolute dollar amounts would be captured by their estimation method as a break in trend.

Clearly, this decision strongly biases the method towards finding a break in trend in any setting in which there is a sustained decline (or increase) in the dependent variable. To see why, it's useful to think in terms of actual numbers. In 2014, Venezuela spent $7.5 billion in food imports; by 2017 those imports had fallen to $1.9 million. Thus, on average food imports declined by $1.8 billion per year (i.e., (7.5-1.9)/3). Specification (1) measured in levels implies that in the absence of a break in
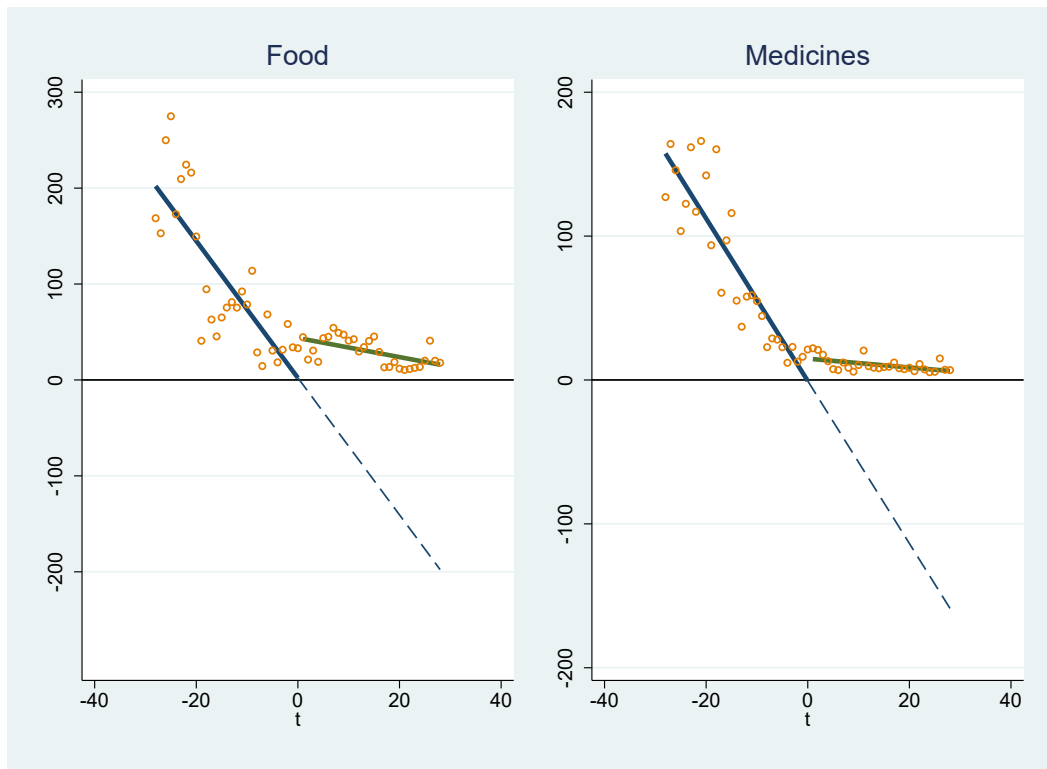
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[5] As discussed by Cunningham (2021, p. 252): "We need a lot of data *around* the discontinuities, which itself implies that the data sets useful for RDD are likely very large. In fact, large sample sizes are characteristic features of the RDD. This is also because in the face of strong trends in the running variable, sample-size requirements get even larger. Researchers are typically using administrative data or settings such as birth records where there are many observations" (emphasis in original).

[6] In the words of Hausman and Rapson (2018, p.535), the one reference cited by Equipo Anova on RD methods: "The use in RDiT of observations remote (in time) from the threshold is a substantial conceptual departure from the identifying assumptions used in a cross-sectional RD, and we show it can lead to bias resulting from unobservable confounders and/or the time-series properties of the data-generating process" (Hausman and Rapson, 2018, p. 535). For recent examples of RdiT applications and how they deal with issues of bandwidth choice, see Godard, Koning and Lindeboom (2019), Kim (2019), Carrears, Visconti and Acácio (2021), and Lovett and Xue (2021).

