Impact of GST on inflation: Evidence from causal analysis

Anoop S Kumar and Santosh Kumar Dash

Abstract[1]

This paper studies the impact of GST implementation on India's price levels by employing a Bayesian causal inference model. We make use of monthly CPI and WPI data as the proxy for inflation and utilize control variables such as exchange rate, repo rate, and energy price. We use monthly data spanning from January 2011 to January 2021 for the analysis. We find that GST positively impacts headline CPI inflation and the price levels of Pan, Tobacco and Intoxicants, Clothing and Footwear, Housing, and Miscellaneous commodity groups while having a negative impact on the Non-exempted Food & Beverages price index. For WPI, we find GST to positively impact headline WPI, manufacturing WPI, and non-exempted WPI. To check the robustness of our results, we employed an in-time placebo falsification test where we changed the GST implementation date to May-2016. We find that the model did not report any spurious impact for Pan, Tobacco and Intoxicants, Clothing and Footwear, Housing, and Miscellaneous. Overall, our results suggest that GST positively affects non-food items while negatively affecting food items. We conclude that the market structure is one potential reason behind the differential price impact of GST. That is, the existing market power determines whether the benefits of GST are passed down to the consumers. This calls for the proactive role of the National Anti-profiteering Authority.

Key words: Goods and Service Tax, Causal impact, Inflation, Bayesian structural time-series models, Causality.

[1] We profoundly thank Prof. T M Thomas Isaac who motivated us to take up this issue for research and for his insightful comments. We like to express our sincere gratitude to the Director, Prof. K J Joseph for his insightful comments which helped us build arguments central to explain the link between GST and inflation. His comments and suggestions immensely helped in preparing this paper. Thanks are due to Prof. D Narayana and Prof. K N Harilal for very detailed critical comments on the earlier version of the paper. Thanks are due to our colleagues at GIFT for their helpful suggestions and feedback. We thank all the panelists and participants of the International Seminar on India's Experience with GST organized by GIFT for their comments. We thank Dr Steven Raj Padakandla for generously providing firm level data. Finally, we are grateful to anonymous referees whose detailed critical comments vastly improved the arguments and inferences. Needless to mention, we owe the errors if there is any.

1. Introduction

Before the introduction of GST, India had a heterogeneous indirect tax structure where both the Union and states used to levy taxes under different tax laws. The erstwhile indirect tax system was characterized by multiplicity and cascading of taxes, besides technical complexities and other issues. The GST was designed to alleviate some of those problems. A significant reform like GST will have economy-wide impacts such as better compliance, tax buoyancy, higher tax revenue collection, welfare, exports, growth, and inflation.

In principle, GST implementation should not have any effect on prices. The revenue-neutral rate (RNR) is calculated in such a way that it should not feed into higher inflation. However, revenue neutrality does not guarantee that the overall economy-wide price effect would be negligible. This is because the weights of commodities in the consumption basket are different from their contribution to indirect tax collections (Government of India (2015). Importantly, the impact of GST on the prices of particular goods and services depends on the structure and design of taxation, such as the degree of exemptions, the rate structure of GST, the weight of goods and services in the CPI basket, the tax base, and efficiency of the administrative machinery, and so on. In the CPI basket, categories like food and beverages (weight of 46% in the CPI index), rent and clothing have large weights that are either exempted or taxed at low rates. However, items not exempted are taxed at a lower rate. Reserve Bank of India (2017) estimates that around 50% of item groups covered in CPI are out of the CPI basket. For the rest of the basket, headline inflation may rise by mere 10 basis points. Further, a survey of 18 FMCG and consumer durables revealed that GST increased prices by 0.8%. Therefore, the impact of GST on price levels was expected to be minimal.

Hence, whether GST will have no effect or effect is conditional upon how various factors interact with each other. GST implementation could have differential effects on the price of goods and services depending on the rate category they belong to. Thus, it shall increase the prices of some goods while decreasing the price of some goods. Analytically, how much price will rise depends on factors such as 1) tax rate structure: how tax rates differ from VAT rates, 2) whether the GST is revenue neutral, and 3) the price behaviour of products excluded from GST, among many other factors. In effect, whether prices will rise after GST implementations depends on how those factors play out.

As the analysis of the Subramanian Committee submitted to the Government of India estimates, an RNR in the 15-15.5 percent range with a merit rate of 12 percent and a standard rate of 18 percent is expected to have minimal impact on inflation (Government of India (2015). Similarly, NCAER (2009) estimates that the overall impact on consumer price inflation is likely to be moderate if the standard GST rate is 18 per cent. Further, it argues that overall price levels may go down due to a more efficient allocation of factors of production.

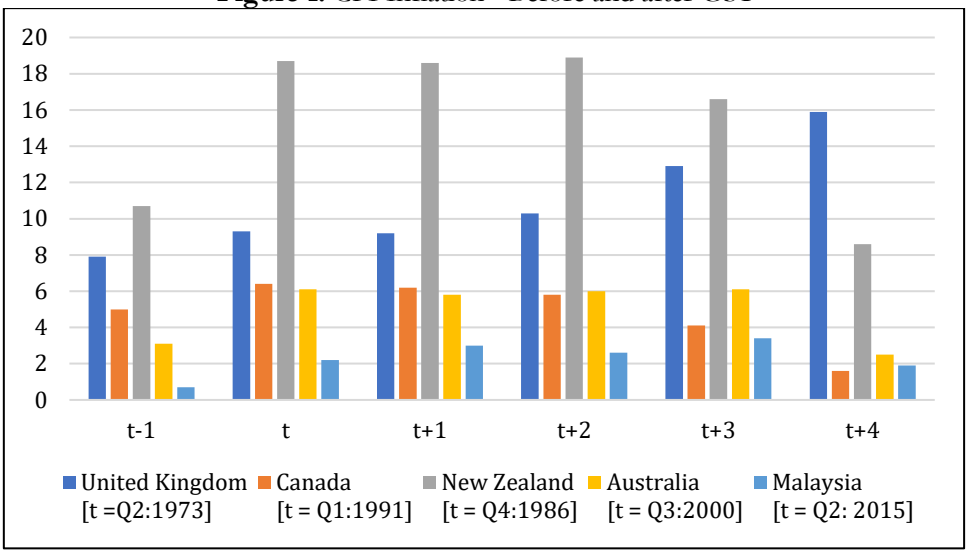
Despite more than four years of implementation of GST, a systematic study investigating the impact of GST on prices or inflation hardly exists. This paper attempts to fill this gap in the literature and contribute to the literature in understanding how large is the impact of GST on prices. In particular, this paper seeks to quantify the impact of GST on price levels.

While implementing the GST, it was claimed that GST would bring down price levels as it harmonizes various indirect tax rates and removes the effect of double taxation. However, this claim has not been agreed upon universally. A study by the Australian Competition and Consumer Commission. (2003) provides evidence that GST initially increases inflation. International experience suggests that there was a steep increase in prices in countries Australia, New Zealand, and Canada after the GST implementation. Inflation remained elevated for a year, and inflation declined, indicating the low persistence of GST-induced inflation (See Figure 1).

However, contrasting evidence shows that GST has not substantially affected inflation (Valadkhani, A. (2005).). He investigated the magnitude and duration of the GST effect on the quarterly growth rate of the eleven groups of the consumer price index (CPI) in Australia. In the case of India, we do not have any substantial evidence that GST increases inflation. He found prices did not increase significantly before or after the introduction of GST beyond what could have been expected. Benedek, *M.* D., De Mooij, R. A.,

& Wingender, M. P. (2015) analyzed the pass-through of monthly VAT changes to monthly consumer prices for 17 Eurozone countries from 1999 to 2013. They find, on average, that pass-through was much less than complete and differs markedly across types of VAT change.

