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# Causes of food inflation in North America: COVID-19 and the Russia-Ukraine war

Food inflation in North America reached its peak in 2022, mainly driven by two factors: COVID-19 and Russia's invasion of Ukraine. COVID-19 disrupted the global supply chain, and triggered labour shortages; consequently, governments in all three North American countries adopted fiscal and monetary policies to offset the impact of the pandemic, mostly by providing direct assistance to businesses and households and by lowering interest rates. The invasion of Ukraine, a major exporter of grain and vegetable oil, increased commodity prices and contributed to higher food prices. Overall, food inflation in the U.S. varies according to both sector and timeframe. In response to the Russian invasion, cereal product prices in the U.S. have increased, whereas meat prices spiked during the COVID-19 pandemic. This study focuses on determining the key factors that have led to higher food inflation in North America, and more specifically the United States. We have found that the unemployment rate, an index of global supply chain pressures, and COVID-19 related aid have directly contributed to U.S. food inflation. Projections from several organisations suggest food inflation will decline in 2023 and 2024.

**Keywords:** COVID-19, food inflation, meat price volatility, and Russia-Ukraine war

**JEL classification:** Q11

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## Introduction

Over the last two decades, average annual inflation in North America has been low or stable. In the U.S. and Canada, annual food inflation averaged 2.3% and 2.6%, respectively, between January 2001 and February 2020 (BLS, 2023a; Statistics Canada, 2023). However, things have changed since then, as two major events occurred. They are: firstly, in 2020, the COVID-19 pandemic; and secondly, in February 2022, the Russian invasion of their neighbouring country Ukraine, which significantly disrupted the supply chain - resulting in a substantial increase in food inflation across the globe. While both events are still ongoing, it is undeniable that the combination of COVID-19 plus the invasion of Ukraine by Russia has substantially increased inflation, and food inflation is not an exception.

In March 2020, the World Health Organisation declared the outbreak of COVID-19 to be a pandemic<sup>1</sup>. Following that declaration, many countries adopted stricter lockdowns and consumer food consumption patterns changed. Disruptions of supply chains impacted the availability and price of many food products. Later, another major world event occurred in February 2022 when the conflict between Russia and Ukraine started, which reduced supplies of grains and vegetable oil and otherwise strained the already fragile supply chain globally (Kim, 2022). As a result, COVID-19 and the war have raised inflation to a level that the world has not seen in decades.

Russia and Ukraine are the world's largest exporters of grains and oilseeds. Between 2016-17 and 2020-22, their combined export share in respect of barley, wheat, and maize was 32%, 38%, and 18%, respectively (Just & Echaust, 2022). The onset of war between those two countries, as well as the resultant disruption of the global supply

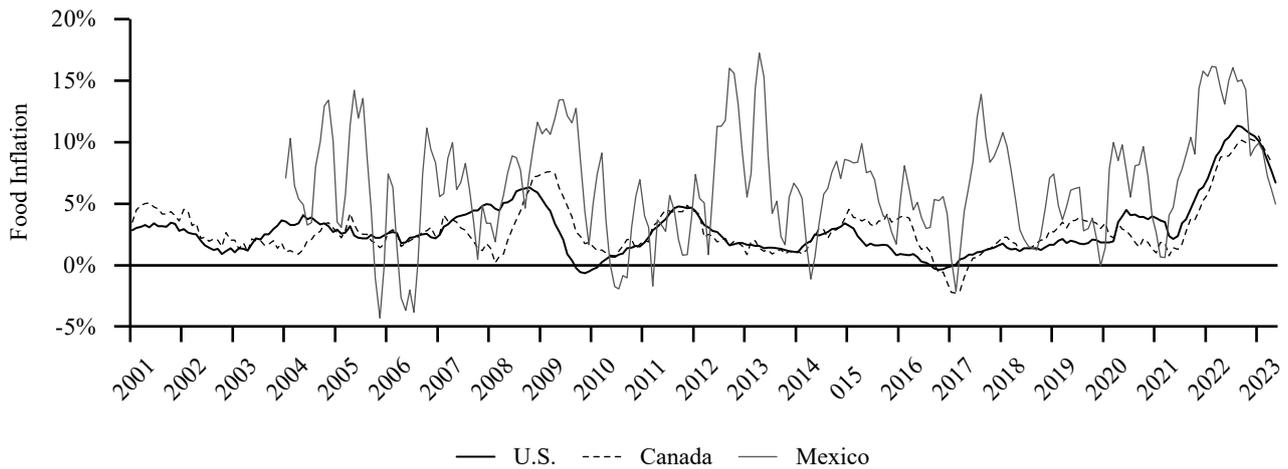
chain of wheat, significantly affected trade and agricultural production, resulting in higher prices in 2022. Moreover, the war has disrupted the supply of energy, fertiliser production, and the supply chain, whose combined impact can be felt far beyond the immediate region - leading to levels of inflation that the world has not seen since 1970s. This poses a threat to food security.