[7] Equipo Anova recognize that the adoption of price, exchange and import controls coincides with the post-sanctions period and that this fact clouds causal interpretation of the parameter. Despite this caveat, they offer as interpretation of their findings the possibility that the change in orientation of government policies is a consequence of the tightening of sanctions against PDVSA. (2021, p. 3).

trend, we should have expected those imports to continue declining at \$1.8 bn a year over the following 28 months. That is clearly impossible, since imports cannot fall below zero.

Figure 1: Implicit counterfactual trend in Equipo Anova estimates

Figure 1 illustrates this point graphically. The figure reproduces the Equipo Anova estimates for both food and medicine imports yet expands the y-axis scale to allow us to display the counterfactual prediction of the evolution of imports in the absence of sanctions implied by their estimates.[8] The solid lines show the Equipo Anova estimates for both the pre- and post-sanctions periods, while the shaded line shows their projection of the pre-sanctions trend estimate to the post-sanctions period. Note that the Equipo Anova statistical tests for slope changes are essentially a comparison of the shaded line and the solid post-sanctions line. Yet this counterfactual is clearly inadequate as it implies that food imports would have fallen to around -\$208mn per month and medicines imports to -\$167mn per month by December of 2019 in the absence of sanctions.

The second major problem in the Equipo Anova results has to do with the omission of important categories of food items from the dependent variable for which they report results. Although Equipo Anova claim to use the same two-digit international Harmonised System categories from the UN Comtrade database as used in another recent study on Venezuelan food imports (Bahar

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[8] Equipo Anova did not respond to our request for their data set and code, so all our estimates are based on our reconstruction of their data, as explained in section 4 below.

et al., 2019), this is not true. The Equipo Anova study omits ten two-digit import categories from their indicator of food imports. These categories include cereals, mill products, oils and sugars, among others (for ease of exposition, we refer to these categories henceforth as "cereals and oils"). On the year of sanctions, these categories accounted for 79.7% of all food imports as calculated by Bahar et al.[9] In other words, the Equipo Anova results are based on a food imports series that covers just around one-fifth of food imports at the time of sanctions (Table 2).

Table 2: Food categories used in Equipo Anova (2019) and Bahar et al (2019)

Code	Description	Bahar et al. (2019)	Equipo Anova (2021)	% of total imports (2017)
02	Meat	Included	Included	3.2%
03	Fish	Included	Included	0.2%
04	Dairy produce	Included	Included	5.9%
06	Trees and other plants	Included	Included	0.0%
07	Vegetables	Included	Included	4.1%
08	Fruits and nuts	Included	Included	0.5%
10	Cereals	Included	Excluded	38.9%
11	Mill products	Included	Excluded	5.5%
12	Oil seeds	Included	Excluded	2.4%
13	Lac, gums, resins	Included	Excluded	0.3%
14	Vegetable plaiting materials	Included	Excluded	0.0%
15	Animal fats	Included	Excluded	11.0%
16	Prepared meats	Included	Excluded	3.5%
17	Sugars	Included	Excluded	8.0%
18	Cocoa	Included	Excluded	0.4%
19	Cereal preparations	Included	Excluded	9.7%
20	Vegetable, fruit and plant preparations	Included	Included	1.2%
21	Miscellaneous edible	Included	Included	3.8%
22	Beverages, spirits and vinegar	Included	Included	1.0%
24	Tobacco	Included	Included	0.4%

An additional issue with the Equipo Anova study refers to the availability of data for their period of study at the time of collection. Because Venezuela reports no disaggregated import data to the United Nations, the Comtrade estimates of the country's imports are based on disaggregated export data reported by Venezuela's trading partners. Since countries report and update this data to the UN with variable delays (generally up to 24 months), data collected too close to the time of study could be incomplete. Therefore, Equipo Anova was not using a complete data series of imports for

