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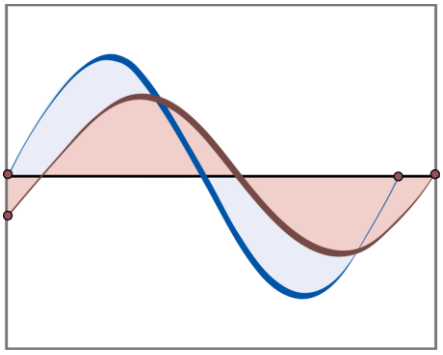

Measuring Price Spillovers: An Investigation of Relative Price Changes in Trinidad and Tobago

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The recent surge in inflation globally has raised concerns about the future dynamics of inflation. This has urged policymakers to go beyond the aggregate level of inflation to shed light on the factors that can cause its persistence. While some measures of inflation, such as food and core inflation can tell how price developments in a good or service (whether transitory or longer-lasting) affect headline inflation, this approach misses the rich nature of studying granular price changes. This paper examines how price changes in an individual good, service or sub-index transmits to other items within the Consumer Price Index of Trinidad and Tobago. Using the methodology of Diebold and Yilmaz (2012), the study reveals significant interconnectedness among price indices. The Furnishing, Household Equipment and Routine Maintenance; Transport; and Milk, Cheese and Eggs categories were found to be major net transmitters of inflation spillovers. Meanwhile, the Housing, Water, Electricity, Gas and other Fuels, Vegetables and Meat sub-indices are net receivers of price spillovers, implying that they are more responsive to price changes. International food commodity prices and energy prices are found to be important drivers of domestic retail prices. Additionally, price spillovers are found to be larger during periods of high inflation and growth, and decrease during periods of low inflation and growth.

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1. Introduction

Since the global oil price shock of the mid-1970s, many central banks worldwide have set maintaining price stability as their primary objective. Countries such as Germany, Japan, and the United States (US) have acted decisively to control inflation. Several central banks have also adopted inflation targeting as their monetary policy regime (Clarida, Gali and Gertler 1998). Within the last two decades, global shocks, including commodity price fluctuations experienced during 2014-2017, climate change impacts (El Niño 2015-2016), the COVID-19 pandemic and more recently the Russia/Ukraine conflict, have had related spillovers on inflation. The synchronisation of inflation across different countries has therefore attracted policymakers' attention. It is found that a higher degree of trade integration is associated with a higher rate of price spillovers (Auer and Saure 2013). Bilateral sector-specific trade integration affects the bilateral co-movements of sectoral prices, making the inflation process more global. Factors such as international co-movement of business cycles, purchasing power parity, technology spillover, common economic shocks and common monetary policy are considered to be important for the international spillover of inflation (Auer and Saure 2013).

The global surge in inflation after some time of relatively low prices has raised concerns about the future path of inflation. The emergence of supply-side impulses from the pandemic (supply-chain bottlenecks, higher labour and shipping costs) and the Russia/Ukraine crisis (higher fuel and fertiliser prices and shortages of some inputs) have kept inflation elevated in 2022, making it difficult for central banks around the world to meet their inflation targets (Agarwal and Kimball 2022). In this regard, a sectoral analysis of inflation is important to understand the causes of the rapid increase as well as its persistence. Though the withdrawal of pandemic-related policy stimuli in 2021 and 2022 and the adoption of monetary policy tightening by some central banks have helped contain inflationary pressures, with global economic activity slower than anticipated and the threat of a resurgence in inflation from emerging conflict in the middle east, monetary authorities may face greater difficulties in maintaining price stability and sustainable economic growth.

In the domestic setting, the uptick in inflation from around mid-2022 has spotlighted the importance of sector-specific developments – especially given elevated food and energy prices and impending electricity rate hikes, which can drive increased price spillovers to other categories of inflation, leading to second-round effects. Historically, inflation in Trinidad and Tobago has followed a pro-cyclical path, rising in periods of economic expansion and falling during recessionary periods. Much of this volatility has been due to food inflation, although the prices of all goods increased steadily over time (Noel 2023). Pandemic-induced supply shocks and the Russia/Ukraine crisis explain a significant share of the contemporary volatility in inflation, specifically through food and energy prices. Empirical studies have shown that over time, shocks to crude oil prices, US GDP, domestic wages, import prices and regional financial conditions have had significant pass-through effects on domestic prices (Roopnarine, Bowrin and Ramirez 2019; Mahabir, et al. 2013). These developments underscore the need to go beyond the aggregate dynamics of inflation to shed light on how sector-specific inflation morphs over time. Ciccarelli and Mojon (2010) noted that without proper knowledge about the mechanism of inflation spillover, countries may overestimate domestic developments (Ciccarelli and Mojon 2010). With an understanding of how relative price changes impact underlying inflation, the Central Bank of Trinidad and Tobago ("the Bank") can be in a better position to optimise monetary policy decisions.

In this paper, we broadly examine the fundamentals of inflation by distinguishing clearly between the multitude of relative price changes and how these affect underlying inflation. The objective of the paper is to determine how price changes in sectoral sub-indices of the Consumer Price Index (CPI)[1] affect price movements in other sub-indices of the index, thereby gauging the total effect on overall inflation. Additionally, the paper examines how price indices in various categories respond to monetary policy. This can be useful in monetary policy formulation going forward. To the best of our knowledge, this paper is the first of its kind applied to Trinidad and Tobago. Therefore, it sets the foundation for understanding relative price changes within sectoral indices of the CPI. The rest of the paper is structured as follows: Section 2 reviews the literature on inflation spillover; Section 3 provides some stylised facts on inflation dynamics in Trinidad and Tobago; Section 4 outlines the methodology used to measure inflation spillover; Section 5 discusses the attendant results and Section 6 concludes and provides some policy recommendations.

2. Literature Review

Many studies have identified the major drivers and causes of inflation within and across countries. The popularity of research in this area may be ascribed to the social and economic consequences of an inflation rate that is either too high or too low. Within the last two decades, a growing body of research has examined various aspects of inflation spillovers, mainly price spillovers across countries and producer price industries, and within specific categories of inflation. Several studies have also applied the spillover concept to the money, stock and bond markets. Examining price spillovers has mainly been undertaken in the US. However, the concept has been explored for other territories, including Switzerland, the Euro Area and Nigeria.

Baurle, Gubler and Kanzig (2021) attempted to answer the research question: How do international price fluctuations spill over to country-specific inflation? The authors found that foreign shocks explain up to 50 per cent of price variations in the Swiss economy, while common domestic shocks account for approximately 20 per cent (the remaining variation being due to item-specific shocks). To a substantial degree, domestic inflation is thus driven by foreign factors. However, this does not necessarily imply that Swiss monetary policy has not been able to have an impact on international spillover effects to domestic inflation. The authors show that spillover effects on Swiss prices depend on the nature of the underlying shocks. Given the variation in transmission, among other factors, the analysis regarding the use of different items of the Swiss Consumer Price Index (CPI) points to substantial heterogeneity in the transmission of foreign inflationary shocks. The inclusion of energy prices plays a crucial role. The impact of foreign inflationary shocks on the Swiss CPI is lower when energy prices are added and the transmission appears slower when energy prices are excluded. Furthermore, there is some heterogeneity in the transmission to the prices of imported goods, domestic goods, and services, which are likely related to differences in tradability and exchange rate sensitivity.

Similarly, Bilgin and Yilmaz (2018), using the Diebold-Yilmaz Connectedness Index Framework[2], analysed the transmission of producer price inflation shocks across manufacturing industries within the US utilising data from 1947 to 2018. The results, which fully utilise the information contained in the generalised variance decompositions from vector autoregression, show that the system-wide connectedness of the input-output network granger causes the producer price inflation connectedness across industries. The input-output network and the inflation connectedness nexus is stronger during periods of major supply-side shocks, such as the global oil and metal price

[1] Effective January 2024, the Central Statistical Office (CSO) renamed the Index of Retail Prices (RPI), which is used to measure the rate of inflation, to the Consumer Price Index (CPI) to maintain consistency with international terminology.
[2] Diebold and Yilmaz (2008) used a generalised vector autoregressive framework to measure total and directional volatility spillovers across commodities in the US. The Diebold and Yilmaz methodology has been used to measure price (risk) spillovers across commodity (stock) markets.

hikes, and weaker during periods of aggregate demand shocks, such as the Volcker disinflation of 1981-84 and the Great Recession of 2008. The findings were noted to be consistent with the work of Acemoglu et al. (2016), which conjectured that supply shocks are transmitted downstream, whereas demand shocks are transmitted upstream. Additionally, the research found that Trump tariffs caused an increase in the system-wide inflation connectedness in the first half of 2018, due to shocks mostly transmitted from tariff-targeted industries, namely basic metals, fabricated metals and machinery (Bilgin and Yilmaz 2018). Several other authors, including Di Giovanni and Levchenko (2010), Auer and Saure (2013), and Antoun de Almeida (2016) also pointed out the role of input-output linkages in driving inflation synchronisation across countries. Auer et al. (2017) build on this application and decompose producer price inflation series into global, sectoral, and country-specific factors. They show that sectoral shocks are the main reason behind the synchronisation of producer price inflation across countries.

Tiwari et al. (2018) assessed inflation spillover across selected Euro Area countries using CPI data covering January 1955 to April 2017. The popular method of Diebold–Yilmaz and the frequency-domain method were employed. The authors analysed 1 to 4 months and greater than four months of spillovers. The study revealed that the co-movement in international inflation rates may be the result of common shocks, similarities in central bank reaction functions, international trade and the operation of purchasing power parity theory. However, to assess the synchronisation of inflation fluctuations across countries or regions, it is critical to know the inflation behaviour and formulation of correct monetary policy (Tiwari et al. 2018).