In keeping with other parts of the world, in Northern America food inflation increased during the COVID-19 pandemic and it has been further aggravated since the start of the war, as shown in Figure 1. In the U.S., average annual food inflation has increased from 2.3% pre-COVID to 4.2% during COVID-19 between March 2022-February 2022 and still further to 10.4% during both COVID-19 and the period after the war began, between March 2022 and December 2022. Canada and Mexico have followed similar patterns. Food inflation in Canada has increased from a pre-COVID-19 level of 2.6% to 9.4% and in the case of Mexico, it has increased from 4.5% to 13.7% (BLS, 2023a; SNIIEG, 2023; Statistics Canada, 2023).

The conflict between Russia and Ukraine started in February 2022, when the global food price was still recovering from the disruption of the supply chain due to COVID-19. Agricultural commodity markets were still rebounding after the COVID-19 episode. Just and Echaust (2022) have found that the Russia-Ukraine war may have increased uncertainty in the global food market. There is enough evidence to support the belief that the high food inflation witnessed across the world was triggered by those two events. However, since January of 2023 food inflation has been falling sharply as shown in Figure 1, as the Central Bank is tightening the money supply in a process which is commonly known as 'Quantitative Tightening'<sup>2</sup>

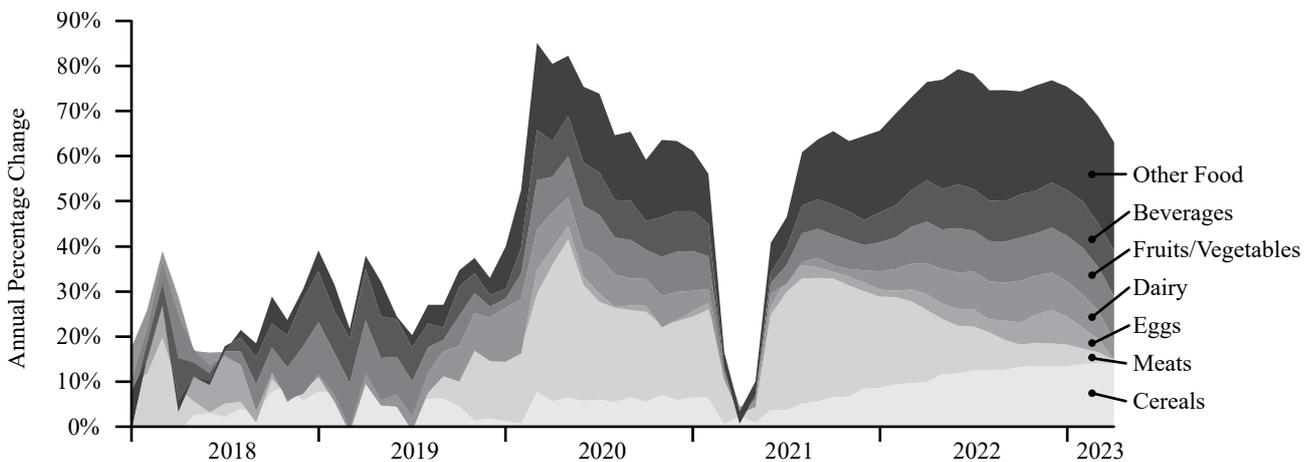
<sup>1</sup> <https://www.who.int/europe/emergencies/situations/covid-19>

<sup>2</sup> <https://www.stlouisfed.org/en/open-vault/2019/july/what-is-quantitative-tightening>



**Figure 1:** Food inflation in the U.S., Canada, and Mexico.

Source: BLS, 2023a; SNIEG, 2023; Statistics Canada, 2023



**Figure 2:** Product-level contributions to monthly U.S. food at home price inflation. Each food group is weighted by its share in BLS's food basket.

Source: BLS, 2023a

## Inflation in North America

The countries in Northern America have seen record inflation as shown in Figure 1. In this section we will discuss inflation during the COVID-19 and COVID-19 + War era in first the U.S., then Canada, and finally, Mexico.