Figure 1: CPI Inflation - Before and after GST



Source: Reserve Bank of India, Monetary Policy Report, October 2016.

Morris*, S.,* Pandey, A., Agarwalla, S. K., & Agarwalla, A. (2017) did an ex-ante analysis of the impact of GST on the Consumer Price Index in India, where they showed that it would be very marginal at best. Using the NSS data, they construct an index to measure the percentage change in tax incidence that GST may bring in CPI. Their results suggest a moderate impact on prices due to the implementation of GST. The sole study after GST implementation by Das, D. (2019) shows that there is no significant effect of GST on price levels at the subnational level. Here, the author analyzed the impact of GST implementation on the general price levels using the difference-in-differences (DID) estimation technique. However, we feel that this result needs to be re-examined due to multiple reasons. First, DID is essentially a static regression model, assuming independent and identically distributed data even though there is a temporal element. Primarily, it considers only two-time points, i.e., before and after the intervention. In practice, we need to consider the manner in which an effect evolves over time, especially its onset and decay structure. Second, they have carried out an analysis of general price levels. In the case of India, food and fuel items occupy a significant space in the consumption bracket. Fuel is excluded from GST, and it is the same for the majority of food items. Hence, employing the general price levels may not yield correct information. Third, the analysis stops at 2018, showing a lack of data in the post-intervention period. Finally, the model did not include other factors that could have an impact of GST on the price level. To form an informed decision, one must quantify the impact of the intervention, that is, the GST, while controlling for other factors that could potentially influence price levels.

Here, we propose to address these issues by employing a Bayesian causal inference method. Using the methods of causal inference, we analyze the impact of GST on price levels. We employ the *Causal Impact* methodology developed by Brodersen*, K.* H., Gallusser, F., Koehler, J., Remy, N., & Scott, S. L. (2015) that employs Bayesian structural time series models to estimate the impact of an intervention on the variable of interest. Here, the model provides counterfactual estimates of the variable using the prior information generated. The causal impact is calculated as the difference between the actual and the counterfactual. In this paper, we estimate the impact of GST on price levels (proxied by CPI and WPI) while controlling for other influencing factors such as exchange rate, energy prices, and interest rate. First, we estimate the impact of GST with the actual intervention date. Later, we estimate the same with an arbitrary intervention date to test the robustness of the results. Our paper adds to the literature as the first comprehensive study in the Indian context that quantifies the impact of GST on inflation.

The remainder of our paper is structured as follows. Section 2 presents the empirical strategy, variable construction, and data sources. We present the empirical results in Section 3, followed by robustness test results and a discussion of results in Section 4. In section 5, we present the concluding remarks.

2. Methodology and data

2.1 Empirical Strategy

Quantifying the impact of GST on prices is a tricky task. We utilize the recently developed causal interference analysis by Brodersen*, K.* H., Gallusser, F., Koehler, J., Remy, N., & Scott, S. L. (2015) to empirically estimate the size of the price effect of GST. The Causal Impact method employs Bayesian structural time-series (BSTS) models to explain the temporal evolution of an observed outcome. Here, the model predicts a counterfactual trend in a synthetic control that would have occurred in a virtual scenario with no intervention. This methodology is very much similar to the synthetic control method of Abadie, A., & Gardeazabal, J. (2003) in capturing the true impact of an intervention. Both the methods employ the control variables to construct a counterfactual of the treated variable to give us an idea of what the trend would be if the treatment had not happened. Using this approach, we can quantify the impact and statistical significance of a particular event (GST implementation) on our variable of interest, namely the CPI or WPI inflation.

BSTS are state-space models defined explicitly by two equations, namely, the observation equation and the state equation. The observation equation is defined as follows:

$$Y_t = Z_t^T \alpha_t + \epsilon_t \qquad (1)$$

Here, Y_t is a scalar observation, Z_t is the *d*-dimensional vector and $\epsilon_t \sim (0, \sigma_t^2)$ is a scalar observation error with zero mean and variance of σ_t^2. The observation equation connects the observed data Y_t to a latent *d*-dimensional state vector α_t.

The state equation is formulated as:

$$\alpha_{t+1} = T_t \alpha_t + R_t \eta_t \quad (2)$$

where T_t is a $d \times d$ transition matrix, R is a $d \times q$ control matrix, η_t is a q-dimensional systems error with a $q \times q$ state diffusion matrix Q_t such that $\eta_t \sim (0, Q_t)$.

This second equation specifically governs the change of the state vector α_t through time. The working of the model comprises three steps. First, the model simulates draws (posterior samples) of the model parameters θ and the state vector α using the observed data in the training period. Second, the model employs posterior simulations to simulate the probabilities $p(\tilde{Y}_{n+1:T} | Y_{1:n})$, which is the posterior predictive distribution, with $\tilde{Y}_{n+1:t}$ as the counterfactual time series and $Y_{1:n}$ as the observed time series before the intervention. Finally, the model computes the posterior distribution of the point-wise impact $Y_t - \widetilde{Y_t}$ for each time unit *t* using posterior predictive samples.

The Causal Impact uses the full pre-and post-treatment time series of predictor variables for matching. In the case of *Causal Impact*, we assume that there is a set control time series that were *themselves not affected by the intervention but nevertheless acts as a predictor of the treatment variable.* Suppose these control variables were affected by the intervention. In that case, we might falsely under- or overestimate the true effect or falsely conclude that there was an effect even though, in reality, there was not. Further, the model also assumes that the relationship between covariates and treated time series remains stable throughout the pre- and post-period intervention.

2.2. Data

Response variable

Data on two major price indices are available, namely CPI (Consumer Price Index) and WPI (Wholesale Price Index). To study how GST has affected inflation, we choose CPI as the primary price variable of

interest. CPI measures change over time in the general level of prices of goods and services that households purchase. It is widely used as a macroeconomic indicator of inflation, as a tool by governments and central banks for inflation targeting and monitoring price stability, and as deflators in the national accounts. Importantly, to measure the impact of GST on prices, CPI is the most appropriate since it includes taxes that final consumers pay. Further, CPI is also used for indexing dearness allowance to employees for increases in prices. We have chosen this as the primary measure of inflation for these reasons.

The Central Statistical Office[2] (CSO), Ministry of Statistics and Programme Implementation (MoSPI), has introduced the All-India Consumer Price Index (CPI) in January 2011 on base year 2012=100. It releases data on CPI for Rural (R), Urban (U), and Combined (C). The CSO has revised the Base Year of the CPI from 2010=100 to 2012=100 with effect from January 2015. We have considered monthly CPI inflation data in our model[3]. CPI groups and weights are given in Appendix - I. This study has considered the CPI (Combined) (*henceforth* CPI-C) measure of price indices. The monthly CPI data is collected from 1114 markets in 310 selected towns by the National Sample Survey Office (NSSO), Directorates of Economics and Statistics of States, and 1181 selected villages by the Department of Posts.

We have spliced the two series together to get CPI indices with the reference period 2012=100. The data spans from January 2011 to December 2020. This implies the price inflation data is available from January 2012 to January 2021. For estimating the causal effect, although the Causal Impact method requires a longer time period to train the model (*pre-intervention period*), the new CPI series data do not permit us since data is available from January 2011.

While studying the impact of GST on headline price indices like the CPI captures the overall economy-wide effect of GST, it does not reflect how prices have responded at a disaggregated level, say, commodity-groups or individual commodity level. Thus, we construct the following nine price series from CPI-Combined data to explore how GST has affected the price level or inflation across various commodity groups. First, we consider commodity-group level price indexes. These indices are Consumer Food Price Index (Food)[4], Food and beverages (F&B), Pan, tobacco and intoxicants, Clothing and footwear, Housing, Fuel and light, Miscellaneous, and headline price index (CPI). Second, we constructed two derived price indices using the weights information provided in Appendix - I. The non-exempted food and beverages price index (Non-exempted F&B) is constructed using items listed under the food and beverages group. They are Pulses and products, Spices, Non-alcoholic beverages, Prepared meals, snacks, sweets, etc.