Several studies also examine relative price changes within sub-categories of inflation. However, some of these studies also control for economy-wide variables including the exchange rate and wages. Baek and Koo (2010) studied the effects of changes in the exchange rate, commodity prices and energy prices on cereal/bakery, meats, dairy, fruits/vegetables and beverages in the US. The authors applied the Johansen cointegration analysis and a vector error-correction (VEC) model using monthly data for the 2001-2010 period. The results show the existence of stable long-run relationships among the selected variables, but more specifically, energy and commodity prices have influenced US food prices mainly through changes in prices of cereal/bakery, meats and dairy. The authors noted that the Energy Independence and Security Act of 2007[3] is one of the main driving forces behind the increase in food price inflation, which negatively affected consumers, especially low-income households. Lambert and Miljkovic (2010) used time series analysis to examine the factors influencing food prices in the US. Using monthly data from January 1970 to February 2009, the study revealed that innovations in farm prices and manufacturing wages, rather than consumer incomes or the prices of other food production inputs such as fuel, played the most significant roles in determining food price changes.

In 2022, the Bank for International Settlements (BIS) examined how shocks affecting certain sectoral price indices in the US affect the variability of prices in other sectors using a generalised forecast error variance decomposition (GFEVD) matrix. Comparing directional spillovers across sectors between high- and low-inflation regimes, the study revealed that price spillovers have diminished and become more concentrated in a few sectors that remain strong exporters of spillovers, such as food and gasoline. This highlights their centrality in driving overall price developments. In line with the finding that total spillovers are lower in a low-inflation regime, it is also the case that directional spillovers are smaller in a low-inflation regime. The study found two categories in which the size of exported spillovers increased – housing and financial services. The paper also included the Producer Price Index (PPI) sub-indices to examine how price changes in items upstream in the value chain, which constitute inputs to the production of final goods and services, transmit downstream (Bank of International Settlements 2022).

[3] The Energy Independence and Security Act of 2007 seeks to expand the production of renewable fuels, reduce US dependence on oil, increase energy security and address climate change.

Balcilar and Bekun (2020) examine the spillover between inflation and selected agricultural commodity prices in Nigeria. The selected agricultural crops for the study were groundnut, soybeans, sorghum, barley, maize, cocoa, rice and wheat, which are the most produced and consumed commodities in all parts of Nigeria. The authors employed the Diebold and Yilmaz (2012) methodology to develop and examine directional spillover, total spillover, and net spillover indices. Further, the study analysed cyclical and secular movements using a rolling window analysis. The empirical results, based on monthly data from January 2006 to July 2016 show that the total spillover effect was roughly 75.0 per cent. This suggests a high interconnectedness between the selected agricultural commodity prices and inflation. Further empirical findings show that inflation, sorghum, soybeans, and wheat were net receivers while cocoa, barley, groundnut, maize, and rice were net sources of spillover. The authors found a negative net spillover for price inflation, implying a net positive spillover from commodity prices to price inflation. The results carry useful implications for the government, farmers, and investors alike in Nigeria, to help insulate the agricultural sector from externalities and ensure optimum price stability (Balcilar and Bekun 2020).

In more general terms, Bajraj et al. (2023), highlighting the co-movement of inflation across countries, sought to decompose headline inflation into its main categories and assess the extent to which the pattern generalises across the disaggregated indices. Using data from 44 countries, the authors observed systemic differences in the levels, trends and volatility of the main inflation sub-categories (food, alcohol and tobacco; energy; industrial goods excluding energy; and services). Further, the authors employed a dynamic factor model to analyse the extent to which the disaggregated inflation data co-move at the local, sectoral and global level. They found that sectoral factors explain a significant portion of the variance in all four categories of inflation with global factors accounting for a more moderate share of the variance. Regarding the effect of local factors, energy prices were found to have little response while the effects on inflation in services and non-energy industrial goods were more pronounced. In summary, the authors found that factors that operate across countries are good predictors of inflation in all its categories while domestic conditions are more relevant in inflation in services and non-energy industrial goods (Bajraj et al. 2023).

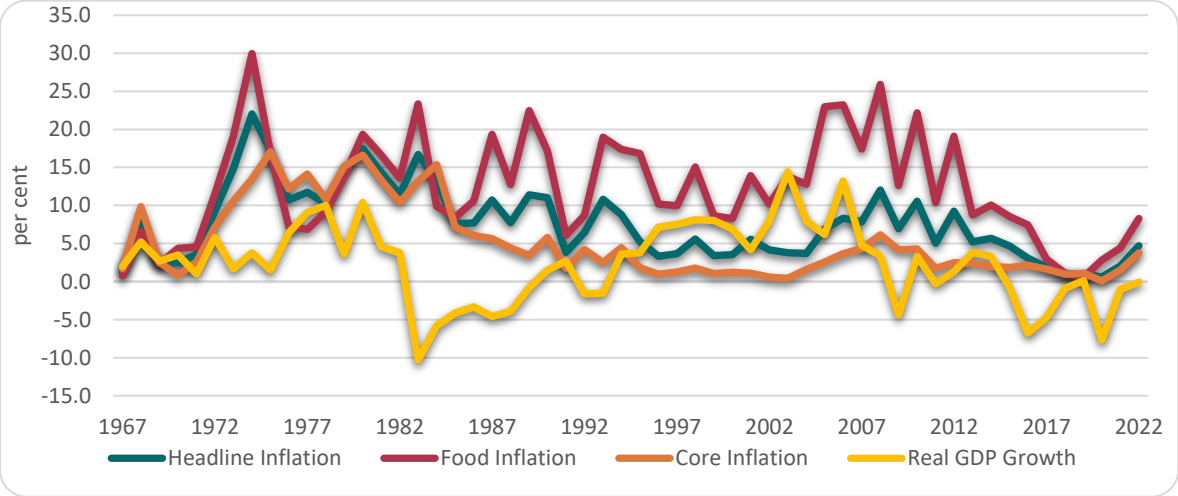
In the Caribbean, empirical studies on this topic generally focus on the import price transmission mechanism from foreign to domestic commodities as opposed to relative price changes within sub-categories of the CPI. Mahabir and Jagessar (2011) reviewed the transmission of selected international food prices to domestic prices in Trinidad and Tobago. This study revealed that changes in international commodity prices (rice, wheat, milk and soya beans) impact related domestic items by the second month, and the effects last between five to nine months. ECLAC (2008) on the other hand, developed a coefficient for estimating the pass-through effects of foreign inflation on domestic inflation by dividing domestic food inflation by world food inflation. The authors' calculation revealed Trinidad and Tobago had an estimated pass-through coefficient of 66.0 per cent, thus indicating that approximately two-thirds of world food inflation was transmitted to domestic prices. Bobb and Sonnylal (2018) examined how changes in the exchange rate influence domestic prices in Trinidad and Tobago. The authors noted that changes in the exchange rate influence domestic prices due to changes in the cost of imported intermediate goods in the production process. Primus et al (2011) on the other hand, using a visual inspection of the movements of international and domestic prices of various items, found that there was asymmetry in the transmission of price increases and decreases from international commodities to local commodities in Trinidad and Tobago. The authors found price increases were reflected in the domestic market within two to five months, while price decreases took much longer to be transmitted. Outside of these studies, empirical discussions on price developments, particularly relative price changes and their attendant second-round impacts on inflation in the Caribbean, appear to be limited. As such, this study provides a platform for understanding and examining second-round effects, which may be otherwise difficult to isolate and measure.

3. Stylised Facts

Within the last decade, several shocks have affected inflation trends globally. These included commodity price fluctuations experienced in 2014-2017, climate change impacts (El Niño 2015-2016), the COVID-19 pandemic (health crisis, commodity price fluctuations, supply chain disruptions 2020-2021), and more recently, the Russia/Ukraine conflict. Trinidad and Tobago not being immune to these exogenous shocks was impacted, experiencing undue price pressures. The COVID-19 pandemic and the Russia/Ukraine conflict placed upward pressure on international commodity prices (such as food, energy, machinery, and equipment) leading to an uptick in headline inflation – driven mainly by higher domestic food inflation. In addition, driven by higher international energy prices, second-round effects from increases in domestic fuel prices in April and October 2022 have added to the upward impetus on domestic prices.

Chart 1 shows a positive co-movement between inflation and real GDP growth[4]. In 2020, the negative supply shock affected food and core inflation. Both food and core inflation lost momentum in 2020 before accelerating in 2021 and 2022, driven by supply-side factors such as higher shipping costs and supply shortages brought on by the lingering pandemic effects and the Russia/Ukraine conflict. Core inflation reached 1.5 per cent and 4.7 per cent in 2021 and 2022, respectively from 0.1 per cent in 2020 while food inflation measured 4.4 per cent and 10.3 per cent in 2021 and 2022, respectively from 2.8 per cent in 2020. Real GDP growth also improved over the period, registering smaller declines, moving from -7.7 per cent in 2020 to -1.0 per cent in 2021 and then to -0.1 per cent in 2022 **(Chart 1)**.

Chart 1: Inflation and Real GDP Growth (Per Cent)



Source: Central Statistical Office

Looking specifically at food inflation, the analysis reveals that imported inflation generally accounted for the volatility in food prices. Meanwhile, increases in prices of fuel at the pump and adverse weather conditions, among other factors, added a country-specific dimension to the inflation outturn. **Table 1** below shows the percentage changes (year-on-year) of different categories of the CPI for 2022. It is noted that the surge in headline inflation came from faster price movements in both food and core inflation. The acceleration in food inflation was broad-based, driven

[4] The Phillips Curve hypothesis suggests there is an inverse relationship between real GDP and unemployment. Similarly, Okun's law suggests a negative relationship between inflation and unemployment. Higher production leads to a lower unemployment rate, further fueling demand. Increased wages can lead to higher demand as consumers spend more freely. This leads to higher GDP combined with inflation.

by faster price increases in most sub-categories, including Breads and Cereals[5]; Meat; Butter, Margarine and Edible Oils; and Food Products Not Elsewhere Classified, most of which have a large import content. During early 2022, domestic food prices were impacted by the surge in international food prices. The Vegetables and Fruits sub-indices also received impulses from the adverse weather experienced in October and November 2022 which led to bouts of flooding in several areas across the country.

Core inflation, the less volatile component of headline inflation, also recorded faster price increases in 2022, mainly towards the end of the year. Core inflation increased to 6.7 per cent (year-on-year) in December 2022 from 4.8 per cent in October 2022. Increasing momentum in prices within the Transport; Hotels, Cafés and Restaurants; Furnishings, Household Equipment and Routine Maintenance; and Housing, Water, Electricity, Gas, and Other Fuels sub-indices were responsible for the pickup in core inflation. Notably, the Transport sub-index experienced faster price movement following the increase in fuel prices in April 2022 and October 2022 **(Table 1)**.