### Inflation in the United States

There are both domestic and international or external factors that played a significant role in drastically increasing inflation in the U.S. The major international (external) factors are: the COVID-19 pandemic and associated policy responses; disruption in the global supply chain; the U.S.-China trade war; the imposition of a stricter lockdown in China, and Russia's invasion of Ukraine. Domestic factors include: governmental fiscal and monetary responses to the pandemic which, led by the Federal Reserve, substantially lowering interest rates during the COVID-19 period (Chafuen, 2021), and labour shortages, to name just a few. The agricultural labour shortage during the COVID-19 period was

triggered by a lack of available immigrant labour attributable to border closures and transportation challenges<sup>3</sup>, followed-by the "great resignation" period<sup>4</sup>. The impact of inflation was felt everywhere in the economy. Between December 2021 and 2022, the consumer price index for food prices in the U.S. increased by 10.4%, and the price of energy increased by 7.3% (Mbah *et al.*, 2023). The food basket of the U.S. CPI – a standard measure of food inflation – is divided into two parts: 1) food at home, and 2) food away from home. The first component carries more weight and, hence, is more important to understand food inflation in the U.S. Overall, food-at-home inflation has increased consistently since COVID-19 started, but its sub-categories have changed in different ways within that timeframe, suggesting that the underlying reasons behind high food inflation in the U.S. may vary. Figure 2 shows that different factors have impacted U.S. food prices at different times. Meats were the dominant factor behind high food inflation when COVID-19 started, for example, in mid-2020 it comprised more than one-third of the food-at-home inflation.

<sup>3</sup> <https://agamerica.com/blog/labor-shortage-impact-on-fruit-and-nut-farms/>

<sup>4</sup> <https://hbr.org/2022/03/the-great-resignation-didnt-start-with-the-pandemic>

However, the contribution of other food at home, i.e., fats and oils, and cereals, became significant and began to outweigh meats' contribution following Russia's invasion of Ukraine. While overall food inflation has started to recede in 2023, other food and cereal prices are still contributing to the overall U.S. food inflation.

However, the inflation rate is expected to fall to 3.5% in 2023 and it is projected to fall further to 2.2% by 2024 (International Monetary Fund, 2022), as the Federal Reserve is periodically increasing interest rates.

### Inflation in Canada

Inflation in Canada has been driven by the following similar factors: the rise in commodity prices due to disruptions in the supply chain induced by the Russia-Ukraine war; a significant spike in consumer demand; and a tightened labour supply due to the impact of COVID on immigration. According to a recent survey performed by Statistics Canada, 43% of respondents believed that inflation has impacted food prices the most. Between April 2021 and April 2022, food prices in Canada increased by 9.7%, causing Canadian to pay substantially higher prices for basic foods items that include fruits, vegetables, and meat (Statistics Canada, 2022). Amid the current high inflation, the Canadian administration – in an attempt to lower the inflation rate to 2% – announced several new monetary policies, including hiking the interest rate (Maguina, 2022). However, Canada may find itself heading towards a recession in 2023, if their interest rate hike – whose purpose was to bring down inflation – has worse consequences than anticipated (Lajartre, 2022).

### Inflation in Mexico

During the pandemic, the food supply chain in Mexico was affected by a sudden change in consumer behaviour, as more people has started dining at home: either by choice, or because they were forced to do this by lockdown. This abrupt change forced food suppliers to pivot from producing foods designed to be served in restaurants to instead producing goods for grocery stores (Smith, 2022). In fact, changed eating habits on the part of consumers has impacted the food and agriculture industry not only in Mexico, but also in the U.S. and Canada. Russia's invasion of Ukraine, which triggered disruption of the wheat supply chain from the world's food basket to the rest of the world, has significantly impacted energy and commodity prices in Mexico. Food inflation, when taken to include processed food and beverage prices, rose by 14.1% while fresh produce rose by 9.5%. In 2021, energy costs went up by 2.9% (Harrup, 2023). A Banxico (Bank of Mexico) study hinted that the rate of inflation may have reached the highest level during the third quarter of 2022, and it is expected to drop to 3% by the end of the third quarter of 2024 (CE Noticias Financieras, 2023). After reaching 8% in 2022, overall inflation is expected to fall to 6.3% in 2023 and it could fall further to a stable rate of 3.9% in 2024.

Previous studies have applied time series techniques to estimate spillover effect of inflation from one country

to another (Aharon and Qadan, 2022; Caldara *et al.*, 2022; Jordan, 2016; Pham and Sala, 2022; Saâdaoui *et al.*, 2022; Shahzad *et al.*, 2023; Tiwari *et al.*, 2019). Another group of studies (Cao and Cheng, 2021; Hung, 2021; Just and Echaust, 2022; MacLachlan *et al.*, 2022; Zhu *et al.*, 2021) have focused on cross commodity inflation, while others have emphasised analysing the role of monetary policies on inflation (Frick, 2022; Friedman, 1970, 1983; Hansen, 1951; Jahan and Papageorgiou, 2014; Mbah *et al.*, 2023). However, unlike these studies, we have focused on tracing the root cause of inflation in Northern America. In this study, we determine the factors that have led to food inflation in Northern America, and more specifically, the U.S. The primary objective of this study is to estimate the impact of COVID-19 and Russia's invasion of Ukraine on the U.S. food inflation. We further estimate several alternative models to gauge whether there is a causal relationship between U.S. food inflation and external and internal factors related to the inflation.