Besides CPI, we also examine the causal impact of GST implementation on Wholesale Price Index (WPI) inflation. WPI is a producer price index, capturing the cost of producing a good or service without taxes. Thus, by design, it will not reflect the true effect of GST since WPI is not the price that end-consumers pay. However, pursuing this exercise has its merits since it will show how the producer prices have responded to a new tax regime, e.g., GST. If WPI has increased after GST implementation, the firms might pass on the rising prices to consumers. So, this will lead to higher consumer prices since the latter includes taxes.

Although commodity-level monthly wholesale price information is available at the all-India level, we focus on select price indices. There are namely, All Commodities (the headline WPI), Non-Food Articles, Fuel & Power, and Manufactured Products. Since Fuel and Power are kept out of the GST net, it is not considered in this study. Similarly, Primary Articles comprise food articles and non-food articles. Food Articles are not considered since these goods are exempted from tax. Since we use Non-Food Articles, examining Primary Articles is not required. Hence, we have used four indices: headline WPI, Non-Food Articles, Manufacturing Products, and Non-exempted WPI. While the first three price indexes are directly

[2] CSO has been rechristened as National Statistical Office (NSO).

[3] This is computed as: $g = \frac{Y_t - Y_{\{t-12\}}}{Y_{\{t-12\}}} * 100$.

[4] The components of this index include all components of Food and beverages price index except Non-alcoholic beverages, and Prepared meals, snacks, sweets etc. commodity groups. See Appendix - I.

taken from the data, Non-exempted WPI is constructed using Non-Food Articles and Manufacturing Products price indices. WPI data is collected from the Office of the Economic Advisor, Ministry of Commerce and Industry. WPI base year 2004-05 is converted to 2011-12 base year.

Predictor variables

The model assumes that predictors are not affected by the intervention (GST implementation). Keeping this in mind, we have chosen covariates such as exchange rate, energy price, and interest rate. An exchange rate depreciation affects the prices of imported commodities and intermediate goods in the first stage. Later, supply and demand dynamics affect the prices of domestically produced goods. This phenomenon is called exchange rate pass-through. A great deal of literature confirms the presence of exchange rate pass-through in India (Ghosh, A., & Rajan, R. S. (2007); Khundrakpam, J. K. (2007); Bhattacharya*, R.,* Patnaik, I., & Shah, A. (2008); Yanamandra, V. (2015); Forbes*, K.,* Hjortsoe, I., & Nenova, T. (2017); Bhat, J. A., & Bhat, S. A. (2021)). In the case of interest rates, RBI employs interest rates to maintain stable price levels (Mohanty, D. (2012, May); Ajmair, M. (2015); Mohan, R., & Ray, P. (2019)). The fluctuations in the crude oil prices are found to impact price levels as the increasing fuel prices would result in increased transportation costs that would ultimately result in increased price levels (Kilian, L., & Zhou, X. (2020); Rubene, I. (2018); Peterson, J. (2006); Thoresen, P. E. (1983)).

We have considered the INR/USD bilateral exchange rate, the repo rate as the measure of interest rate, and the energy price index as a proxy for fuel price. While these predictors influence inflation, it is reasonable to assume that the implementation of the GST in no way influences them. Interest rate and fuel price Data on repo rate and INR/USD exchange rate is taken from the Handbook of Statistics on Indian Economy (RBI). The energy price index is taken from World Bank Commodity Price Data (World Bank).

3. Estimation results

3.1 CPI inflation

We present the estimation results in Table 1. In the table, the column 'Actual' represents the average value of CPI growth in the *post-intervention period* (July 2017 - January 2021). In contrast, the column 'Predicted' indicates the average value of counterfactual CPI growth in the *post-intervention period.* The absolute difference between these two variables is reported in the 'Absolute effect' column. We have estimated the counterfactual inflation for all the groups and plotted them along with the actual inflation and point-wise casual impact. We present the plots in Appendix - II.

The results provide us with an interesting picture of the impact of GST on price levels. First, we look into the overall price index (CPI). During the post-intervention period, CPI inflation on average grew by 4.61%. However, in the absence of an intervention, we would have expected an average response of 3.24%. Subtracting this counterfactual prediction from the observed response yields an estimate of the causal effect of 1.37 percentage points (PPS *henceforth*) with a 95% interval of [0.30, 2.43]. This causal effect estimate is statistically significant 1% level of significance (see Figure A.1 in Appendix - II). This means that the positive effect observed during the intervention period is unlikely due to random fluctuations. Our finding that GST implementation leads to an increase in the CPI inflation rate aligns with international experience (Australian Competition and Consumer Commission. (2003); Palil, M. R., & Ibrahim, M. A. (2011)).

Table 1: The effect size of GST on CPI inflation

Dep. Variable	Actual (%)	Predicted (%)	Absolute effect (Percentage points)	95% CI	P-value
CPI	4.61	3.24	1.37***	[0.30, 2.43]	0.006
Food	4.47	3.60	0.86	[1.93, 3.45]	0.283
Food & Beverage (F&B)	4.17	4.41	0.24	[2.69, 2.15]	0.470
Pan, Tobacco, Intoxicants	6.71	5.99	0.72*	[0.19, 1.62]	0.055
Clothing & Footwear	3.34	2.61	0.72*	[-0.37,1.81]	0.093
Housing	5.41	3.43	1.99***	[0.79, 3.19]	0.001
Miscellaneous	5.16	3.02	2.14***	[1.49, 2.78]	0.000
Non-exempted F&B	2.84	7.25	-4.42***	[-5.48, -3.37]	0.000

Note: Dependent variables are price indexes; 95% CI is the 95% confidence interval; */**/***<10/5/1%.

Second, let us look into the Consumer Food Price Index (Food) inflation. Here, the actual food price growth in the GST period is 4.47%, whereas the counterfactual is 3.60%. That is, without the implementation of GST, the food inflation would have been 3.60%, indicating that, with the implementation of GST, food inflation increased by 0.86 PPS. However, this causal effect is statistically insignificant (see Figure A.2 in Appendix - II). This finding of insignificant effect is expected since most food goods are exempted from GST or taxed at 5%. Data compiled from the Central Board of Indirect Taxes and Customs (CBIC) indicates that the average tax rate of 18 food items has fallen from 5% in the Pre-GST regime to 3% in the GST regime[5].

Next, we consider the response of the food and beverage price group to GST. The implementation of GST did not have a significant positive impact on food and beverage price inflation. Since this group comprises mainly food goods with 39.06% weight in the 45.86% food and beverage group which are mainly exempted or mostly taxed at 5%, the implementation of GST did not lead to a significant increase in price during the intervention period. A note from the Central Board of Indirect Taxes and Customs (CBIC) indicates that Pre-GST tax rates for 26 items were 8% which declined to 6% post GST implementation (See Footnote 5).

Pan, Tobacco and Intoxicants (PTI) are considered demerit or sin goods under the GST and, therefore, attract the highest tax rate of 28%. In addition to GST, smokeless tobacco and cigarettes attract a compensation cess of 0.5%. Compared to the pre-GST regime, there is only a marginal increase of around 1 to 2 PPS for PTI products. The Causal Impact analysis suggests that post GST introduction, the prices of PTI goods have increased by 72 PPS, against the counterfactual prediction of 5.99% inflation. This causal effect estimate is positive and statistically significant at 10%. The increase in the price levels for this segment is in line with our expectations.