The dynamics and future trajectory of inflation can help shape monetary policy. Since the introduction of the Repo rate in May 2002, the Bank has made decisions to increase, decrease or hold the rate steady in response to several factors. **Chart 2** shows no clear association between the Repo rate and inflation. However, there have been instances where contractionary policy (increases in the Repo rate) coincided with rising inflation and vice versa. It is also evident that the Repo rate has been generally higher in high inflation periods versus low inflation periods. Since the reduction of the Repo rate in March 2020, the Bank has held the rate constant. However, the Bank sought to employ other monetary policy tools, such as open market operations, to address inflationary impulses.

[5] The National Flour Mills Limited (NFM) announced a 33.0 per cent increase in the wholesale price of flour (along with a 28.0 per cent average increase in the retail price) in late June 2022.

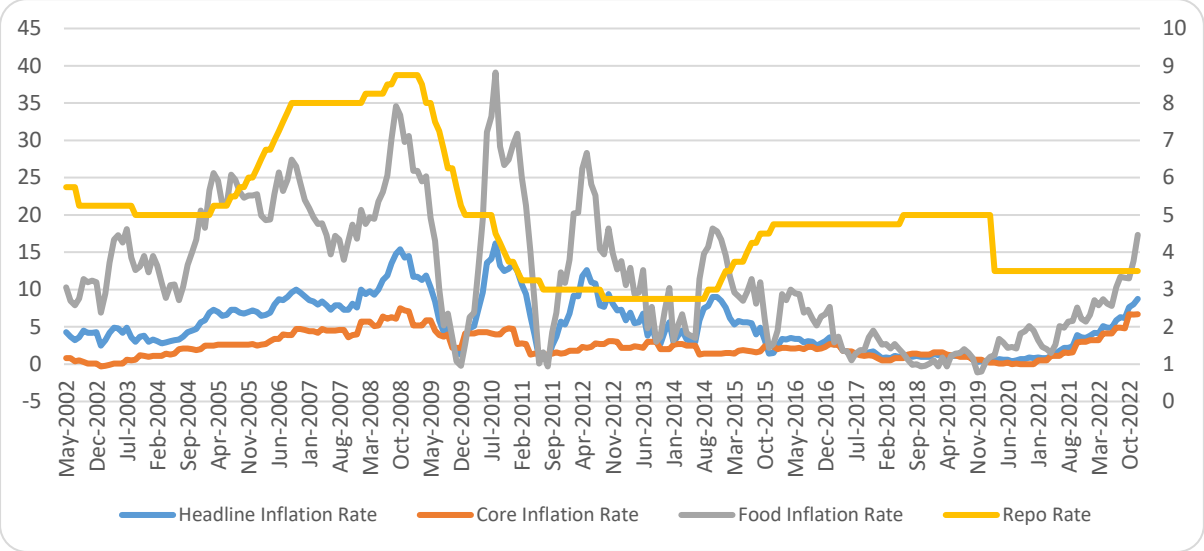
Table 1
Heat Map Depicting Inflation Rate of Selected Categories of the Consumer Price Index for 2022*

	Year-on-Year Per Cent Change												Weight
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Headline Inflation	**3.8**	**4.2**	**4.1**	**5.1**	**4.9**	**4.9**	**5.9**	**6.3**	**6.2**	**7.6**	**8.0**	**8.7**	**1,000**
Food and Non-Alcoholic Beverages	**6.6**	**8.6**	**7.9**	**8.7**	**8.1**	**7.8**	**10.3**	**11.7**	**11.6**	**11.5**	**13.8**	**17.3**	**173**
Bread and Cereals	5.6	8.1	7.2	8.1	8.4	7.4	15.3	18.0	17.1	19.1	21.1	21.3	33
Meat	6.3	14.4	12.4	14.1	13.7	15.8	14.8	14.9	13.4	9.5	9.6	10.6	31
Fish	6.7	5.1	6.3	8.3	11.0	10.3	6.5	5.7	8.0	8.8	6.9	10.1	11
Vegetables	11.8	11.5	10.1	9.5	3.8	1.6	8.4	12.4	13.8	9.3	15.3	26.1	24
Fruits	7.2	9.8	13.3	13.4	11.5	9.0	5.2	9.8	9.2	5.1	5.1	5.8	6
Milk, Cheese & Eggs	5.3	6.0	5.9	6.6	6.2	5.4	6.3	6.2	6.1	8.5	8.9	11.7	21
Butter, Margarine, Edible Oils	9.1	8.9	8.3	13.2	12.9	11.1	13.8	14.3	12.6	14.3	21.4	24.3	10
Sugar, Jam, Confectionery, etc.	5.1	5.2	4.8	1.7	3.9	4.9	6.5	1.8	3.7	8.2	7.8	7.6	6
Food Products NEC	9.0	7.1	4.7	5.4	4.6	5.2	8.5	13.2	12.3	15.9	20.9	30.8	13
Non-Alcoholic Beverages	0.4	2.4	3.1	2.7	3.9	4.4	5.6	5.6	5.8	8.4	11.5	13.2	18
Core Inflation	**3.2**	**3.2**	**3.2**	**4.1**	**4.1**	**4.1**	**4.9**	**4.9**	**4.8**	**6.7**	**6.6**	**6.7**	**827**
Alcoholic Beverages & Tobacco	2.8	3.3	3.5	3.4	3.1	2.1	3.0	3.6	2.1	-0.1	0.6	0.8	9
Clothing and Footwear	0.1	0.6	0.7	-0.1	-0.1	-0.9	0.2	0.0	-0.4	2.2	1.8	1.9	57
Furnishings, Household Equipment and Routine Maintenance	3.4	3.4	3.4	4.4	4.4	4.4	7.7	7.7	7.7	9.3	9.3	9.3	67
Health	3.1	3.1	2.3	1.7	1.5	1.6	2.5	3.0	2.8	2.1	1.2	1.8	41
Of which: Medical Services	2.2	2.2	2.2	-1.5	-3.8	-3.6	1.4	1.4	1.4	0.7	0.7	0.7	10
Housing, Water, Electricity, Gas & Other Fuels	6.7	6.7	6.7	6.6	6.6	6.6	5.8	5.8	5.8	5.0	5.0	5.0	275
Of which: Rent	0.4	0.4	0.4	-0.3	-0.3	-0.3	0.6	0.6	0.6	1.7	1.7	1.7	22
Home Ownership	8.3	8.3	8.3	8.4	8.4	8.4	7.4	7.4	7.4	6.2	6.2	6.2	193
Education	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	10
Recreation & Culture	-2.6	-2.6	-2.6	-0.2	-0.2	-0.2	0.5	0.5	0.5	4.2	4.2	4.2	66
Hotels, Cafes & Restaurants	2.2	2.2	2.2	4.5	4.5	4.5	5.9	5.9	5.9	9.5	9.5	9.5	25
Transport	2.2	2.2	2.2	5.9	5.9	5.9	8.6	8.6	8.6	14.6	14.6	14.6	147
Communication	3.1	3.1	3.1	2.3	2.3	2.3	1.7	1.7	1.7	2.7	2.7	2.7	45
Miscellaneous Goods and Other Services	1.0	1.0	1.0	1.8	1.8	1.8	2.8	2.8	2.8	6.6	6.6	6.6	86

Source: Central Statistical Office and Central Bank of Trinidad and Tobago

*Green reflects an inflation rate that is less than or equal to 0 per cent, yellow reflects an inflation rate between 0.1 and 5.0 per cent, the lighter shade of orange reflects an inflation rate between 5.1 per cent and 10.0 per cent, the darker orange reflects an inflation rate between 10.1 per cent and 15.0 per cent and red reflect an inflation rate greater than 15.1 per cent.

Chart 2: Inflation and the Repo Rate (Per Cent)



Source: Central Statistical Office and the Central Bank of Trinidad and Tobago

4. Methodology and Data

4.1 Econometric Methodology

To examine the impact of relative price changes on various categories of inflation, the methodology of Diebold and Yilmaz (2012) is employed. Similar to the BIS Annual Economic Report 2022, Box A, we construct a generalised forecast error variance decomposition (GFEVD) by first modelling quarterly growth rates in sector-level consumer price indices as a Vector Autoregression (VAR), controlling for common, economy-wide explanatory variables such as changes in government revenue, the Repo Rate, oil prices and international food prices. The data on sector-level consumer price indices are discussed further in section 4.2. The GFEVD shows how shocks to particular sub-indices within the CPI affect the variability of prices in other sub-indices over a 10-year horizon[6].The generalised impulse responses of each shock are then used to construct the decomposition of forecast errors. Using the Diebold and Yilmaz (2012) model, three main spillover indices are constructed: total spillovers, directional spillovers and net spillovers. The methodology is structured under the VAR model approach and is based on a covariance of stationary VAR given by:

$$y_t = \phi_0 + \sum_{i=1}^{p} \phi_i y_{t-i} + \varepsilon_t, \qquad (1)$$

Where $y_t = (y_{1t}, y_{2t}, \ldots, y_{nt})$ is a vector of covariance stationary series; t refers to time, where t= 1, 2...T; φ_i denotes an (n x n) matrix of parameters where i=0,1, 2…p; and ε_t is a (n x 1) vector of zero mean errors required to be independent and identically distributed (iid) with covariance mean matrix:

$$\sum, \varepsilon_t \sim iid = (0, \sum)$$

Covariance stationarity of the VAR ensures that it has a moving average (MA) representation of the form:

[6] The GFEVD therefore measures the share of variance of price changes that are explained by shocks to prices in other price sub-indices over a ten-year horizon.

$$y_t = \sum_{i=0}^{\infty} A_i \, \varepsilon_{t-i}, \qquad (2)$$

where the coefficient matrices A_i obey the recursion $A_i = \phi_1 A_{i-1} + \phi_2 A_{i-2} + \phi_3 A_{i-3+\ldots} \phi_p A_{i-p}$, with A_0 an N x N identity matrix and $A_i = 0$ for $i < 0$. The spillover index is derived from Eq. (2) that forms the variance decomposition.