## Data and Methodology

### Data

This article utilises several data sources to measure factors behind recent high food inflation in the U.S. We have used observations for the last five years on monthly basis from January 2013 to December 2022 to capture the most frequent variations in the food inflation.

The majority of the information used in this study was obtained from the U.S. Bureau of Labor Statistics (BLS, 2023a), notably national inflation and labour market statistics. For the target variable, we used seasonally adjusted monthly Consumer Price Index (CPI) for food, collected throughout major cities in the U.S. We then converted the food CPI to food inflation (FI) by calculating the monthly percentage change in CPI from one year to another year to understand how food prices changed from year to year on monthly basis. We also used CPI for all items and converted it into headline inflation. Our target variable remains food inflation; however, we wanted to understand how the two measures changed over the observed period.

We used the Current Population Survey of the BLS (BLS, 2023b) to understand labour force linkages with food inflation. We used seasonally adjusted monthly total unemployment (TU), seasonally adjusted monthly unemployment rate (U), and total job openings in non-farm sector (TV). To capture both elements of labour supply and demand in the market, we used the ratio of total job openings to total unemployment represented henceforth as unemployment ratio (UV):

$$UV_t = TV_t/TU_t \quad (1)$$

Ball *et al.* (2022) observed that the ratio explained more variation in core inflation, hence, we also relied on this ratio to capture its influence on food inflation. In macroeconomics, this association is captured through the Beveridge curve

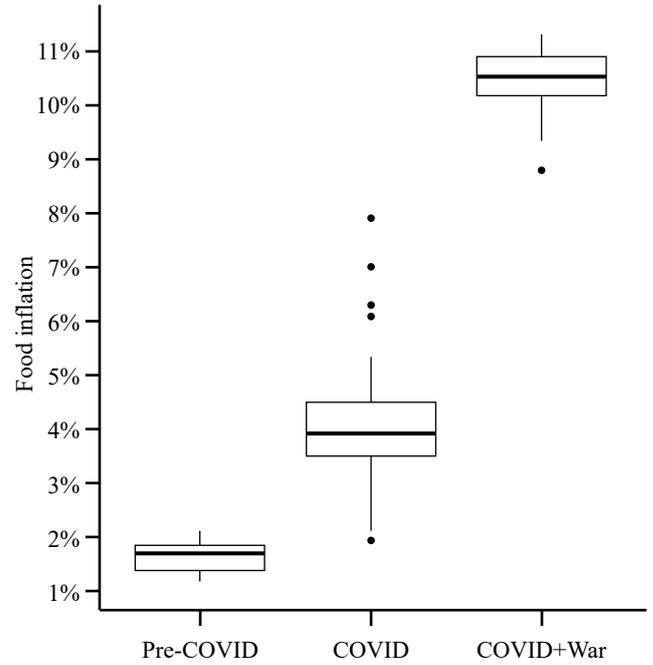
and suggests an inverse link between the two where more job openings reduce unemployment level (Yashiv, 2006).

To capture supply-side disturbances, we used the newly established Global Supply Chain Pressure Index (GSCPI) by the Federal Reserve Bank of New York. The index captures many aspects of the trade and supply lines among major trading economies in the globe. The set of indicators used in the index captures cost of shipping and air transportation, cost of raw materials, country specific manufacturing data in seven global economies, and indicators that capture delivery time, backlogs and purchased stocks (Benigno *et al.*, 2022). The GSCPI comprises data on Baltic Dry Index (BDI), Harpex index, BLS data, and IHS Markit’s Purchase Manager Index (PMI) surveys. Among the seven economies, China is of the particular importance when it comes to supply chain conditions. Other economies are Japan, Korea, Taiwan, EU, UK, and the U.S. We believe this index is comprehensive enough to capture many supply issues encountered since onset of the COVID-19.

We used COVID-19 stimulus (COVIDAID) data to understand how COVID-19 related financial aid could have impacted food inflation in the U.S. (USASPENDING, 2023). We used the amount of money awarded through contracts by federal government to individuals, organisations, businesses, or state, local, or tribal governments. We then aggregated the award spendings by month to capture demand side influence arose from pandemic related aid on food inflation.

Russia’s invasion of Ukraine has also contributed to food inflation in the U.S. since it began in February 2022. Input costs such as oil, natural gas, and market uncertainty arising from supply chain disruption increased commodity prices in the U.S., which in turned increased food prices. Wheat futures increased by 60% and corn and soybean futures by more than 15% in the immediate aftermath of Russian invasion (Glauber, 2023). In 2021, the top Ukrainian agricultural exports were corn, wheat and barley among grains, and sunflower seed, sunflower oil, and sunflower meal among oilseed products (USDA, 2022). We extracted monthly Ukrainian export (EXPUR) data for these six commodities from UN Comtrade Database and then aggregated them in our model to understand the war’s effects on food inflation (UN, 2023).