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[9] The omission of these categories appears to have been an inadvertent error caused by a typo in footnote 2 on page 6 of Bahar et al. (2019), which fails to mention that the authors included 1-digit Harmonised System code 1 in their calculations. Nevertheless, revision of the replication code published by Bahar et al. (2019) verifies that all code 1 categories were included in their study. Equipo Anova claim to have also constructed an alternate series including most of the omitted code 1 categories in their footnote 18 and to have obtained similar results to those reported in their note, yet do not publish these. Their claim is consistent with our findings because the problem in their results is caused by the combination of using incomplete data *and* a misspecified regression. Our reconstruction of their alternate measure finds that the trend break results hold only in the misspecified levels specification which they use in their paper, yet not in the appropriate logarithmic one.

the post-sanctions period at the time, but rather the series based on the subset of countries that had reported up to the end of the sample when their study was written at the end of 2020.[10]

As we show in Table 3, correcting for these omissions makes the Equipo Anova results on food imports disappear. [11] The columns of table 3 report results according to different specifications of the dependent variable, while the rows capture differences in functional form and econometric method. Thus, the first column reports the food import series used by Equipo Anova, which excludes cereals and oils, the second column reports the full Comtrade food import series that includes cereals and oils and the third column reports results using medicines imports. We highlight in bold face and shade the cells corresponding to the Equipo Anova published results in the first row, and those of the fully corrected specifications in the third row. Once we use the full Comtrade food imports series and use a logarithmic specification (column 2, panel 2), the change in slope for food imports is no longer significant while the change in levels is only significant at p=.094. Even that very weak result disappears once we use the updated data, driving both coefficients below standard significance levels (column 2, panel 3).[12] The contrast between the specification published by Equipo Anova and the logarithmic specification with complete and updated data is displayed graphically in Figure 2.

### Table 3: Trend Interruption Specifications

			Equipo Anova food imports (excluding cereals and oils)	Food imports (including cereals and oils)	Medicine imports
Levels	Data available as of October 2020	Change in level	**44.86*** (13.82)**	91.94** (42.62)	**19.6*** (5.70)**
		Change in slope	**6.46*** (1.09)**	6.21** (2.79)	**5.47*** (0.49)**
Logarithms	Data available as of October 2020	Change in level	0.53** (0.25)	0.38* (0.22)	-0.05 (0.19)
		Change in slope	0.04*** (0.01)	0.01 (0.01)	0.07*** (0.01)
Logarithms	Data available as of December 2022	Change in level	0.56** (0.26)	**0.34 (0.22)**	-0.22 (0.20)
		Change in slope	0.05*** (0.01)	**0.02 (0.01)**	0.1*** (0.01)

Specifications originally reported by Equipo Anova (2021)
Specifications that correct data omissions and functional misspecification using most recent data

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[10] To be fair on this point, the Equipo Anova data was the best available data given their choice of window at writing. Yet given what we know about the delays in reporting, the data was clearly still preliminary at the moment and, as we show below, their results are additionally weakened when we use the updated data. A more prudent presentation of the results at the time should have stressed their preliminary nature.

[11] Note that by most recent data we refer to the updated data for the same period of study (April 2015-December 2019)

[12] In response to earlier critiques of the paper's functional form choice, lead Equipo Anova researcher Omar Zambrano posted on Twitter scatter plots showing results using a logarithmic specification and argued that they showed that the originally published results continued to hold even using a nonlinear functional form. However, the food results published on his Twitter thread are based on the restricted food import series that excludes cereals and oils and thus do not correct the data omission problem. See Zambrano (2021a) and Zambrano (2021b).