In the VAR framework introduced above, own variance shares are the fractions of the H -step-ahead error variances in forecasting x_i due to shocks to x_i, for i = 1, 2, ..,N, and cross variance shares are the fractions of the H -step-ahead error variances in forecasting x_i due to shocks to x_j, for i, j = 1, 2, .., N. The Diebold and Yilmaz (2012) model uses only the cross variance shares in calculation of total spillovers, directional spillovers and net spillovers. The index of total spillover is constructed by summing all the off-diagonal elements of the GFEVD matrix. Based on the work of Koop et al. (1996) and Balcilar and Bekun (2020) generalised VAR framework, H-step-ahead forecast error variance decomposition represented by $S_{i,j}^{g}$ (H) is obtained by:

$$S_{i,j}^{g}(H) = \frac{\sigma_{i,j}^{-1} \sum_{h=0}^{H-1} (e_i' A_h \sum e_j)^2}{\sum_{h=0}^{H-1} (e_i' A_h \sum A_h' e_i)^2}, \quad H = 1,2, \ldots.10 \qquad (3)$$

where $\sigma_{i,j}$ is the standard deviation of the disturbance of the j[th] equation, Σ is the covariance matrix of the disturbance vector ε, and e_i is the selection vector with one as the i[th] element and zeros otherwise. $S_{i,j}$ is the cross variance share of variable j in the H -step-ahead forecast error of variable i. The generalised VAR framework forecast error variance shares do not necessarily add to 1; hence, in general $\Sigma_{j=1}^{N} S_{i,j}^{g}(H) \neq 1$. Taking this into account, the normalise entry of each of the generalised variance decomposition matrix by the row sum to obtain pairwise directional connectedness from variable j to variable i is given by:

$$S_{i,j}^{\sim g}(H) = \frac{S_{i,j}^{g}(H)}{\sum_{j=1}^{n-1} S_{i,j}^{g}(H)} \qquad (4)$$

Where $\Sigma_{j=1}^{N} S_{i,j}^{\sim g}(H) = 1$ and $\Sigma_{i,j=1}^{N} S_{i,j}^{g}(H)$ = N. Thus the total spillover index is deduced by:

$$S_{i,j}^{g}(H) = \frac{\sum_{i,j=1, i \neq j}^{n} \theta_{ij}^{\sim g}(H)}{\sum_{i,j=1}^{n} \theta_{ij}^{\sim g}(H)} = \frac{\sum_{i,j=1, i \neq j}^{n} \theta_{ij}^{\sim g}(H)}{N} \qquad (5)$$

By summing the off-diagonal elements of the variance decomposition matrix (column by row), we can obtain a measure of the extent of spillovers 'exported to' and 'imported from' each sub-index (sector). The technique also offers the opportunity to explore the flow of direction of the spillover across inflation sub-indices and selected commodity prices under review. The directional spillover is of two types: namely "to" directional spillover and "from" directional spillover. The "to" directional spillover, that is spillover from all other variables j to variable I denoted by subscript $(i \leftarrow *)$ measures the spillovers transmitted from one variable to all other variables. Meanwhile, the "from" directional spillover, denoted by subscript $(* \leftarrow i)$ accounts for spillovers received by one variable from all other variables. The import "to" directional spillover is computed by:

$$S_{i\leftarrow *}^{g}(H) = \frac{\sum_{i,j=1,j\neq i}^{n} \theta_{ij}^{\sim g}(H)}{\sum_{i,j=1}^{n} \theta_{ij}^{\sim g}(H)} = \frac{\sum_{j=1,j\neq i}^{n} \theta_{ij}^{\sim g}(H)}{N}, \qquad (6)$$

while the "from" directional spillover, is represented as:

$$S_{*\leftarrow i}^{g}(H) = \frac{\sum_{j=1,j\neq i}^{n} \theta_{ij}^{\sim g}(H)}{\sum_{i,j=1}^{n} \theta_{ij}^{\sim g}(H)} = \frac{\sum_{i,j=1,j\neq i}^{n} \theta_{ij}^{\sim g}(H)}{N}. \qquad (7)$$

Thus, the net spillover can be computed as the difference between the "to" and "from" directional spillover indices. It is described as:

$$S_{i}^{g}(H) = S_{*\leftarrow i}^{g}(H) - S_{i\leftarrow *}^{g}(H). \qquad (8)$$

4.2 Data Description

The core data used in this paper is the CPI. The CPI is a weighted average of the proportionate changes in the prices of a specified set or 'basket' of consumer goods and services between two periods. By monitoring the cost to purchase this fixed basket, analysts can determine how inflation is trending in the economy. The CPI gauges prices in 15 administrative areas in Trinidad and Tobago, making it nationally representative. Prices are recorded monthly, quarterly and semi-annually for different goods, services and sectors, which are then aggregated into three levels: headline, food and core **(Table 2)**.

- Headline inflation measures total consumer inflation within an economy, including commodities such as food and energy[7], which generally tend to be much more volatile and prone to inflationary spikes. Headline inflation may not accurately represent the economy's underlying inflationary trend since sector-specific inflationary spikes are usually transitory.
- Core inflation measures underlying inflation and excludes the most volatile component(s). Core inflation is calculated as the year-on-year per cent change in the CPI, excluding the food and non-alcoholic beverages sub-index.
- Food inflation measures the year-on-year per cent change in the food and non-alcoholic beverages sub-index in the CPI.

It should be noted that only selected sub-indices are retained in the final model specification. Additionally, a fiscal variable, government revenue (GR); and a monetary policy variable (MP) are included in the model **(Appendix 1)**. External variables including, West Texas Intermediate (WTI) prices and the United Nations (UN) Food and Agriculture Organisation's (FAO) Food Price Index (FAO) are also incorporated in the model. Data on inflation (CPI) was sourced from the Central Statistical Office (CSO). The data on government revenue was sourced from the Ministry of Finance (MoF), data on monetary policy (Repo Rate) was sourced from the Central Bank of Trinidad and Tobago. Data on the WTI crude oil price was sourced from Bloomberg while the data on the UN FAO Food Price Index was sourced from the FAO's website. Other variables were also considered in the model specification including the unemployment rate, the output gap, and US GDP. However, these were dropped in the final model

[7] Energy prices in Trinidad and Tobago are administered by the State. Domestic energy prices therefore do not exhibit the volatility usually associated with international energy prices.

selection[8]. All data with the exception of WTI were log-linearised and the model covered the sample period 2007QI to 2022QIV.

Table 2: Consumer Price Index Sub-Indices

Details	Weight
Headline Inflation	**1,000**
Food and Non-Alcoholic Beverages	**173**
Bread and Cereals	33
Meat	31
Fish	11
Vegetables	24
Fruits	6
Milk, Cheese & Eggs	21
Butter, Margarine, Edible Oils	10
Sugar, Jam, Confectionery, etc.	6
Food Products NEC	13
Non-Alcoholic Beverages	18
Core Inflation	**827**
Alcoholic Beverages & Tobacco	9
Clothing and Footwear	57
Furnishings, Household Equipment and Routine Maintenance	67
Health	41
Housing, Water, Electricity, Gas & Other Fuels	275
Education	10
Recreation & Culture	66
Hotels, Cafes & Restaurants	25
Transport	147
Communication	45
Miscellaneous Goods and Other Services	86

Source: Central Statistical Office

5. Discussion of Results

Before estimating the VAR, the variables were evaluated for stationarity using the Augmented Dickey-Fuller (ADF) Test and the Phillips Perron (PP) Test. VAR requires the data to be stationary. The results of the unit root tests are presented in **Appendix 1**. All of the variables (food, core and headline sub-indices as well as their selected sectoral components) were found to be integrated of order one (non-stationary). They therefore had to be differenced (times one) to become stationary. Following the estimation of the VAR, several model authenticity checks were undertaken to ensure a reliable model. It was found that the error terms of the estimated model are normally

[8] In specifying the model, the authors attempted to develop a Phillips Curve Model whereby inflation is a function of its determinants, comprising of supply and demand side factors including the output gap and the unemployment rate.

distributed, and the residuals are free from serial correlation and heteroscedasticity. The stability of the model was assessed using the eigenvalues of the companion matrix of the VAR model. The model was found to be stable as all the eigenvalues are inside the unit circle. The results of the lag order selection criteria suggest a total of three lags to remove autocorrelation and heteroscedasticity from the model.

The key ingredient for constructing the spillover indices is the GFEVD matrix. This measures the share of the variance of each of the CPI sectors (the rows) explained by shocks to each of the sectors (the columns). In other words, it measures how shocks to prices in particular sectors transmit to other sectors, which should reveal how individual price changes can morph into broad-based inflation[9]. **Table 3** displays the spillover calculations for the selected price indices of the CPI under review, and **Table 4** extends the analysis to include exogenous variables (international food prices and oil prices). The last two rows of Tables 3 and 4, respectively, report the total 'to connectedness' and 'net connectedness' of each CPI category i. Similarly, the last column of Tables 3 and 4 shows the 'from connectedness', which reflects the components that are receivers of inflation shocks that originated in other sectors.

The empirical results show that the total spillover index is 51.3 per cent, indicating a significant level of interconnectedness among the price indices **(Tables 3).** In other words, just over 50.0 per cent of the total forecast error variances across all price indices can be attributed to a spillover effect. Idiosyncratic shocks account for the remaining 48.7 per cent. Across the components of the CPI, Furnishing, Household Equipment and Routine Maintenance (111.5 per cent), Butter, Margarine and Edible Oils (83.4 per cent), and Milk, Cheese and Eggs (73.3 per cent) generated the highest share of inflation connectedness (transmitters of inflation spillovers) to other industries. These are followed by Transport (66.0 per cent), Fish (61.0 per cent), Bread and Cereals (59.9 per cent), Recreation and Culture (51.5 per cent), Non-Alcoholic Beverages (50.7 per cent), Fruits (39.8 per cent), Health (35.2 per cent) and Miscellaneous Goods and Services (30.3 per cent). CPI components with higher 'from connectedness', in other words, major receivers of inflation spillovers are Housing, Water and Electricity (70.9 per cent), Vegetables (70.0 per cent), Bread and Cereals (68.8 per cent), Butter, Margarine and Edible Oils (68.7 per cent), Furnishing, Household Equipment and Routine Maintenance (63.8 per cent), Transport (50.6 per cent), Fish (51.1 per cent) and Non-Alcoholic Beverages (49.4 per cent). This implies that these categories are more vulnerable to inflation shocks from other sectors. In examining the net spillover effects, the Furnishing, Household Equipment and Routine Maintenance (47.7per cent) and the Milk, Cheese and Eggs (26.0 per cent) categories were major net transmitters of inflation spillover. Thus, price increases in commodities within Furnishing, Household Equipment and Routine Maintenance (cleaning and maintenance products and large household appliances) can have significant spillover effects on other components of the CPI and core inflation. Similarly, increases in the price of items in the Milk, Cheese and Eggs category can have significant price spillover effects on other components of the CPI and by extension food inflation. Meanwhile, the Housing, Water, Electricity, Gas and Other Fuels (-43.7 per cent) and the Vegetable (-40.3 per cent) sub-indices are net receivers of price spillovers, implying that they are more responsive to price changes in other categories of inflation.