Additionally, we added two dummy variables: COVID and COVID+WAR to capture the overall impact of those events. COVID is a dummy variable with two levels capturing the timing since COVID-19 started. “Pre-COVID” refers



**Figure 3:** Comparison of the U.S. food inflation between pre-COVID period and COVID and COVID+War period.

Source: BLS, 2023a

to the timing from January 2018 to February 2020, while “COVID” refers to the period after COVID infections began to increase rapidly around the world in March 2020. Though COVID-19 broke out in early 2020, its influence began to be felt in earnest around March 2020, and particularly so in the U.S., in terms of affected cases and deaths from the virus. COVID+WAR is also a dummy variable with two levels that captures the timing of the war started in Ukraine in late February 2022. “Pre-War” refers to the timing from January 2018 to February 2022, while “War” refers to the time from March 2022 to December 2022. The “War” period also overlaps with the “COVID” period, that war occurred while COVID-19 was still ongoing. Therefore, we called this period as “COVID+WAR”.

U.S. food inflation increased substantially during the COVID period, and further accelerated as the war between Ukraine and Russia commenced. Average food inflation was 2.3% before COVID-19, jumped to 4.2% when COVID-19 started, and it averaged 10.4% between March and December 2022 as shown in Figure 3.

**Table 1:** Descriptive statistics of the monthly data from January 2018 to December 2022.

	Headline Inflation, %	Food Inflation (FI), %	Unemployment Rate (U), %	UV <sup>a)</sup>	GSCPI <sup>b)</sup>	Covid Aid (COVIDAID) Million USD	Ukraine Exports (EXPUR) 000 MT
MIN	0.23	1.16	3.50	0.20	-0.65	0	1,232
1 <sup>st</sup> Qu.	1.70	1.76	3.60	1.00	0.39	0	3,608
Mean	3.64	4.12	4.94	1.20	1.39	654	4,823
3 <sup>rd</sup> Qu.	6.02	5.13	5.70	1.52	2.67	942	5,838
MAX	8.93	11.33	14.70	2.01	4.31	4,893	7,791
SD	2.64	3.20	2.33	0.46	1.33	921	1,493
CV	0.73	0.78	0.47	0.38	0.95	1.41	0.31

<sup>a)</sup> The ratio of job openings to unemployment. <sup>b)</sup> Global Supply Chain Pressure Index. Note: SD: Standard Deviation, CV = Coefficient of Variation. Source: Own composition based on UN (2023) and USDA (2023) data

## Methodology

We arranged all data on a month-to-month basis and ran ordinary least square (OLS) regressions to understand COVID-19 and war-related factors affecting food inflation in the U.S. We only used the last five complete years of monthly data, from January 2018 to December 2022, with 60 observations. In so doing, we followed the approach of Ball *et al.* (2022), who used OLS regressions to understand variations in food inflation using, food prices, Global Supply Chain Pressure Index, and backlogs of work among others. Table 1 provides descriptive statistics for the data we used in this model.

Table 1 indicates that in the last five years on average, food inflation was higher than headline inflation and exhibited both more extreme values and more variation, since it has a higher coefficient of variation. GSCPI data indicates that the overall index remained low except in the last quantile, which drove the mean value and variation. COVID-AID indicates that around five billion USD had been spent on COVID-19-related award contracts by the end of 2022 (USASPENDING, 2023). EXPUR has gradually increased over the last five years, except during the time of the Russian invasion, at which point Ukrainian agricultural exports dropped significantly until the Black Sea Grain Initiative was signed in late July 2022.

We have estimated multiple regression models to understand how food inflation is influenced by some of the factors mentioned earlier in Table 1:

$$FI_t = \alpha_1 + \beta_1 U_t + \gamma_1 GSCPI_t + \delta_1 COVIDAID_t + \varepsilon_1 \quad (2)$$

where food inflation (FI) is a function of unemployment rate (U), the global Supply Chain Pressure Index (GSCPI), and COVID assistance (COVIDAID) in year  $t$ .  $\alpha_1$ ,  $\beta_1$ ,  $\gamma_1$ , and  $\delta_1$  are the intercept and slope coefficients, respectively.  $\varepsilon_1$  is the error term which is independent and identically distributed  $\varepsilon_1 \sim iid(0, \sigma^2)$ .

From the macroeconomic literature, we expect a negative sign on  $\beta_1$  since this represents the well-known Phillips Curve.  $\gamma_1$  shows how the supply chain issues could have impacted food inflation, and we expect a positive sign on this parameter. We also expect a positive sign on  $\delta_1$ , implying that increased COVID-19 assistance could have impacted food inflation through demand-pull.