**Figure 2: Trend interruption estimates, food imports**
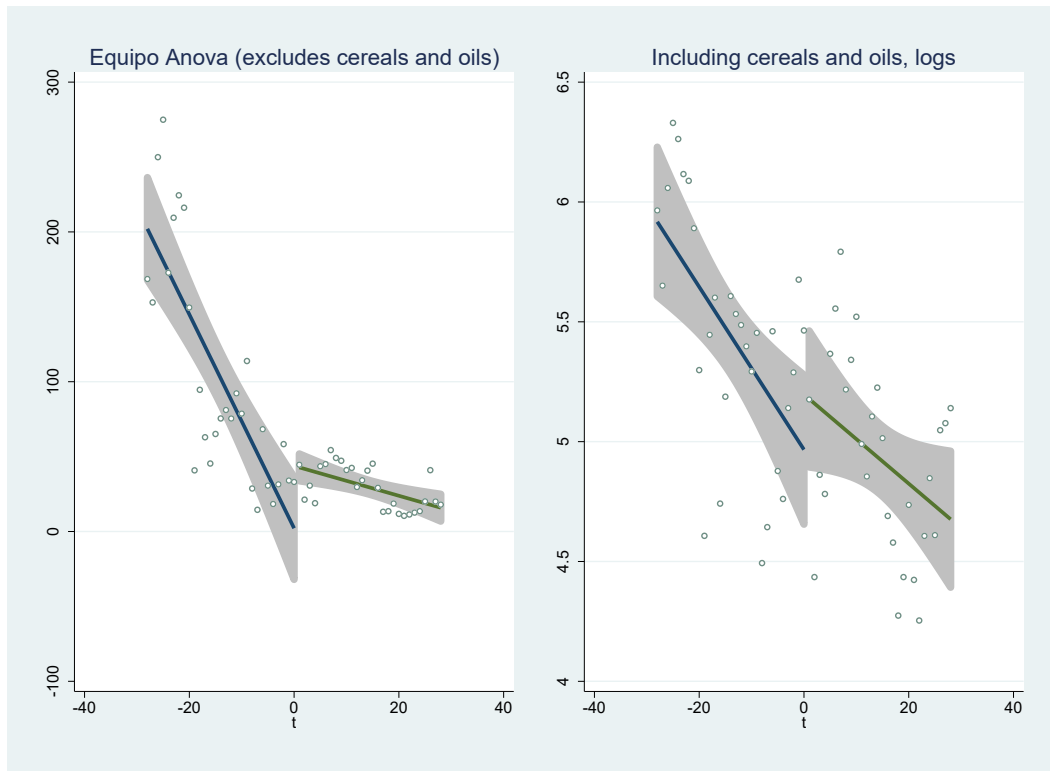
Sources: UN Comtrade, own calculations

The last column of Table 2 shows the results for medicines imports. In this case, the estimated increase in import levels at the time of sanctions also disappears once we adopt a logarithmic specification (panels 2 and 3, column 3). In fact, the point estimate on the levels coefficient turns negative (albeit insignificant). The trend coefficient, in contrast, remains strongly positive, indicating an increase in the rate of growth of food imports.

Figure 3 considers this result in greater detail. Note that medicines imports were declining at a rate of 9 log points per month, or the equivalent of a 66% decline per year, before the 2017 sanctions. Since this decline was strongly statistically significant (t=12.6), just a stabilization of imports at very low levels would be enough to result in a statistically significant break in trend. That is what the data shows happened. In the post-sanctions sample, the trend coefficient is not significantly different from zero (t=1.3). In other words, the change in trend result essentially captures the fact that medicines imports stabilized at very low levels. The positive – though insignificant - post-sanctions slope coefficient appears to be mostly driven by observations from the last months of 2019, when the economy had begun to experience some recovery in oil output, rather than anything that happened in the vicinity of the imposition of the 2017 financial sanctions.[13]

Figure 3: Trend interruption estimates, medicine imports (logs)