Analysis of the impact of GST on the price of Clothing and Footwear groups suggests that GST has had a positive and statistically significant effect of 72 PPS. In the absence of an intervention, we would have expected an average response of 2.61. But post-intervention period, it instead grew at 3.34%. This might be because natural fibres (cotton, wool) that were previously exempted from taxes are currently taxable under the GST regime (at 5%).

In the case of housing, Table 1 indicates that the implementation of GST led to a large, positive, and statistically significant effect of 1.99 PPS on price levels. This means that the positive effect observed during the intervention period is statistically significant and unlikely due to random fluctuations. Figure A.6 in Appendix - II depicts the counterfactual estimates and actual inflation. Analysis by PwC (2018) suggests that the effective GST rate for the sale of under-construction properties is 12% or 8% of the entire agreement value as compared to around 5.5% (i.e., 4.5% Service Tax and 1% VAT under the composition scheme with limited credits) under the VAT regime. They estimate that the overall tax burden of GST would rise to around 17%-13%. This, in turn, will lead to cost escalations for the final consumers. In addition to that, the housing sector is beset by multiple GST rates (5%, 12%, 18%, and

[5] GST-rate-changes-2809.pdf, https://www.cbic.gov.in/resources//htdocs-cbec/gst/GST-rate-changes-2809.pdf.

28%) on procurement of inputs and input services which adds complexity to the taxation system and leads to unnecessary classification disputes. It may be noted here that GST allows the benefit of input tax credit (ITC), which should ideally reduce the agreement value. However, our analysis suggests that despite the provisions for ITC, GST has resulted in higher housing prices. It may be that producers/builders are not passing the full benefit of ITC.

Prices of Miscellaneous groups, which mainly comprise various services, have seen a 2.14 PPS increase in prices post implementation of GST. During the post-intervention period, prices of miscellaneous products rose 5.16%. By contrast, we would have expected an average response of 3.02% in the absence of an intervention. Table 1 shows that the estimate of the causal effect due to the GST intervention is statistically significant at a 1% level of significance. Using CBIC-provided tax rate data (See Footnote 5), we find the average tax rate of 41 items to be 24%. With regard to services, while the taxes stood at 15% in the erstwhile tax regime, most of the services are taxed at 18% in the GST regime. Consequently, the cost of services such as the ones related to hotels and restaurants and communication has increased for the end consumers.

In the case of non-exempted food and beverages, implementation of GST is found to have a negative and significant impact of 4.42% on price levels. Recall that this price index is constructed using price indices of Pulses and products, Spices, Non-alcoholic beverages, and Prepared meals, snacks, sweets etc. This large deviation of counterfactual prediction from the observed inflation can be attributed to the following. The average inflation of non-exempted food and beverages during the training period was very high (8.4%). But starting from April 2017, prices of non-exempted food and beverages collapsed to -0.4% over the next two years. This fluctuation was mainly driven by the prices of Pulses and products, and Spices.

To summarise our results from the analysis of various CPI-based commodity price indices, the implementation of GST has resulted in a decrease in price levels of food items. In contrast, it has a significant impact on commodity groups such as headline CPI, Pan, Tobacco and Intoxicants, Clothing and Footwear, Housing, Miscellaneous, and Non-exempted F&B. On the other hand, commodity groups such as Food and Food & Beverage (F&B) did not experience any significant effect of GST in the post-intervention period.

3.2 WPI inflation

Next, we analyze the causal impact of GST implementation on various wholesale price indices. Table 2 reports the results of the causal estimates, and Figure A.9: presents the plots of counterfactual estimates and actual inflation. First, let us focus on the headline price index, namely, WPI. Post-GST implementation, the actual WPI growth is 2.37%, whereas the counterfactual prediction is -1.79%. That is, without the implementation of GST, the WPI inflation would have been -1.79%, indicating that, with the implementation of GST, WPI inflation increased by 4.16 PPS. This implies that GST intervention had a positive and statistically significant effect on WPI inflation. WPI inflation was growing at a negative rate of 0.3% for the last two years preceding GST implementation. The prices started rising in July 2017. This perhaps indicates that firms have increased prices post GST implementation.

Table 2: The effect size of GST on WPI inflation

Dependent Variable	Actual (%)	Predicted (%)	Absolute effect (Percentage points)	95% CI	P-value
WPI	2.4	-1.8	4.2***	[2.8, 5.5]	0.001
Non-Food Articles	1.7	2.9	-1.2	[-5.4, 1.3]	0.200
Manufacturing Products	2.1	-1.7	3.8***	[3.0, 4.7]	0.001
Non-exempted WPI	2.1	-1.2	3.3***	[2.4, 4.2]	0.001

Note: Same as Table 1.

Next, we consider the Non-Food Articles, which have 4.26% weight in the WPI basket. It is observed from Table 2 that the implementation of GST did not result in higher prices for Non-Food Articles. The counterfactual prediction for Non-Food Articles inflation is 2.9% against the observed 1.7%. Hence, the estimate of the causal effect of the intervention is found to be not significant.

Manufacturing inflation increased by 2.12% during the post-intervention period. By contrast, in the absence of an intervention, we would have expected an average response of -1.70. This yields an estimate of the causal effect of 3.83 PPS which is statistically significant. This implies that core inflation has increased post GST implementation, translating into higher headline inflation if it persists. This is evident from a 4.2 PPS rise in WPI inflation since July 2017.

Finally, we construct a Non-exempted WPI that combines Non-Food Articles and Manufacturing Products indices. We find it increased by 3.3 PPS in the post GST period. The probability of obtaining this effect by chance is minimal, implying that the causal effect can be considered statistically significant.

4. Robustness tests and discussion

Was the estimated impact of GST on inflation spurious? How much confidence do we have in the estimated impact size and direction? In other words, how much of the estimated impact size can be attributed to the implementation of GST? Are the findings robust, or is it sensitive to the date of GST implementation? Did the causal analysis truly capture the impact of GST on inflation?

Preliminary investigation indicates that the results cannot be attributed to chance factors. That is to say; the causal analysis correctly captured the true impact (direction and impact size) of GST on inflation. A look at the charts (shown in Appendix - II) indicates that the counterfactual inflation estimated before the intervention period moved in tandem with actual inflation. In the plots, the top panel depicts actual (black line) and counterfactual inflation (dotted line). The bottom panel depicts the point-wise causal impact, defined as the difference between the actual and the counterfactual series.

The plots show that counterfactual inflation can track the actual inflation in terms of direction and size. In particular, it is observed that while actual and counterfactual inflation moves together in the same direction, there is a wedge between the two for WPI price indices such as CPI-Combined inflation, Food inflation, and Food and Beverage inflation in the early period.

4.1. Falsification test

In causal inference, the preliminary investigation by looking at the counterfactuals can be often misleading. The control variables might not eliminate potential confounders, which may contaminate the estimate of causal impact. Thus, it is important to test that the associations identified are true rather than spurious. Falsification methods are appropriate in this context as they may provide an intuitive and additional safeguard when the objective is to assess the true impact of GST implementation on inflation. A falsification hypothesis is a claim that is distinct from the one being tested that, we believe, is highly unlikely to be causally related to the intervention in question (Prasad, V., & Jena, A. B. (2013). Researchers often conduct falsification tests to provide stronger and more robust evidence that their research design is valid and that their conclusions are sound. For instance, a falsification hypothesis may be that GST implementation has affected the price of products (i.e., inflation). If we fail to reject the false hypothesis using the falsification test, it would suggest that an association between GST implementation and product price inflation initially suspected to be causal is perhaps confounded by unobserved factors. However, if this false hypothesis is rejected, it can lend support to the main study hypothesis of interest. Thus, through a falsification test, we seek to positively demonstrate that the data is consistent with the identification assumptions or theory.