Model 2 also estimate U.S. food inflation. Here, we introduce the ratio of job openings to unemployment:

$$FI_t = \alpha_2 + \beta_2 UV_t + \gamma_2 GSCPI_t + \delta_2 COVIDAID_t + \varepsilon_2 \quad (3)$$

where,  $\alpha_2$ ,  $\beta_2$ ,  $\gamma_2$ , and  $\delta_2$  are the intercept and slope coefficients, respectively.  $\varepsilon_2$  is the error term which is independent and identically distributed  $\varepsilon_2 \sim iid(0, \sigma^2)$ .

Here, all right-hand side variables have remained the same from Eq. (2), expect that we have changed the unemployment rate with UV from Eq (1). Since UV is the ratio of job openings to unemployment, it satisfies all the properties of ratio, where we expect a positive correlation between food

inflation and job openings and a negative one between food inflation and unemployment.

In model 3, we have extended Eq. (3) by adding Ukrainian agricultural exports to the model to capture influence of war-related factors on food inflation, as shown in Eq. (4):

$$FI_t = \alpha_3 + \beta_3 UV_t + \gamma_3 GSCPI_t + \delta_3 COVIDAID_t + \theta_3 EXPUR_t + \varepsilon_3 \quad (4)$$

where,  $\alpha_3$ ,  $\beta_3$ ,  $\gamma_3$ , and  $\delta_3$  are the intercept and slope coefficients, respectively.  $\varepsilon_3$  is the error term which is independent and identically distributed  $\varepsilon_3 \sim iid(0, \sigma^2)$ .  $\theta_3$  can explain how the Russian-Ukraine war elements contributed to the food inflation.

Lastly, in model 4, we introduced two dummies along with the unemployment ratio as shown in Eq. (5):

$$FI_t = \alpha_4 + \beta_4 UV_t + \rho_4 COVID_t + \lambda_4 (COVID + WAR)_t + \varepsilon_4 \quad (5)$$

where,  $\alpha_4$ ,  $\beta_4$ ,  $\gamma_4$ , and  $\delta_4$  are the intercept and slope coefficients, respectively.  $\varepsilon_4$  is the error term which is independent and identically distributed  $\varepsilon_4 \sim iid(0, \sigma^2)$ .  $\rho_4$  explains if the difference between “Pre-COVID” and “COVID” was significant, while  $\lambda_4$  shows if the true difference between “NO-WAR” and “COVID+WAR” was significant on food inflation.

## Results and Discussion

We have estimated four models to understand how COVID-19 and war-related factors influenced food inflation in the U.S. Table 2 presents the findings of our regression models. The components of our first equation are unemployment rate (U), the Global Supply Chain Pressure Index (GSCPI), and COVID-19-related assistance provided by federal government (COVIDAID). We have found that all the three variables contributed significantly to food inflation in the U.S.

From the macroeconomics literature we expect a negative link between unemployment and inflation (including food inflation). This relationship is well documented through the famous Phillips curve. We found that estimated  $\beta_1$  is -0.297 significant at the 5% level. This was particularly evident when unemployment rate jumped to record-high 14.7% in April 2020 with the start of COVID and then gradually decreased from there, eventually reaching a plateau at the end of 2022, whose level was similar to where it started out before COVID-19 occurred.

With the start of COVID-19, global supply and trading issues emerged due to labour shortages and lockdowns. The GSCPI index shot up for the first time by 1.37 points in March 2020, but subsided in the later months. However, the GSCPI started to increase further in 2021 and peaked at 4.31 at the end of 2021, from there it receded but remained higher than pre-COVID-19 levels. In our model estimated  $\gamma_1$  is 0.798 and contributed to food inflation positively, as expected.

Plotting monthly food inflation against GSCPI in Figure A1 supports the hypothesis that food inflation positively responded to global supply issues. Sub-setting data among COVID-19 and the COVID+WAR period further indicates that throughout 2020 and 2021, food inflation increased to coincide with supply-chain constraints, but later supply issues gradually improved as countries adjusted to the “new” normal conditions during COVID-19 period. However, since 2022 food inflation and GSCPI were not positively correlated. In fact, the relationship turned negative, as other factors started to influence food inflation in the U.S., notably factors related to the Russia-Ukraine War.

On the demand side, our model indicates that the COVID-19 stimulus encouraged food inflation in the U.S. by injecting money into the market, leading to higher expenditure and more personal consumption while supply issues were still persistent. This is because in response to the weakening economy due to COVID-19 spread, the U.S. government passed the Coronavirus Aid, Relief, and Economic Security (CARES) Act promising 2.2 trillion USD in March 2020. Later, the American Rescue Plan Act further obligated 1.9 trillion to COVID-19 response in March 2021. In total, 4.51 trillion USD has been earmarked for pandemic response, out of which, so far 4.21 trillion USD has been paid to individuals, organisations, businesses, or state, local, or tribal governments as contracts or financial assistance (USASPENDING, 2023). In our model estimated  $\delta_1$  is 0.002 and hence supported our hypothesis that COVID-19 assistance positively contributed to food inflation. Figure A2 highlights that linkage.