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[13] Venezuela's oil output hit a low of 644 tbd in September of 2019 and rose by 14% in the last three months of 2019, which also correspond to the last three months of the Equipo Anova sample and the highest post-sanctions levels of medicines imports.
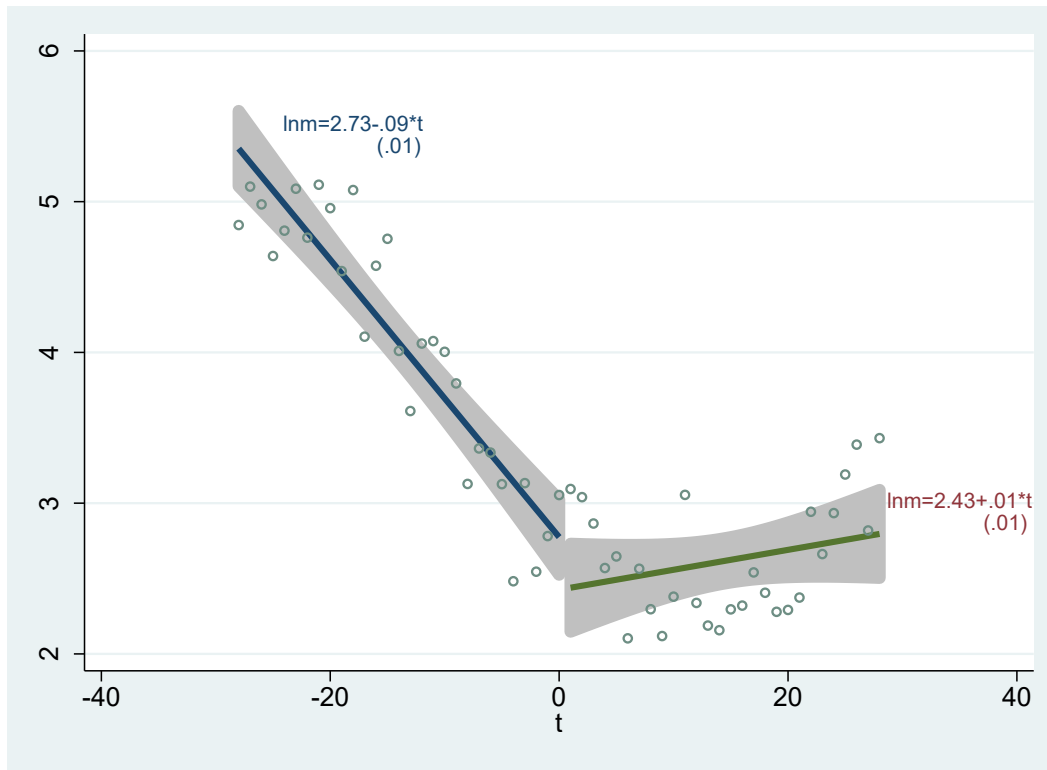
Sources: UN Comtrade, own calculations

Here it makes sense to think again in terms of implicit counterfactuals. Had medicines imports continued to decline at the pre-intervention rate of 9 log points per month after August of 2017, they would have fallen from $21 million per month at the time of sanctions (and $123 million per month two years before sanctions) to $1.5 million per month at the end of the sample in December 2019. While the logarithmic specification ensures that the projection of medicines imports at the end of the sample is greater than zero and thus mathematically feasible, that does not mean that it captures a realistic counterfactual of what would have happened to medicines imports in the absence of sanctions. Put differently, what the Equipo Anova estimate for medicines tells us is simply that medicines imports did not continue shrinking at a rate of two-thirds per year. It in no way establishes that it is reasonable to think of a sustained rate of decline to near-zero import levels as a reasonable counterfactual scenario in the absence of sanctions.

An extensive empirical literature shows that medicines demand is income inelastic, implying that the share of income devoted to medicines purchases increases as incomes drop (Danzon et al., 2015, Ringel et al., 2005; Farag et al., 2012).[14] Therefore, a country that suffers a sustained decline in incomes like that of Venezuela should see a relative stabilization of medicines demand with the decline in imports, even in the absence of changes in public policies. In other words, even the logarithmic specification may be insufficient to capture nonlinearities in the counterfactual expected path of the

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[14] Generally, most values in the literature tend to be between 0.6 and 0.9. See Fan and Savedoff, 2012; Gerdtham and Jönsson 2000; Baltagi and Moscone 2010; Xu et al. 2011; Lépine, 2014; Tangtipongkul, 2016; Jeetoo and Jaunky, 2022; Dubey, 2020; Magsi et al, 2021.

economy in the presence of income-inelastic demand for medicines.[15] Furthermore, the sole existence of economic and political elites with access to sources of foreign exchange suggests that they will always find a way to ensure their access to basic medicines, implying that we should expect medicines import demand to be bounded above zero.