However, Prasad, V., & Jena, A. B. (2013) warn that falsification analysis is not a perfect tool for validating the associations in observational studies. They argue that neither the absence of implausible falsification hypotheses implies that the primary association of interest is causal, nor does the presence of it guarantee that real relations do not exist. They opined that if a false relationship among the variables is present, the study findings should be interpreted with caution and taken with a pinch of salt.

There are many ways to conduct falsification tests. Among them, a placebo test is an often-implemented tool when one needs to evaluate the true impact of an intervention (Abadie, *A.,* Diamond, A., & Hainmueller, J. (2015)). Here, we build alternative models of inference to see the extent of intervention. The alternative models are constructed based on the assumption that the robustness of the results obtained is questionable if we estimate effects that are similar or greater in magnitude in the situation

where the intervention did not occur. The objective of this study is to quantify the impact of GST on inflation. The results obtained will be questionable if our model estimates similar effects when we change the intervention date to a different point. This method is called an in-time placebo, where the intervention points are shifted. To test our claims, we apply the in-time placebo test.

In our setting, let us assume that the GST was implemented before the actual implementation in July 2017. If this false hypothesis can be shown not to exist, it will lend credence to this study's argument that price change in either way can be attributed to the implementation of GST. The causal analysis should find a statistically insignificant effect on inflation since the GST was implemented in July 2017, not before it. In other words, we would expect not to find a significant effect of this imaginary intervention, i.e., counterfactual estimates and actual data should more or less match each other. To administer this test, we assume that GST was implemented in May 2017. In other words, we reassign the intervention period to May 2017. Then, data from January 2012 to April-2017 should be used to train the model (pre-intervention period), and data from May 2017 is used to estimate the counterfactual prediction (post-intervention period). The cut-off date for this falsification test is chosen closer to the intervention time period for two reasons. First is the data constraint. The Bayesian structural time-series model approach to causal inference needs a sufficiently long period for training the data. Since the time period for this study is from January 2012 to January 2021, and the pre-intervention period (pre-GST period) is from January 2012 to April 2017, we did not choose an earlier cut-off period for the falsification test. Second, we believe that choosing a date closer to the intervention period will best capture the effect of GST on inflation if there is any.

Table 3: Results of the falsification test - CPI inflation

Dependent Variable	Actual	Predicted	Absolute effect	95% CI	p-value
CPI	1.46	3.00	-1.54	[-4.28, 1.18]	0.130
Food	-2.12	2.68	-4.8**	[-10.57, 0.70]	0.045
Food & Beverage (F&B)	-1.10	3.49	-4.59**	[-9.67, 0.56]	0.041
Pan, Tobacco, Intoxicants	5.70	6.21	-0.51	[-2.91, 1.79]	0.326
Clothing & footwear	4.17	3.48	0.69	[-2.06, 3.41]	0.311
Housing	4.70	3.31	1.39	[-1.80, 4.48]	0.186
Miscellaneous	3.29	3.05	0.24	[-1.40, 1.91]	0.186
Non-exempted F&B	2.84	7.25	-4.41	[-5.48, -3.37]	0.384

Note: All dependent variables are price indexes; 95% CI is the 95% confidence interval.

For models in which the dependent variables are CPI-Food and Food & Beverage (F&B), the causal analysis cannot reject the falsification hypothesis that an imaginary GST intervention, implemented in May 2017, which is before the actual GST implementation, affected inflation. The causal impact model could not predict the data well following this imaginary intervention for these price indices. This may *prima facie* reflect the presence of confounders or unobservable factors which have polluted the impact estimate of GST on inflation. Thus, it may suggest that the associations identified are spurious rather than true correlations. However, we argue that this may not be true for the following reason. Food prices (CPI-Food) fell severely starting from November 2016, and they became zero by April 2017. Note that this piece fall has nothing to do with GST implementation. Before November 2016, the average CPI-Food inflation was 8%. As a result, the model could not predict the inflation for June 2017. Since price indices like Non-exempted F&B are derived indices by subtracting food components, this might have contributed to the mismatch between the counterfactual estimate and actual inflation. As a result, the model overestimated the impact, and since the observed data was nowhere close to it, a significant effect of imaginary GST intervention in May 2016 on inflation of those price indices is observed.

On the other hand, with price indices that are not directly related to the movement of food prices, the model can predict closely the inflation post the imaginary GST intervention in May 2016. For price indices such as CPI, Pan, Tobacco, Intoxicants, Clothing & footwear, Housing, Miscellaneous, and Non-exempted F&B, the causal impact model is able to predict the data well. As expected, the results suggest an absence of any significant effect, implying counterfactual estimates and actual data concur reasonably

closely. This validates our argument that fluctuation in food prices can potentially explain the statistically significant false effect observed for food-related commodity groups.

4.2. Discussion

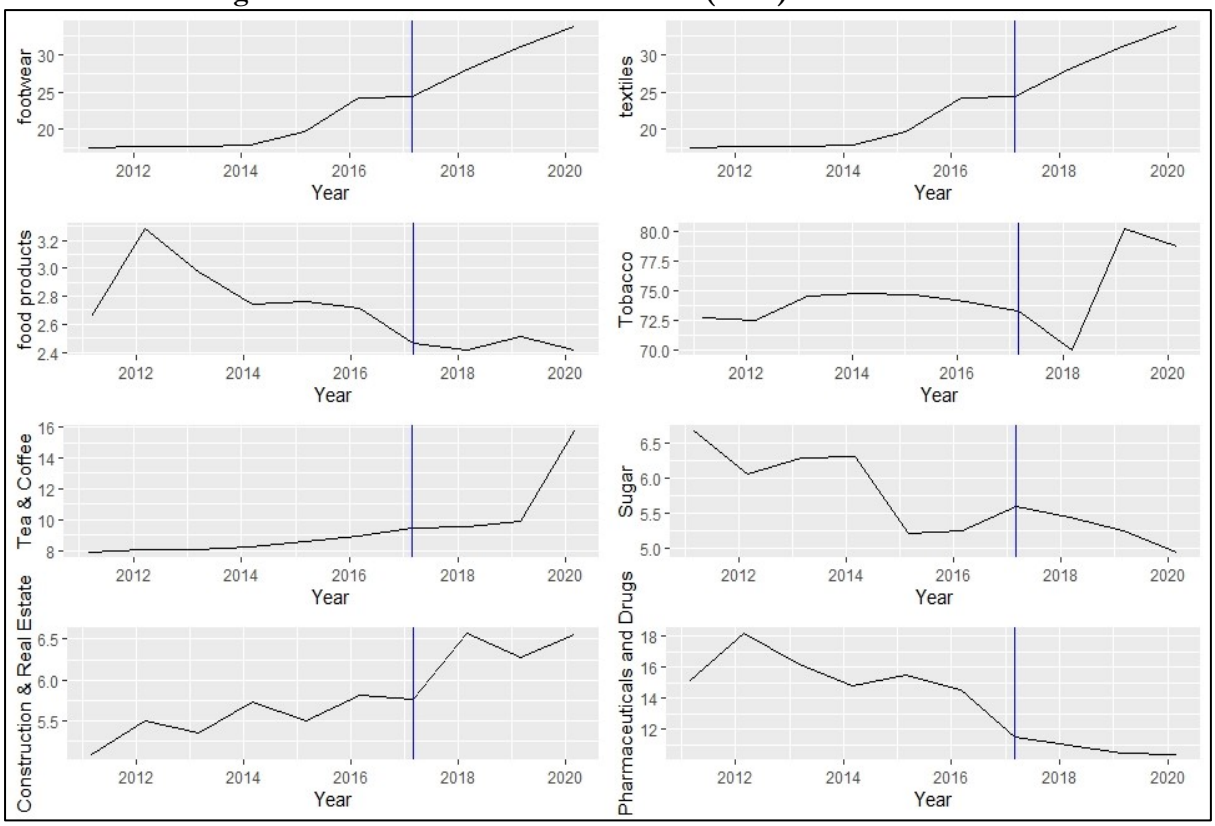
We have seen that the implementation of GST has significantly affected the price levels for various segments. At the outset, this is against the proposed objectives of GST. It was assumed that GST would take care of the cascading effects, and the resultant benefits accrued to the firms should be transferred to the consumers in terms of price reduction. We see this happening for food items. However, we do not observe the same for other segments. This prompts us to explore this issue in some detail by looking at those particular market structures to see whether it has an impact on price formation.