When exogenous variables (WTI Prices and the FAO Food Price Index) are incorporated into the analysis, the total spillover index increased to 58.9 per cent **(Table 4)**. The Furnishing, Household Equipment and Routine Maintenance (116.2 per cent) remained the main transmitter of inflation shocks, followed by Transport (93.3 per cent), Butter, Margarine and Edible Oils (91.2 per cent) and Milk, Cheese and Eggs (87.8 per cent). Meanwhile, the Bread and Cereals (83.9 per cent) followed by the Vegetables (75.2 per cent), Housing, Water, Electricity, Gas and Other Fuels (74.8 per cent) and the Butter, Margarine and Edible Oils (71.9 per cent) sub-indices were higher

[9] Another useful application is to look at the inflation connectedness across producer prices components to see whether there is any underlying relationship with its input-output network. In Trinidad and Tobago, data on producer prices is based on a 1978 base, while the CPI is constructed on a 2015 base. In the absence of more timely data, this analysis was omitted from the paper.

receivers of inflation spillovers. Net transmitters of inflation spillovers are the Furnishing, Household Equipment and Routine Maintenance (49.4 per cent), Transport (32.8 per cent) and Milk, Cheese and Eggs (27.1 per cent) sub-indices. Meanwhile, net receivers of inflation spillovers are the Vegetables (-41.2 per cent), Housing, Water and Electricity (-30.9 per cent) and Meat (-21.4 per cent) sub-indices. Examining price spillovers from international food prices to categories of domestic food prices **(Appendix 2)** shows Bread and Cereals (8.8 per cent), Fruits (4.8 per cent), Meat (2.9 per cent), Butter, Margarine and Edible Oils (2.2 per cent), Vegetables (1.6 per cent), Non-Alcoholic Beverages (1.5 per cent) and Fish (1.3 per cent) as major receivers of price spillovers. Similarly, the Housing, Water, Electricity, Gas and Other Fuels (13.0 per cent) followed by Furnishing, Household Equipment and Routine Maintenance (6.2 per cent), Recreation and Culture (4.7 per cent) and Transport (4.1 per cent) are major receivers of price spillovers from an oil price shock to core inflation categories of the CPI **(Appendix 3)**.

Table 3
Bilateral Price Spillover Across Retail Price Indices[1]
Source CPI Category

Destination CPI Category	Bread and Cereals	Milk, Cheese and Eggs	Meat	Vegetables	Butter, Margarine and Edible Oils	Fish	Fruits	Housing, Water and Electricity	Transport	Miscellaneous Goods and Services	Furnishing, Household Equipment and Routine Maintenance	Recreation and Culture	Non-Alcoholic Beverages	Health	Clothing and Footwear	From Others
Bread and Cereals	0.0	12.7	0.8	2.1	13.9	4.7	1.7	0.5	3.6	0.8	17.5	4.0	4.2	0.7	1.7	68.8
Milk, Cheese and Eggs	0.9	0.0	0.3	2.4	1.7	11.0	2.3	3.9	14.6	2.3	1.2	3.7	1.3	0.5	1.2	47.3
Meat	2.2	1.9	0.0	0.8	1.3	6.4	2.2	0.9	0.9	3.9	3.2	3.2	1.0	9.0	3.2	40.1
Vegetables	1.5	3.2	0.9	0.0	8.0	5.5	2.8	2.0	14.1	2.2	15.8	1.1	4.2	4.1	4.5	70.0
Butter, Margarine and Edible Oils	12.4	13.3	0.9	1.2	0.0	4.3	1.4	0.3	2.5	0.5	16.2	0.6	13.0	0.7	1.3	68.7
Fish	1.9	9.0	4.3	4.7	4.0	0.0	1.5	1.3	2.7	2.5	6.3	4.9	3.6	2.8	1.6	51.1
Fruits	2.0	2.8	0.5	3.4	2.8	6.3	0.0	2.6	3.4	2.7	4.3	6.6	2.2	1.4	1.2	42.1
Housing, Water, Electricity, Gas and Other Fuels	13.3	15.8	1.9	3.0	10.5	3.7	1.6	0.0	2.3	2.7	11.0	1.7	0.8	1.8	0.8	70.9
Transport	5.4	4.4	1.1	2.7	2.6	2.2	0.8	2.4	0.0	4.7	10.2	6.8	4.0	2.9	0.4	50.6
Miscellaneous Goods and Services	4.3	0.8	1.2	0.9	0.5	1.2	8.8	2.0	5.2	0.0	4.2	1.7	1.0	0.5	1.6	33.8
Furnishing, Household Equipment and Routine Maintenance	5.1	1.5	3.8	2.4	13.7	2.4	4.8	4.1	4.8	1.4	0.0	12.0	4.7	1.5	1.8	63.8
Recreation and Culture	5.1	2.6	0.3	1.0	0.5	5.9	8.4	0.9	5.4	2.5	2.5	0.0	0.8	0.6	0.7	37.0
Non-Alcoholic Beverages	2.4	2.3	1.9	1.1	17.2	2.3	1.5	1.7	1.4	0.4	10.0	1.7	0.0	3.5	2.0	49.4
Health	1.8	1.8	2.6	2.0	4.6	3.4	0.9	3.6	4.5	0.7	2.2	2.1	6.7	0.0	5.7	42.6
Clothing and Footwear	1.4	1.0	2.9	1.6	2.1	1.7	1.2	1.1	0.6	3.0	6.9	1.3	3.4	5.3	0.0	33.7
Contribution to Others	59.9	73.3	23.5	29.2	83.4	61.0	39.8	27.2	66.0	30.3	111.5	51.5	50.7	35.2	27.5	0.0
Contribution including own	91.1	126.0	83.4	59.2	114.8	109.8	97.6	56.3	115.4	96.5	147.7	114.5	101.3	92.7	93.8	51.3%
Net Spillover	-8.9	26.0	-16.6	-40.8	14.7	9.9	-2.3	-43.7	15.4	-3.5	47.7	14.5	1.3	-7.4	-6.2	

Source: Authors' Construction

1 Share of the variance of sectoral price changes explained by shocks to prices in other sectors over a horizon of 10 quarters.

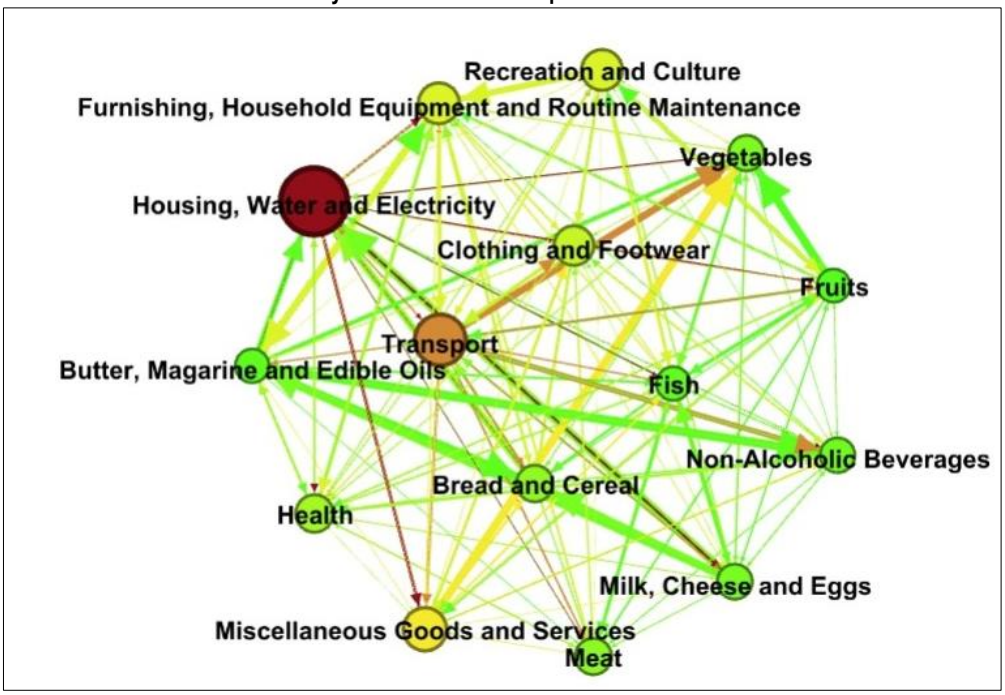
Table 4
Bilateral Price Spillovers across Retail Price Indices[2]
Source CPI Category