To a certain extent, it is precisely the concern with the sensitivity to functional form of trend break specifications that has led to the development of an extensive literature in RDD approaches. While reiterating our prior caveats on the application of RDD designs to low-frequency data and in the absence of information on covariates to assess validity, it is instructive to consider the results of applying a more conventional RDD framework instead of the linear trend break specification to this data. We show these results in Table 4, where we test for the existence of breaks in trend with a more appropriate RDD design that uses local polynomial estimators with robust bias-corrected intervals, a triangular kernel and a mean-squared error optimal bandwidth selector as suggested by Calonico et al. (2017, 2020). In order to appropriately select the bandwidths, we use data from January 2012 to December 2020. We note that the optimal bandwidths selected by this method range from 8.5 to 12.9 months, well below the 28 months selected by Equipo Anova (2021).

Table 4: Regression Discontinuity Design Estimates

		ANOVA food imports (excluding cereals and oils)	Food imports (including cereals and oils)	Medicine imports
Regression Discontinuity, Logarithms	Change in level	-0.14 (0.39)	-0.75 (0.58)	0.68*** (0.18)
	Change in slope	-0.55* (0.32)	-0.82* (0.45)	-0.23* (0.16)

We find no evidence of an improvement in food and medicine imports in the RDD estimates associated with the imposition of financial sanctions. Regarding food imports, both the level and the slope of the trend *decline* around the time of sanctions, with the change in slope being borderline significant regardless of whether we include cereals and oils. Thus, if anything the data points in the direction of suggesting that a *deterioration* in availability of food imports occurred at the time of sanctions. In the case of medicine imports, the level and slope coefficient estimates point in different directions, with the point estimates indicating a strongly significant increase in the level of imports at the time of sanctions and a borderline significant decline in the slope of the trend. This suggests that there may have been a short-lived rise in medicines imports at the time of sanctions (possibly driven by rising oil prices in the fourth quarter of 2017). The magnitude of this increase is around three times the change in slope, suggesting that any improvement in medicines import levels was offset in less than four months by the increased rate of decline over time.

It may seem hard to reconcile the medicines RDD results (which find an increase in levels yet no change in trends) with those from the trend break specification (which find a stabilization in trend but no significant change in levels). Yet a close look at the data in Figure 3 shows that they are in fact

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[15] The issue is not just one of functional form, but rather of the incompleteness of the univariate framework to adequately assess the effect of an intervention such as sanctions when many other relevant covariates are changing strongly. A more adequate framework for assessing this question could be to ask the extent to which medicines purchases deviated from those that would have been expected given the country's economic contraction and existing income elasticity estimates. Exploring this and other alternative frameworks is a possible direction for future research.

compatible. The RDD result weighs heavily observations at the time of the 2017 financial sanctions, and we can see that these did in fact increase for a few months after the sanctions, but then declined steeply, only to begin to rise again at the end of 2019. In contrast, the trend break estimator in equation (1) finds no statistically significant trend in the post-sanctions data precisely because it is influenced both by observations near the cutpoint (which indicate a decline) as well as those far from it (which show some recovery).

4. Comments on replication

As noted previously, Equipo Anova has not made replication data or files available for their study, nor did they reply to our e-mail requests for these. While their data is constructed from a public United Nations Trade Statistics Comtrade site, the data in that site changes over time as participant countries update their statistics. This makes it impossible to reproduce the exact data set used by the Equipo Anova team.