Model 2 improved on the first one, as we are using the ratio of job openings to unemployment (unemployment ratio) instead of just using unemployment rate. Using the unemployment ratio significantly improved the model fit by increasing R-squared from 0.59 to 0.70, while retaining the remaining variables. The reason could be that the ratio captures both labour supply and demand into the market. The two significantly diverged when COVID-19 hit unemployment, causing the ratio to decline significantly. However, later job openings outpaced unemployment and the ratio peaked around the start of 2022. In our second estimated model,  $\beta_2$  is 2.984 indicating that higher job openings from economic prosperity leads to higher food inflation, or that a lower unemployment rate leads to food inflation (as shown in Figure A3).

In Model 3, we have improved things further by adding an indicator EXPUR that was impacted by Russia-Ukraine war. EXPUR predict how war intensity could have impacted food inflation in the global level, including the U.S. Adding that element has further improved our model; R-squared increases to 0.72. Interestingly, while the estimated  $\theta_3$ 's sign is consistent with the theory, the coefficient is not statistically significant. This suggests that we have no evidence to conclude that the impact of Russia's invasion of Ukraine on agriculture commodities has influenced U.S. food inflation.

Finally, we have run a regression with two dummies representing COVID-19 and COVID+WAR periods along with the unemployment ratio – Model 4. This model shows the most variation in food inflation with improved R-squared of 0.93. Both coefficients  $\rho_4$  and  $\lambda_4$  were statistically significant,

**Table 2:** U.S. food inflation estimates.

Explanatory variable	Dependent variable: Food Inflation, %			
	(Model 1)	(Model 2)	(Model 3)	(Model 4)
Intercept	3.097	-1.303	-0.030	-0.213
Unemployment Rate (U)	0.297* (0.123)			
Unemployment Ratio (UV)		2.984*** (0.541)	2.951*** (0.533)	1.600*** (0.340)
Global Supply Chain Pressure Index (GSCPI)	0.798*** (0.226)	0.516** (0.184)	0.491** (0.182)	
COVIDAID	0.0021*** (0.0003)	0.0017*** (0.0002)	0.0017*** (0.0002)	
Ukrainian export (EXPUR)			-0.0002 (0.0001)	
COVID-19 dummy (COVID)				2.841*** (0.254)
Russia-Ukraine War dummy (COVID+WAR)				4.787*** (0.451)
Observations	60	60	60	60
R <sup>2</sup>	0.590	0.706	0.720	0.932

Notes: Standard errors reported in parentheses. Statistically significant difference \*\*\* at the 0.1% level, \*\* at the 1% level, and \* at the 5% level. Source: Own calculations

**Table 3:** ANOVA statistics.

	Df	Sum of Squares	Mean Square	F-value	P-value
COVID	1	278.85	278.85	273.9	0.000***
COVID+WAR	1	276.72	276.72	271.8	0.000***
Residuals	57	58.03	1.02		

Statistically significant difference \*\*\* at the 0.1% level, \*\* at the 1% level, and \* at the 5% level. Source: Own calculations

**Table 4:** The U.S. food inflation elasticities during the COVID+War period.

	Unemployment Ratio (UV)	Global Supply Chain Pressure Index (GSCPI)	Covid Assistance (COVIDAID)	Ukrainian Exports (EXPUR)
U.S. Food Inflation	0.60	0.19	0.33	-0.19

Source: Own calculations

suggesting that there are many unaccounted variables that we failed to capture in Models 1-3. Model 4 suggest that both COVID-19 and the war, along with the unemployment ratio, have significantly impacted U.S. food inflation.

Furthermore, we have performed an ANOVA test to understand if the means of those two external events are statistically different. Table 3 shows that both COVID and COVID+WAR had significant impacts, and they are not redundant.

We have further utilised Model 3 to better understand the factors contributing to U.S. food inflation. We have calculated average U.S. food inflation elasticities with respect to 1) Unemployment Ratio, 2) Global Supply Chain Pressure Index, 3) Covid Assistance, and 3) Ukrainian Exports over the period since the start of Russia-Ukraine war. Table 4 shows that the unemployment ratio (UV) was the highest impact among other variables, suggesting that a 1% increase in the UV triggers 0.60% increase in food inflation, followed by the Covid Assistance elasticity (0.33). Both GSCPI and EXPUR have comparable elasticities but with opposing directional effect; 1% increase in COVIDAID or 1% decrease in EXPUR lead to 0.19% increase in food inflation. The outcome met our expectation and is consistent with economic theory.