Destination CPI Category	Bread and Cereals	Milk, Cheese and Eggs	Meat	Vegetables	Butter, Margarine and Edible Oils	Fish	Fruits	Housing, Water and Electricity	Transport	Miscellaneous Goods and Services	Furnishing, Household Equipment and Routine Maintenance	Recreation and Culture	Non-Alcoholic Beverages	Health	Clothing and Footwear	Food and Agriculture Index	WTI Oil Price	From Others
Bread and Cereals	0.0	11.5	0.7	2.1	14.2	5.0	1.0	1.6	8.5	0.3	16.6	2.8	7.6	0.4	1.0	4.4	6.2	83.9
Milk, Cheese and Eggs	1.4	0.0	0.1	2.0	1.6	9.0	1.1	3.7	17.9	0.5	1.2	3.9	1.8	0.5	0.9	2.6	12.6	60.7
Meat	1.9	1.8	0.0	1.3	0.8	6.6	1.1	0.7	1.8	3.1	2.6	4.1	1.5	8.5	2.7	2.6	3.3	44.4
Vegetables	2.1	2.8	0.7	0.0	7.6	5.6	3.0	1.7	11.2	2.1	14.6	1.4	4.5	2.7	4.7	1.9	8.6	75.2
Butter, Margarine and Edible Oils	9.4	11.3	1.0	1.3	0.0	3.7	0.8	0.4	5.7	0.1	14.7	0.6	14.2	1.4	0.9	1.3	5.0	71.9
Fish	3.1	7.4	4.0	4.5	3.3	0.0	1.2	1.6	2.9	2.3	5.3	5.0	3.6	2.1	1.6	2.6	7.6	58.0
Fruits	1.9	1.2	0.3	3.3	2.6	6.3	0.0	3.9	4.5	1.2	3.9	7.2	2.1	2.6	0.8	5.3	3.9	50.9
Housing, Water, Electricity, Gas and Other Fuels	6.5	15.2	1.6	2.6	10.5	3.9	2.0	0.0	5.8	1.1	10.3	1.8	2.2	3.1	0.8	2.6	5.0	74.8
Transport	3.1	6.3	1.1	1.9	2.4	2.5	0.2	3.7	0.0	4.0	9.8	7.0	4.2	2.4	0.7	1.3	9.8	60.5
Miscellaneous Goods and Services	1.7	1.2	1.2	0.5	0.9	0.8	5.8	4.7	5.6	0.0	4.0	2.7	1.1	0.6	1.3	5.1	0.6	37.7
Furnishing, Household Equipment and Routine Maintenance	6.3	1.7	3.3	2.3	12.6	2.6	4.4	3.8	4.9	1.3	0.0	11.1	4.4	1.6	1.7	1.6	3.1	66.8
Recreation and Culture	5.3	2.2	0.2	1.0	0.4	5.7	8.4	1.0	6.2	2.6	2.3	0.0	1.0	0.4	0.6	1.3	6.5	45.2
Non-Alcoholic Beverages	6.3	3.8	2.8	0.6	15.8	2.5	0.6	2.3	2.1	0.4	9.2	2.2	0.0	4.4	1.8	0.7	0.9	56.2
Health	1.0	2.5	2.2	2.1	5.3	3.7	2.9	4.2	3.8	0.5	2.1	1.9	7.4	0.0	4.8	1.9	0.5	46.8
Clothing and Footwear	1.2	1.0	2.6	1.3	2.1	1.4	0.6	1.7	1.9	3.2	6.9	1.6	3.6	4.5	0.0	3.9	0.2	37.6
Food and Agriculture Organisation Index	11.7	8.5	0.5	5.1	7.9	4.0	0.8	6.4	2.6	1.4	7.9	2.9	2.0	1.7	1.9	0.0	2.6	67.7
WTI Oil Price	4.4	9.5	0.7	2.2	3.2	11.5	0.8	2.5	8.0	0.3	4.8	3.3	2.3	2.0	1.4	7.1	0.0	63.9
Contribution to Others	67.2	87.8	23.0	34.0	91.2	74.6	34.7	43.9	93.3	24.4	116.2	59.4	63.4	38.7	27.6	46.4	76.3	0.0
Contribution including own	83.3	127.1	78.6	58.8	119.3	116.6	83.8	69.1	132.9	86.6	149.4	114.2	107.2	91.9	90.0	78.7	112.4	58.9%
Net Spillover	-16.7	27.1	-21.4	-41.2	16.0	16.6	-16.2	-30.9	32.8	-13.3	49.4	14.2	7.2	-8.1	-10.0	-21.3	12.4	

Source: Authors' Construction
2 Share of the variance of sectoral price changes explained by shocks to prices in other sectors over a horizon of 10 quarters.

Another useful application is to display the inflation connectedness across components graphically. Using the network graphing convention applied in Bilgin and Yilmaz (2018) and the open-source Gephi software, a network visualisation of inflation connectedness measures is presented in **Chart 3**[10]. Node sizes are based on the weight of the sub-indices within the CPI. From the visualisation, Housing, Water, Electricity, Gas and Other Fuels; Transport; Furnishing, Household Equipment and Routine Maintenance; Miscellaneous Goods and Services; and Recreation and Culture make up the larger nodes. The weight of the line is equivalent to the bilateral spillover between sub-indices. The visualisation reflects the significant connectedness across the inflation components. The size of the connections is reflective of the bilateral spillover measures, which is strongest for Furnishing, Household Equipment and Routine Maintenance; Butter, Margarine and Edible Oils; and Milk, Cheese and Eggs[11].

Chart 3: Network Analysis of Bilateral Price Spillover Across Retail Price Indices



Source: Authors' Construction

A monthly version of the VAR model is also estimated to examine price changes over different periods of the business cycle. Using a monthly dataset across the following three sample periods: January 2007 - October 2012; November 2012 - September 2017; and October 2017 - December 2022[12], it is observed that price spillovers intensify during periods of high inflation and GDP growth and weaken during periods of low inflation and GDP growth **(Chart 4)**. This is in line with the finding that total spillovers are lower in a low-inflation regime (Bank of International Settlements 2022). For an economy like Trinidad and Tobago, it also highlights the procyclical

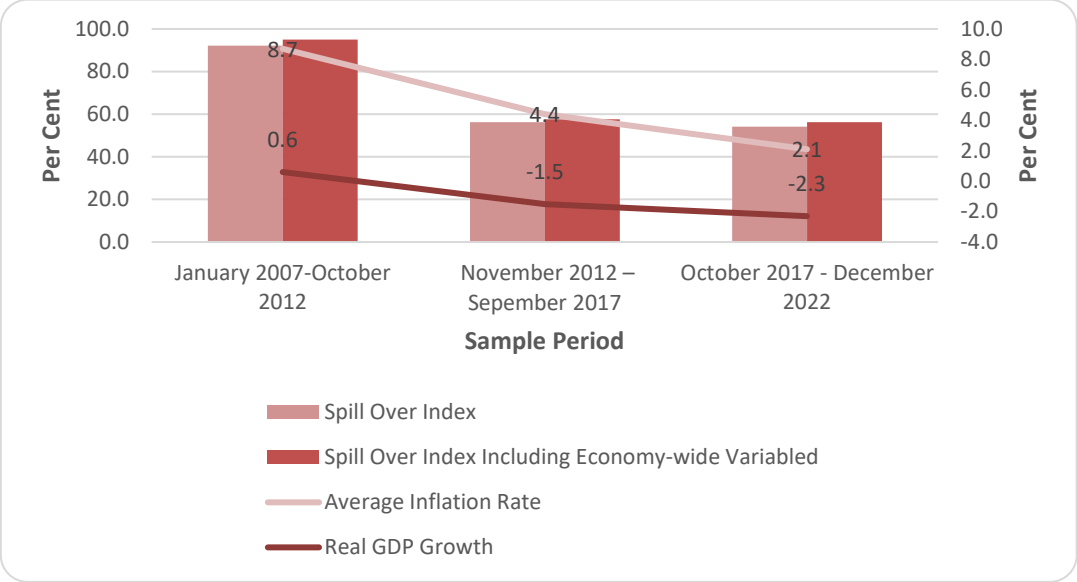
[10] Node locations are determined by the Fruchterman Reingold layout. The algorithm finds a steady state in which repelling and attracting forces exactly balance; nodes repel each other like similar poles of two magnets, while edges between two nodes attract their nodes, like springs. The attracting force of an edge is proportional to the average pairwise directional connectedness between the two nodes, which also determines the thickness of the edge. The Fruchterman Reingold layout is applied because of its force-directed nature, which locates nodes with strong connections close together, making it easier to see the network's structure. Label Adjust improves the readability of labels by adjusting the positions of the labels automatically and making the node labels more readable as the labels are not overlapping each other.

[11] The colour spectrum of the network shows bright green reflecting the smaller connection weights and the dark red reflecting the larger connection weights. The broken lines reflect the least connection weights.

[12] The sample periods were selected based on the availability of monthly data for the CPI indices and the need to have a minimum of 30 data points for each sample period – to satisfy the central limit theorem and assume normality.

behaviour of inflation, rising in periods of boom and falling in recessionary periods[13]. From the model results, total price spillovers were highest (92.2 per cent) during and after the period of the global financial crisis (2007-2009), when headline inflation went into double-digit territory and economic activity averaged 0.6 per cent[14] . Over January 2007 – October 2012, headline inflation averaged 8.7 per cent. Conversely, total price spillovers were lowest (56.2 per cent) from October 2017 to December 2022 when inflation averaged 2.1 per cent and real economic activity measured -2.3 per cent on average. Accounting for international factors such as international food prices (FAO Food Price Index) and WTI oil prices in the model, the estimates of total spillovers intensified, further highlighting the centrality of international food prices and energy in driving domestic price developments.

Chart 4: Bilateral Price Spillovers over Different Sample Periods



Source: Authors' Compilation

Impulse responses are also examined for the unrestricted VAR – to trace the response of headline, core, and food inflation to a one standard deviation shock to selected price indices and economy-wide variables **(Appendices 4 - 6)**. While it is expected that most of the sub-indices will have a positive contribution to food, core and headline inflation, the aim is to examine the timing and quantum of these responses as these can shape monetary policy and the Bank's reaction function[15]. The plots of the impulse responses reveal an overall positive response of headline, core, and food inflation to an increase in their respective price indices and economy-wide variables, with the exception of the monetary policy variable. The Bread and Cereals; Meat; Furnishing, Household Equipment and Routine Maintenance; Transport; Milk, Cheese and Eggs; Vegetables; and Housing, Water and Electricity sub-indices are found to have immediate and direct increasing effects on headline, food and core inflation. However, it should be noted that the timing and quantum of these effects differed for each sub-index. For example, the response of core inflation to a one standard deviation shock to the transport sub-index deteriorated after six months (2 periods), implying that the pass-through of higher fuel prices and ensuing transportation costs were complete

[13] Trinidad and Tobago is an energy-based economy whose economic prospects are largely based on the rents received from the sale of hydrocarbon resources. Historically, the country's spending behaviour has been greater in high commodity price cycles and lower in low commodity price cycles. Similarly, inflation has been procyclical, rising in periods of booms and declining in periods of recessions.