Recall that in a perfectly competitive market, the firms are the price takers and the products are homogenous to a degree. Any potential benefits from any new reforms such as GST shall be passed down to the consumers as a single firm cannot alone influence the prices, and the consumers can switch to other products in case one firm decides not to pass down the benefits. However, if the said market is not perfectly competitive (i.e., oligopoly, monopolistic competition), then the market leaders can determine the price and decide not to pass down the benefits to the consumers. Further, we usually observe significant product differentiation in imperfect markets, due to which the consumers cannot easily substitute the products. By virtue of market power, they would correspondingly increase the prices of products. Further, in such markets, there is a possibility of profiteering.

If this intuition is correct, then we should observe a highly concentrated market. Thus, we explore whether the market structure has some influence on price formation. Towards this, we calculate two measures of market concentration, namely, Herfindahl–Hirschman Index (HHI) and the four-firm concentration ratio (FFCR), for select market segments that approximately correspond to the sectoral CPI that we analyzed in the previous section. We investigate whether HHI or FFCI increased after the implementation of GST. Market power should be ideally examined at the product level. However, since this paper deals with sub-groups of the CPI basket, it was not possible to carry out the market structure analysis at an industry level and match that with the price trend. Thus, the findings concerning the market structure and concentration have to be taken cautiously.

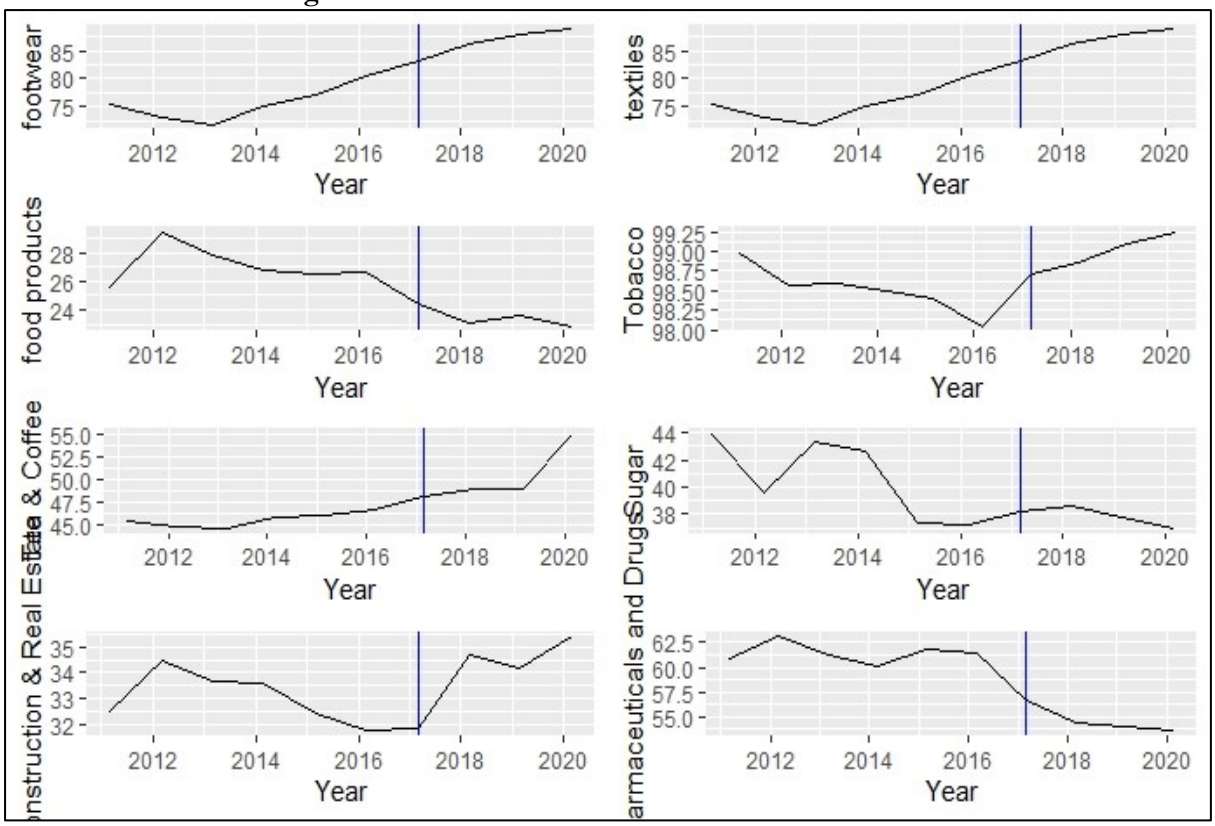
Data on the annual sales revenue of listed firms are taken from ProwessIQ of the Centre for Monitoring Indian Economy (CMIE) over the period 2010-11 to 2019-20. The number of firms varies across sectors. The HHI numbers have been scaled to 100. A higher number represents a higher degree of concentration or market power. Similarly, a higher FFCR score indicates a higher market share by the top four firms in the industry. We present the results in Figure 2 and Figure 3.

Figure 2: Herfindahl–Hirschman Index (HHI) for select sectors



The vertical line in the plot represents the implementation of GST in 2017. We observe that the value of the index (HH) has been increasing since 2014 and has picked up momentum after 2017. We see that HHI increased for Clothing, Footwear, Tobacco, Tea & Coffee, and Construction & Real Estate while it reduced for Food Products, Pharma, and Sugar. We see a similar trend in FFCI as well. Here too, FFCI is reduced for Food Products, Pharma, and Sugar. For segments like Footwear, Clothing, and Tobacco, where the FFCI was high, we see a meteoric rise in market power, corresponding with our earlier results. However, in the case of Food Products, where there are many players in the market, we see a reduction of market power, corresponding with the price level decreases.

Figure 3: Four-firm concentration ratio for select sectors



Rising market concentration may result in asymmetric price transmission, which is why perhaps actual price decline did not happen. Asymmetric price transmission refers to firms passing on higher tax costs to consumers but does not reduce prices when tax rates decline. This is because the extent of competitiveness of a sector, coupled with the sector-specific demand conditions, plays a part. From these results, we assume that there is a high chance of profiteering in the segments where the market power has increased.

5. Conclusion

In this study, we analyzed the impact of GST on price levels in India. Towards this, we employed a Bayesian causal inference model while controlling for factors such as exchange rate, interest rate, and energy prices. We considered both CPI and WPI measures of inflation. In the case of CPI, we found that GST implementation has resulted in a decrease in price levels of food items while having a significant positive impact on headline CPI, Pan, Tobacco and Intoxicants, Clothing and Footwear, Housing, Miscellaneous, and Non-exempted F&B. However, commodity groups such as Food and Food & Beverage (F&B) did not experience any significant effect of GST in the post-GST period. In the case of WPI, we found that implementation of GST leads to a significant increase in headline WPI, manufacturing, and non-exempted WPI.

To test the robustness of the model, we applied an in-time placebo test by keeping the date of intervention as May-2017 instead of July 2017. Here, we found that except for Food and F&B, all the other segments did not exhibit any significant change in inflation due to intervention. In the case of Food and F&B, the price levels were falling from November 2016, which might be the reason behind the spurious results.