We approach this problem by attempting to replicate as closely as possible the Comtrade data available at time of writing of the Equipo Anova study to reconstruct their series. Although Comtrade does not maintain a version of their data set at different moments in the past, they do publish the date and time of submission of each country-level observation and its updates. Using this information, we constructed a proxy of the data available at the time of writing of the Equipo Anova report by deleting observations for which no data had been submitted by the partner country at that time. Note that in doing so we kept observations for which the trading partner had submitted some data at the time, even if that data was subsequently updated (we can only observe the updated data). The logic of this is that we consider the updated observation (which is available to us) a better proxy than zero for the observation available at time of their writing (which is not available to us.) Zero is, of course, the value that would be implicitly attributed to the observation were we to omit it from our aggregate estimate. Since we do not know with precision the time at which Equipo Anova downloaded the data used in their report (published in January of 2021), we experimented with several dates in 4Q20 and chose October 1, 2020 as the estimated download time given that it made our estimated series closest to the one shown in their paper. This calculation was done with the Comtrade data available as of August 2022.

Ideally, we would want to compare our reconstructed series with the Equipo Anova data to see how closely we have replicated their findings. While we do not have the Equipo Anova series, we do have the scatter plots of the variables against time and the regression coefficient estimates published in their paper. We thus used Plot Digitizer, a data extraction tool that converts visual graphs to numerical series, to infer their data from their published figures. The extracted data replicates the coefficient estimates reported by Equipo Anova in their tables to a precision of less than one decimal point. The reconstructed and the extracted series have correlation coefficients of .9998 for food and .9993 for medicines, while the point estimates, standard errors and pre and post-sanctions average levels are nearly identical (Table 5). We reach the conclusion that Equipo Anova excluded commodity categories 10-19 from their food imports series based on observing that only the reconstructed series

excluding these categories matches both their published results and the data extracted from their images.[16]

Table 5: Comparison of results from Equipo Anova scatter plots and Comtrade replication.

		Data extracted from Equipo Anova scatter plots	Data replicated with Comtrade data
Equipo Anova food imports (excluding cereals and oils)	Change in level	44.26***	44.86***
		(13.68)	(13.82)
	Change in slope	6.48***	6.46***
		(1.09)	(1.09)
	Average level	66.29	66.37
	Pre-sanctions	104.94	104.60
	Post-sanctions	28.98	29.47
	Correlation	0.9998	
Medicine imports	Change in level	21.47***	19.6***
		(5.76)	(5.70)
	Change in slope	5.79***	5.47***
		(0.52)	(0.49)
	Average level	44.96	44.98
	Pre-sanctions	80.84	80.43
	Post-sanctions	10.32	10.75
	Correlation	0.9992	

5. Concluding remarks

In contrast to the claims of Equipo Anova (2021), we find no evidence of the improvement in imports of food and medicines at the time at which the U.S. imposed financial sanctions on Venezuela in August 2017. Instead, we find their results to be a consequence of data coding errors and questionable methodological choices. Their research design uses an unreasonable functional form that implies a counterfactual of negative imports in the absence of sanctions and omits data accounting for four-fifths of the country's food imports at the time of sanctions. Once these errors are corrected, any evidence of an improvement in the level or rate of change in food imports disappears. While we do find that medicines imports stabilized at very low levels after sanctions, the most reasonable explanation for this result appears to be that it is a consequence of the low income elasticity of medicines demand. Correct application of the regression discontinuity design methods which Equipo Anova (2021) claim incorrectly to have used delivers no evidence of a consistent improvement in imports of essentials, with most of the point estimates being of the opposite sign to that claimed by Equipo Anova. Neither close inspection of the corrected data nor a battery of statistical tests shows evidence of any sustained significant improvement in food or medicines imports following the 2017 financial sanctions.

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[16] As shown in Table 5, the food series extracted from the figures published by Equipo Anova (2021) has a .9998 correlation and an average value that is nearly identical to that of the reconstructed series generated excluding categories 10-19. In contrast, it has a .8841 correlation and an average value that is one-third of the average level of the reconstructed series generated including categories 10-19.

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