[14] In the absence of monthly estimates of real GDP, quarterly indicators of economic activity based on the Central Bank of Trinidad and Tobago's Quarterly Index of Real Economic Activity were utilised to inform the analysis.

[15] Reaction function is used to reflect the banks response to inflationary shock, if any.

after two quarters. Economy-wide variables, particularly exogenous factors such as international food prices and energy commodity prices, were also examined and were found to have increasing effects on headline, food, and core inflation. However, it should be noted that the responses of headline, food, and core inflation to these shocks were also dissimilar. The impact of a one standard deviation shock to oil prices was much more direct and immediate while there was a lagged effect for international food prices. This verifies the lagged transmission of international food prices to domestic prices, consistent with Mahabir and Jagessar (2011) and ECLAC (2008).

Finally, the impact of monetary policy on retail price components were considered. Price responses to monetary policy shocks can vary across sectors. In this section, the price responses of selected inflation categories to a one-standard deviation shock to monetary policy (contractionary) are examined **(Appendix 7)**. It is found that all the price indices (including the major categories) respond negatively to contractionary monetary policy, implying that contractionary monetary policy has a cooling effect on inflation. However, it should be noted that the response of core inflation to contractionary monetary policy is immediate and direct as opposed to food inflation. Food inflation has a delayed response, possibly since food inflation (historically) has a supply-side dynamic that may require supply-side intervention. Using monetary policy to affect the supply side may better be able to achieve results in the long-term as it speaks to increasing output through the credit and investment channels. This suggests that if inflation is being driven by factors within core inflation (traditionally a demand-side phenomenon), the use of monetary policy may be more effective. However, if overall inflation is being driven by food items, a combination of supply-side interventions and monetary policy may be required to control inflation.

6. Conclusion and Recommendation

The paper examines relative price changes within components of Trinidad and Tobago's CPI to identify the sources (sub-indices) that may propagate inflation. Price spillovers are also compared over different periods of the business cycle. The responses of different components of food and core inflation to monetary policy shocks are also examined. The empirical results show that there is significant inflation connectedness among the price indices. The Furnishing, Household Equipment and Routine Maintenance, Transport, and the Milk, Cheese and Eggs categories were found to be net transmitters of inflation spillovers, suggesting that they are propagators of higher inflation. Meanwhile, the Housing, Water, Electricity, Gas and Other Fuels, Vegetables, Meat, and Bread and Cereals sub-indices are net receivers of price spillovers, implying that they are more responsive to increases in other sub-categories of inflation. Adjusting for international factors, the results show that international food prices and energy prices contribute to the forecast error variance of price inflation. This variation increased during periods of relatively higher inflation and real GDP, and declined during periods of lower inflation and real GDP. In analysing the impact of monetary policy on components of inflation, contractionary monetary policy was found to have an immediate cooling effect on components of core inflation. However, its impact on food components was slower, possibly due to the supply-side dynamic associated with food prices, which may require supply-side policies and government (fiscal) intervention.

The paper has useful implications for policymakers in understanding price spillovers and managing inflation better. The results of the paper can assist policymakers to tailor policy concerning the underlying sources of inflation and their potential persistence. Given that the Furnishing, Household Equipment and Routine Maintenance; Transport; and Milk, Cheese and Eggs sub-categories were found to be strong net transmitters of inflation, upward impetus in prices in these categories can lead to spillovers into other categories through second-round effects. Strategies to limit price pressures in these categories can include fostering the nurturing and development of local manufacturers of furniture (and household equipment) and poultry in an effort to boost supply. Particular focus on these sectors can be assimilated into the Government's ongoing efforts towards developing the country's non-energy manufacturing sector. Regarding prices in the Transport sub-index, broadening the local energy mix to

reduce reliance on fossil fuels will help to alleviate the adverse spillovers from the volatility of international energy prices. In this regard, government can progress steps to transition to cleaner and/or renewable transportation fuels. On the flip side, the Housing, Water, Electricity, Gas and Other Fuels and Vegetables sub-categories were found to be the most receptive to price spillovers. Regarding housing, strategies can focus on managing growth in the cost of shelter, that is growth in the rental value of housing which account for the lion's share of the Housing, Water, Electricity, Gas and Other Fuels sub-category. These can include, increasing the level of investment in the public housing stock (single unit family homes and rental units) and further incentivising home construction by private contractors/investors. These will help to boost the housing supply and alter the supply/demand dynamics in the market, thereby containing increases in market rental value[16]. In terms of the Water, Electricity, Gas and Other Fuel components, it should be noted that these categories are, in part, subsidised by the Government and account for approximately 11.0 per cent of the sub-index. Thus, these administered prices can be directly impacted by government policy. Concerning the Vegetables sub-index, targeted incentives for the production of local agricultural produce can help to manage price pressures. Alternative methods of farming such as above ground cultivation, including hydroponics and the use of greenhouses can limit losses due to adverse weather (flooding) and other factors, and can assist in ensuring an adequate supply of produce in local markets.

Considering that international factors (international food and energy prices) contribute to the inflation process and are exogenously determined, the transmission of price spillovers from global food and energy may be managed by addressing the demand for foreign goods and services, through import substitution strategies. Managing the demand for foreign goods and services will require a shift in consumer taste and preferences in the consumption of local products. However, to facilitate this transition, there must be local substitutes. Therefore, boosting local agricultural and manufacturing output should be a priority. Moderating our demand for foreign goods and services also implies encouraging the manufacturing sector to infuse more local content into their production mix, thereby lowering their demand for those intermediate goods with high import content. Bobb and Sonnylal (2018) found that changes in the exchange rate influence domestic prices, due to changes in the cost of imported intermediate goods in the production process. There is potential to develop vertical linkages that can provide the necessary inputs, where possible, to the local manufacturing sector. Over time, with the development of such industries and adjustments to the import mix, imported inflation can be contained.

On the monetary policy front, it is found that monetary policy has a direct cooling effect on headline and core inflation, particularly categories of core inflation. Monetary policy is inherently forward-looking, and will only reach its full effect over time. As a result, improving knowledge of how long monetary policy takes to impact inflation can be pivotal in shaping monetary policy responses and keeping inflation expectations well anchored. Additionally, knowledge of the timing and quantum of the response of overall inflation to sectoral shocks as well as how sectoral price indices respond to monetary policy can be useful in calibrating the Bank's reaction function. Core inflation is much more responsive to contractionary monetary policy than food inflation, possibly because food inflation has a supply-side dynamic. As such, a combination of fiscal, monetary and structural policies working in tandem is required to effectively manage inflation.

[16] The CPI aims to capture the change in the consumption value of a home; that is, the price of the shelter it provides and not the change in the value of the home. As such, changes in the rental value is captured as a means of measuring the cost of shelter for homeowners. For property taxation purposes, the annual rental value is computed based on a calculation of the annual rent the property would attract if placed on the market.

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8. Appendices

Appendix 1

Results of the ADF and PP Unit Root Test

Acronym	Variable	Level	First Differenced	Second Differenced
FAO	Food and Agriculture Organisation Index		√	
WTI	West Texas Intermediate Oil Price	√		
GR	Government Revenue		√	
MP	Monetary Policy (Repo rate)		√	
HINF	Headline Inflation		√	
FINF	Food Inflation		√	
BC	Bread and Cereal		√	
ME	Meat		√	
VG	Vegetables		√	
MI	Milk, Cheese & Eggs		√	
NAL	Non-Alcoholic Beverages		√	
BM	Butter, Margarine, Edible Oils		√	
FH	Fish		√	
FR	Fruits		√	
HW	Housing, Water, Electricity, Gas and Other Fuels		√	
CINF	Core Inflation		√	
FU	Furnishings, Household Equipment and Routine Maintenance		√	
TR	Transport		√	
RC	Recreation and Culture		√	
CL	Clothing and Footwear		√	
HE	Health		√	

Source: Author's Construction

Appendix 2

Bilateral Price Spillovers Across Food Components of the RPI and FAO[2]

Spillover (Connectedness) Table

	dlbc	dlmi	dlme	dlvg	dlbm	dlfh	dlfr	dlnal	dfao	From Others
dlbc	33.0	14.2	0.2	4.4	18.2	7.1	1.3	12.7	8.8	67.0
dlmi	2.2	63.7	1.4	8.5	3.1	7.9	8.3	2.8	2.2	36.3
dlme	2.1	3.1	80.4	3.0	0.8	6.1	0.9	0.6	2.9	19.6
dlvg	5.4	8.5	2.7	60.6	5.2	6.3	7.4	2.4	1.6	39.4
dlbm	14.4	14.1	0.4	1.5	39.2	5.5	1.3	21.4	2.2	60.8
dlfh	3.5	6.8	9.6	11.9	2.0	61.1	1.2	2.5	1.3	38.9
dlfr	0.6	3.8	1.3	7.6	3.6	7.8	68.4	2.0	4.8	31.6
dlnal	10.6	3.6	0.7	0.2	19.1	2.9	0.6	60.9	1.5	39.1
dfao	15.1	9.3	0.7	2.9	12.8	4.7	1.1	6.2	47.2	52.8
Contribution to others	54.0	63.5	17.0	39.9	64.8	48.2	22.2	50.7	25.2	385.5
Contribution including own	87.0	127.2	97.4	100.4	104.0	109.3	90.6	111.7	72.4	42.8%