We identified the market structure as one potential reason behind the differential price impact and therefore estimated HHI and FFCR for market segments roughly corresponding to sectoral CPIs. We found that in the segments that already exhibited an oligopolistic/monopolistic nature, the benefits of GST were not passed down to the consumers, as evidenced by the increasing market power post-2017. However, in segments like food, pharma, and sugar, a reduction in market power is observed.

To conclude, our study found evidence that GST positively impacted the inflation of the non-food sector. In the case of Food, GST is found to reduce the price levels, which is desirable. Further, we found that the existing market power determines whether the benefits of GST are passed down to the consumers. Our results point out the possibility of profiteering in select segments after GST. One policy implication of this is that National Anti-profiteering Authority should monitor the prices of critical or essential goods and services to see the price impact of GST. Similarly, the Competition Commission of India should keenly observe anti-competitive producer behaviour that hurts consumers via excessive price increases. These measures may ensure that producers do not take advantage of the GST.

As the GST was implemented only in the recent past, there is not enough data to analyze the long-run impact of GST on the price levels. Hence, we refrain from speculating on this aspect. This is one major limitation of our study. Further, the chances of omitted variable bias cannot be ruled out. However, most of our results are in line with the ground reality and international evidence. We plan to study the long-run impact of GST on price levels once there is sufficient data available.

References

Abadie, A., & Gardeazabal, J. (2003). The economic costs of conflict: A case study of the Basque Country. *American Economic Review*, 93(1), 113-132.

Abadie, A., Diamond, A., & Hainmueller, J. (2015). Comparative politics and the synthetic control method. *American Journal of Political Science*, 59(2), 495-510.

Ajmair, M. (2015). Determinants of Inflation in India. *The Indian Economic Journal*, *63*(2), 248-254.

Australian Competition and Consumer Commission. (2003). GST Final Report: ACCC Oversight of Pricing Responses to the Introduction of the New Tax System.

Benedek, M. D., De Mooij, R. A., & Wingender, M. P. (2015). *Estimating VAT pass through*. International Monetary Fund.

Bhat, J. A., & Bhat, S. A. (2021). On the dynamics of exchange rate pass-through: asymmetric evidence from India. *International Journal of Emerging Markets*.

Bhattacharya, R., Patnaik, I., & Shah, A. (2008). Exchange rate pass-through in India. *New Delhi: National Institute of Public Finance and Policy*.

Brodersen, K. H., Gallusser, F., Koehler, J., Remy, N., & Scott, S. L. (2015). Inferring causal impact using Bayesian structural time-series models. *Annals of Applied Statistics*, 9(1), 247-274.

Das, D. (2019). GST Pass-through Across Indian Sates: Evidence from Difference-in-Differences. *The Indian Economic Journal*, 66(1-2), 42-49.

Forbes, K., Hjortsoe, I., & Nenova, T. (2017). *Shocks versus structure: Explaining differences in exchange rate pass-through across countries and time* (No. 50). External MPC Unit Discussion Paper.

Frakt, A. (2014). Methods: Falsification tests, https://theincidentaleconomist.com/wordpress/methods-falsification-tests/, retrieved on May 15, 2021.

Ghosh, A., & Rajan, R. S. (2007). How high is exchange rate pass-through in India? Has it changed over time?. *The Journal of International Trade & Economic Development*, *16*(3), 373-382.

Government of India (2015). Report on the Revenue Neutral Rate and Structure of Rates for the Goods and Services Tax (GST), Ministry of Finance, December.

Khundrakpam, J. K. (2007). Economic reforms and exchange rate pass-through to domestic prices in India.

Kilian, L., & Zhou, X. (2020). Oil prices, gasoline prices and inflation expectations: A new model and new facts. Federal Reserve Bank of Dallas Working Paper 2025.

Mohan, R., & Ray, P. (2019). Indian monetary policy in the time of inflation targeting and demonetization. *Asian Economic Policy Review*, *14*(1), 67-92.

Mohanty, D. (2012, May). Evidence of interest rate channel of monetary policy transmission in India. In *Second International Research Conference at the Reserve Bank of India, February* (pp. 1-2).

Morris, S., Pandey, A., Agarwalla, S. K., & Agarwalla, A. (2017). Impact of the Proposed GST on the Consumer Price Index in India. *Indian Institute of Ahmadabad,* Working Paper W. P. No. 2018-07-02.

NCAER (2009). Moving to Goods and Services Tax in India: Impact on India's Growth and International Trade, December.

Palil, M. R., & Ibrahim, M. A. (2011). The impacts of goods and services tax (GST) on middle income earners in Malaysia. *World Review of Business Research*, *1*(3), 192-206.

Peterson, J. (2006). Economic Effects of Recent Increases in Energy Prices. Congressional Budget Office.

Prasad, V., & Jena, A. B. (2013). Prespecified falsification end points: can they validate true observational associations?. *The Journal of the American Medical Association*, 309(3), 241-242.

Rubene, I. (2018). The role of energy prices in recent inflation outcomes: a cross-country perspective. *Economic Bulletin*, 7.

Reserve Bank of India (2017) Fourth Bi-monthly Monetary Policy Statement for 2017-18, accessed from https://rbidocs.rbi.org.in/rdocs/Bulletin/PDFs/0BUL1010173E934C45C5B5438493F56B423D08B81F.PDF

Thoresen, P. E. (1983). Inflation controlled by energy prices. *Energy Economics*, 5(3), 202-206.

Valadkhani, A. (2005). Pre- and Post-Dynamic GST Effects on Goods and Services Included in the CPI Basket, Department of Economics, University of Wollongong.

Yanamandra, V. (2015). Exchange rate changes and inflation in India: What is the extent of exchange rate pass-through to imports?. *Economic analysis and policy*, *47*, 57-68.

Appendix - I

CPI Groups and Weights					
All India Consumer Price Indices					
(Base: 2012=100)					
Group Code	**Sub-group Code**	**Description**	Weights (%)		
			Rural	Urban	Combined
	1.1.01	Cereals and products	12.35	6.59	9.67
	1.1.02	Meat and fish	4.38	2.73	3.61
	1.1.03	Egg	0.49	0.36	0.43
	1.1.04	Milk and products	7.72	5.33	6.61
	1.1.05	Oils and fats	4.21	2.81	3.56
	1.1.06	Fruits	2.88	2.90	2.89
	1.1.07	Vegetables	7.46	4.41	6.04
	1.1.08	Pulses and products	2.95	1.73	2.38
	1.1.09	Sugar and Confectionery	1.70	0.97	1.36
	1.1.10	Spices	3.11	1.79	2.50
	1.2.11	Non-alcoholic beverages	1.37	1.13	1.26
	1.1.12	Prepared meals, snacks, sweets etc.	5.56	5.54	5.55
1		**Food and beverages**	**54.18**	**36.29**	**45.86**
2		**Pan, tobacco and intoxicants**	**3.26**	**1.36**	**2.38**
	3.1.01	Clothing	6.32	4.72	5.58
	3.1.02	Footwear	1.04	0.85	0.95
3		**Clothing and footwear**	**7.36**	**5.57**	**6.53**
4		**Housing**	**-**	**21.67**	**10.07**
5		**Fuel and light**	**7.94**	**5.58**	**6.84**
	6.1.01	Household goods and services	3.75	3.87	3.80
	6.1.02	Health	6.83	4.81	5.89
	6.1.03	Transport and communication	7.60	9.73	8.59
	6.1.04	Recreation and amusement	1.37	2.04	1.68
	6.1.05	Education	3.46	5.62	4.46
	6.1.06	Personal care and effects	4.25	3.47	3.89
6		**Miscellaneous**	**27.26**	**29.53**	**28.32**
General Index (All Groups)			**100.00**	**100.00**	**100.00**
Consumer Food Price Index (CFPI)			**47.25**	**29.62**	**39.06**

Source: The Central Statistics Office (CSO), Ministry of Statistics and Programme Implementation (MoSPI).

Appendix - II

Figure A.1: CPI Figure

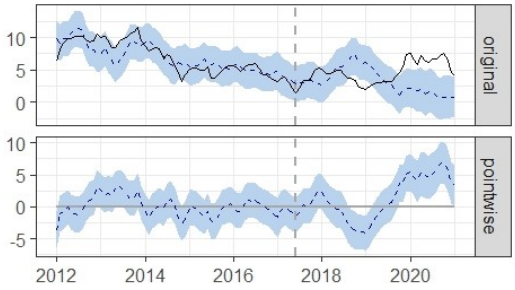


Figure A.2: CPI-Food

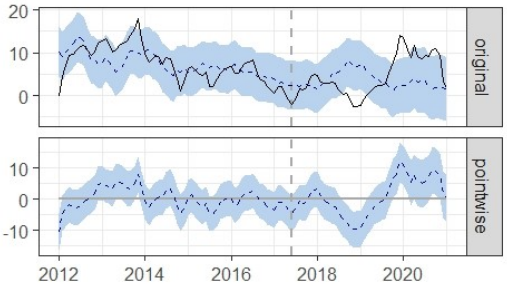


Figure A.3: CPI Food & Beverages (F&B)

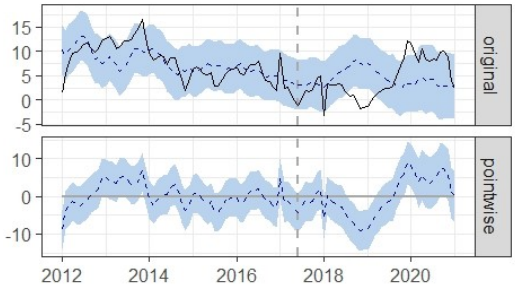


Figure A.4: Pan, Tobacco, Intoxicants

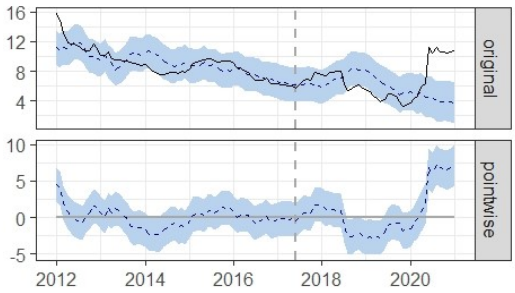


Figure A.5: Clothing & Footwear

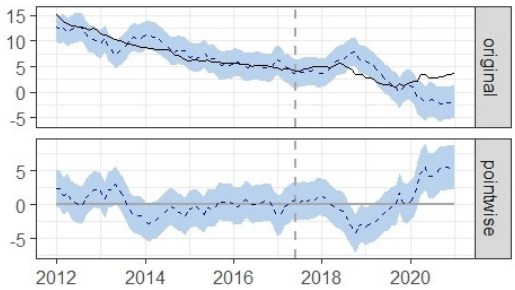


Figure A.6: Housing

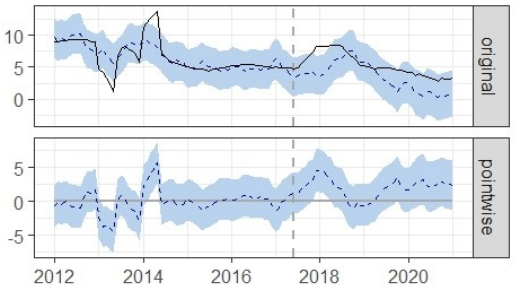


Figure A.7: Miscellaneous

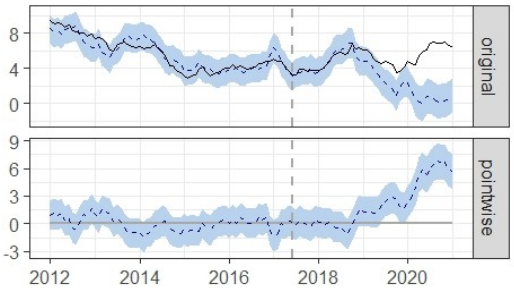


Figure A.8: Non-exempted F&B

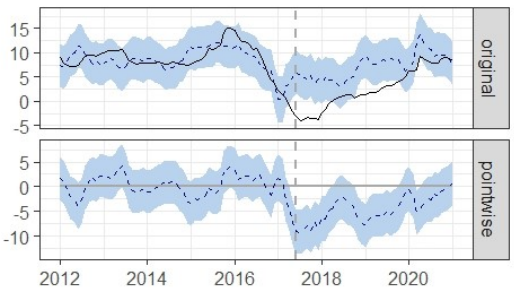


Figure A.9: WPI

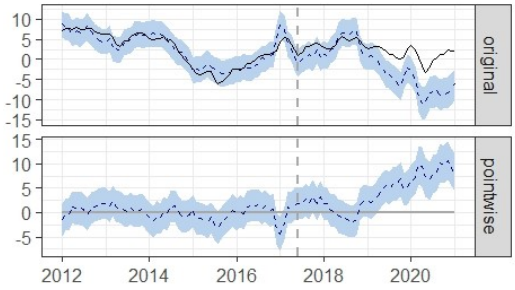


Figure A.10: Non-Food Articles

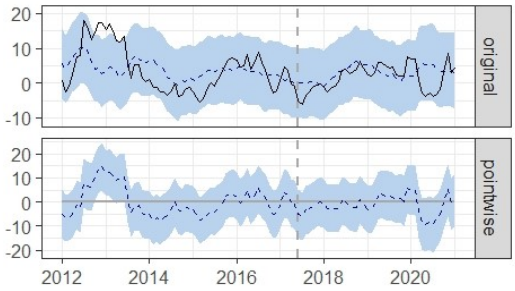


Figure A.11: Manufacturing Products

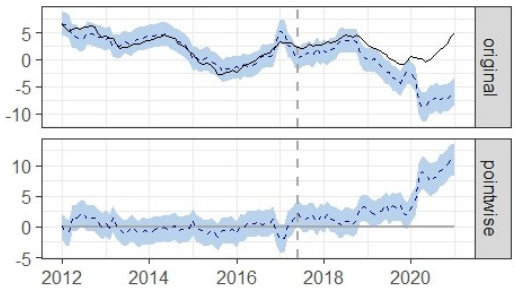
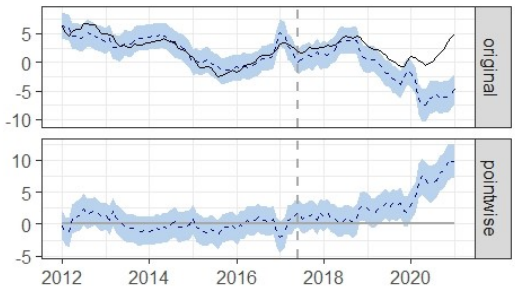


Figure A.12: Non-exempted WPI



Gulati Institute of Finance and Taxation (GIFT), Thiruvananthapuram, Kerala, formerly Centre for Taxation Studies, was conceived as a premier national institute to promote theoretically grounded and empirically based research within an interdisciplinary perspective to aid policy making at the national and sub-national level. Affiliated to Cochin University of Science and technology, GIFT is also mandated to facilitate research leading to PhD, apart from being a highly acclaimed institute undertaking training programs for capacity building of different stakeholders, including Government officials. It also offers a Post Graduate Diploma in Goods and Services Tax.