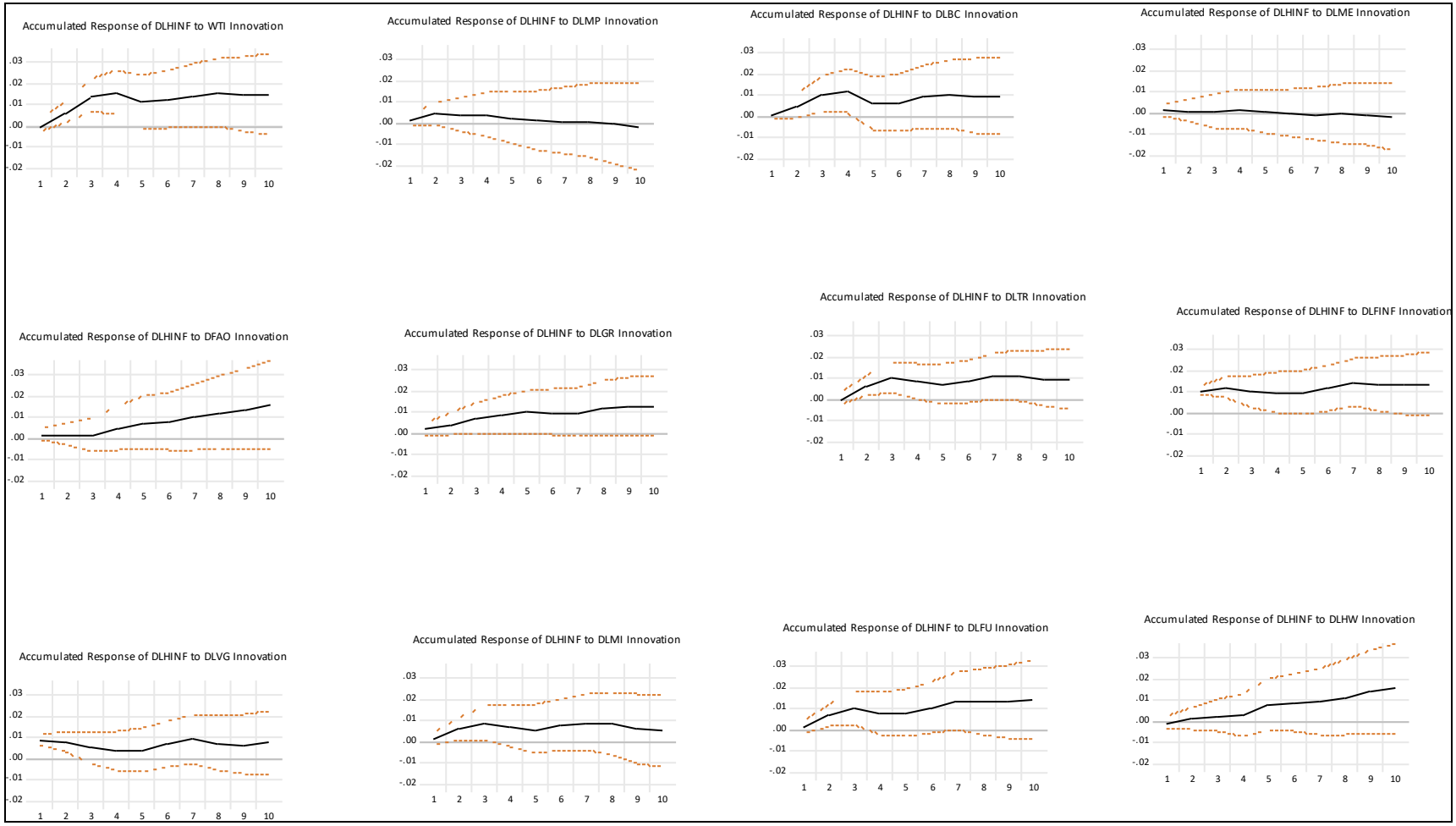
Appendix 3
Bilateral Price Spillovers Across Core Components of the RPI and WTI Prices[2]

Spillover (Connectedness) Table

	dlhw	dltr	dlms	dlfu	dlrc	dlhe	dlcl	wti	From Others
dlhw	60.2	1.0	3.0	17.6	1.9	2.3	1.0	13.0	39.8
dltr	4.5	69.3	6.2	7.6	6.5	1.0	0.8	4.1	30.7
dlms	2.8	8.0	80.8	1.2	4.3	0.2	2.5	0.3	19.2
dlfu	4.4	6.3	0.4	65.2	16.2	0.3	1.1	6.2	34.8
dlrc	1.4	8.0	4.3	4.9	75.6	0.6	0.5	4.7	24.4
dlhe	2.8	6.5	0.5	0.9	2.7	78.4	6.8	1.5	21.6
dlcl	1.8	1.0	5.3	3.8	1.5	5.7	80.4	0.5	19.6
wti	6.3	1.7	0.8	6.7	1.1	6.7	1.4	75.1	24.9
Contribution to others	24.0	32.4	20.4	42.8	34.2	16.8	14.2	30.2	215.1
Contribution including own	84.2	101.7	101.2	107.9	109.8	95.2	94.5	105.4	26.9%

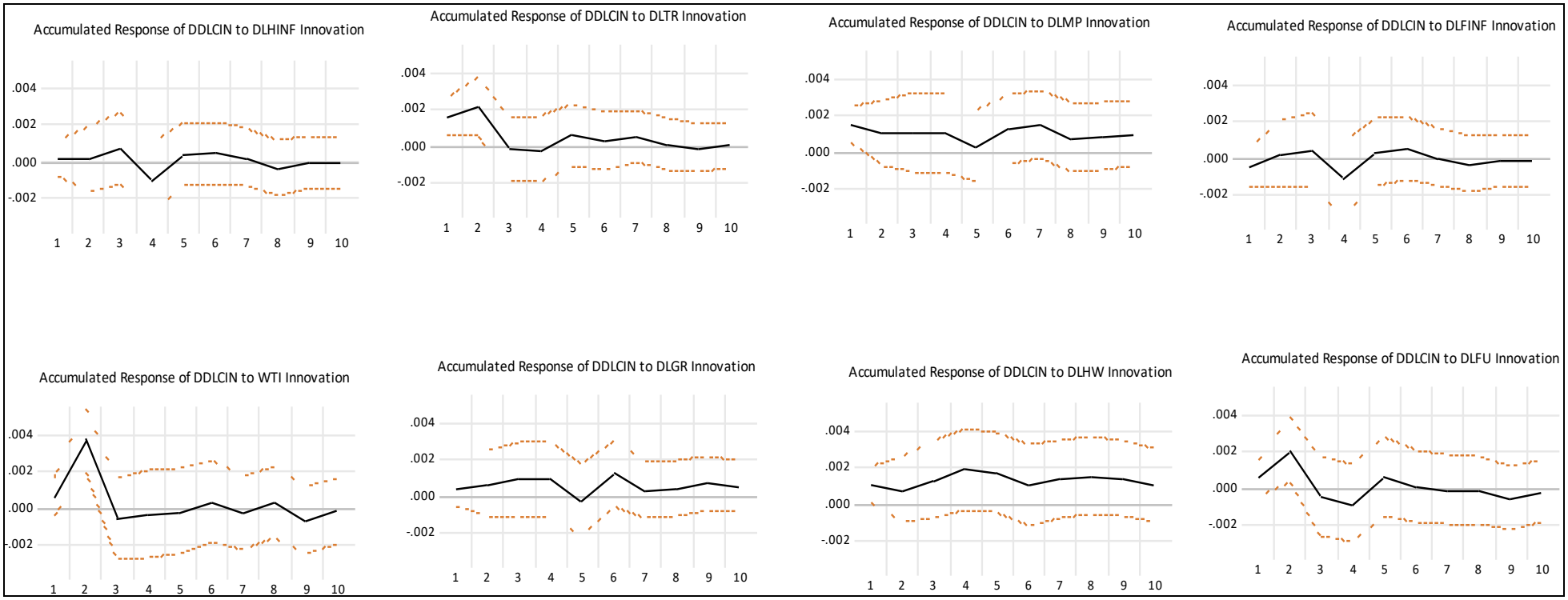
Appendix 4

Estimated Impulse Function Response of Headline Inflation to Selected Price Indices



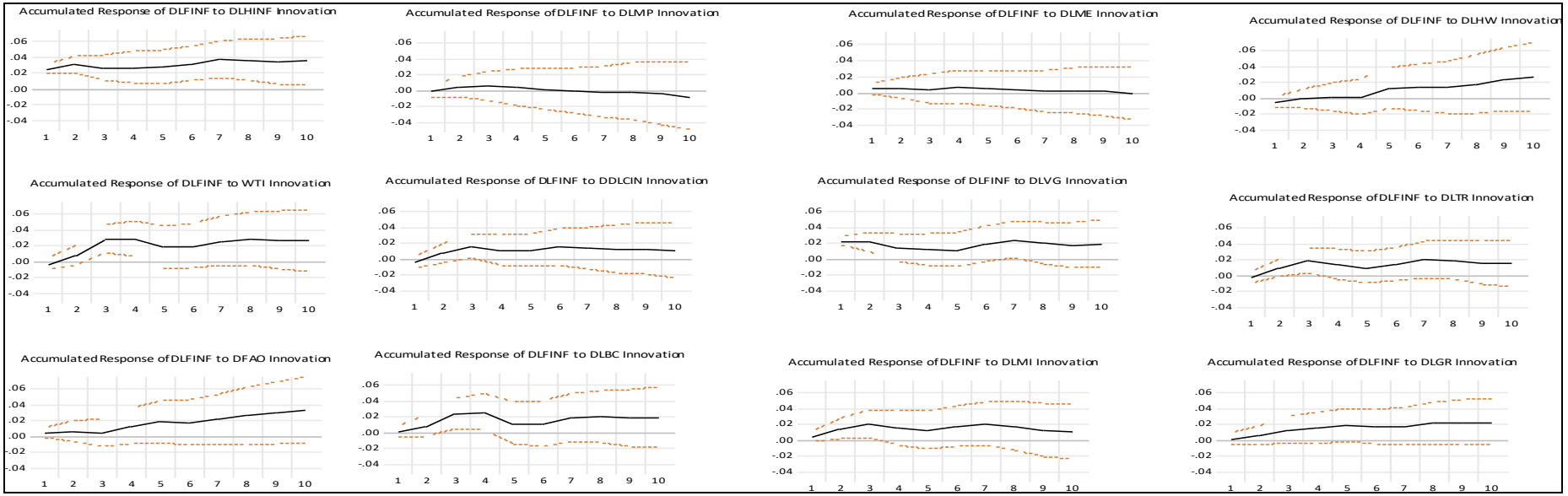
Appendix 5

Estimated Impulse Function Response of Core Inflation to a One Standard Deviation Shock to Selected Price Indices



Appendix 6

Estimated Impulse Function Response of Food Inflation to a One Standard Deviation Shock to Selected Price Indices



Appendix 7

Estimated Impulse Function Response of Selected Price Indices to Monetary Policy