## Conclusion

Across identification schemes, the supply-side factors we have modelled make the dominant contribution to food price changes over time. Yet, beginning with the onset of the pandemic, the demand factors in our models (the money supply and per-capita U.S. income, leaving aside core prices, which are also potentially affected by these variables but modelled explicitly) have grown in importance in terms of the contribution they make to realised food price changes by about 20% relative to the previous 5-year period (on average). As these demand-side factors were affected by monetary and fiscal stimulus programmes, which supported economic activity during and after the initial pandemic-driven contraction, our results suggest that stimulus measures may be partially responsible, among other factors, for the food price inflation observed. Other potential explanations for a growing role of demand factors in food prices include the rapid release of pent-up demand, or preference changes generated by the lifting of pandemic lockdowns. Our findings invite further research to investigate precisely why recent rising food prices appear more sensitive to demand pressures.

When food inflation among North American countries reached its peak, it was mainly driven by two factors: COVID-19, and the Russia-Ukraine war. Multiple COVID-19-related factors have led to such inflation. COVID-19 has disrupted the global supply chain, triggered a shortage of labour as a lower number of migrants began to arrive, and lastly central banks

in all three North American countries adopted monetary and fiscal policies to reduce the impact of the pandemic, mostly by lowering interest rates and providing financial relief. Russia's invasion of Ukraine has caused food inflation to deteriorate further. Our study shows that both external and internal factors have impacted U.S. food inflation.

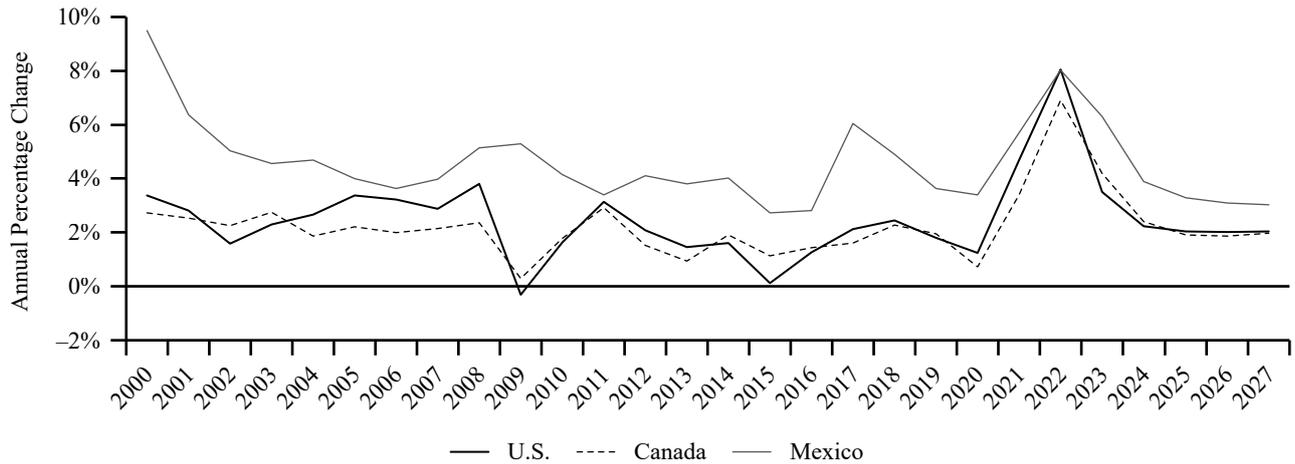
External forces such as the spread of COVID-19 and the spillover effects of Russia's invasion of Ukraine – both in the region and elsewhere – have significantly impacted food inflation in the North American countries. We used proxy variables to gauge the intensity of the two events on the U.S. food inflation. First, the Global Supply Chain Pressure Index that captures the global supply chain issues was aggravated by the onset of COVID-19 and significantly impacted food inflation in the U.S. Second, we used Ukrainian agricultural exports to estimate the intensity of the war's effects on food inflation. However, we found no statistical evidence to support the conclusion that the agricultural trade disruption in Ukraine has directly impacted the U.S. food prices.

In association with external factors, internal elements also contributed to food inflation in the U.S. The U.S. government used both of its fiscal and monetary tools to limit impact of COVID-19 and war to their economy. On the monetary front, the Federal Reserve Bank lowered interest rates to boost economic activity that was hit hard by onset of the pandemic. This led to more job openings and lower unemployment and ultimately contributed to higher food inflation. In our estimated model we captured this behaviour by means of the unemployment ratio and discovered that it has substantially contributed to food inflation in the U.S. On the fiscal policy front, increased government spending through financial assistance also accelerated economic activity through more consumption which in turn impacted food inflation in U.S. We captured this behaviour with COVID-19 stimulus and found that its impact was statistically significant to food inflation in the U.S.

However, it is anticipated that the overall inflation among these countries may be lower in the coming years and could reach 2% equilibrium in the long run (Mbah *et al.*, 2023). Figure 4 shows the long-term inflation among North America countries and Figure 5 depicts the U.S. long-term consumer food price.

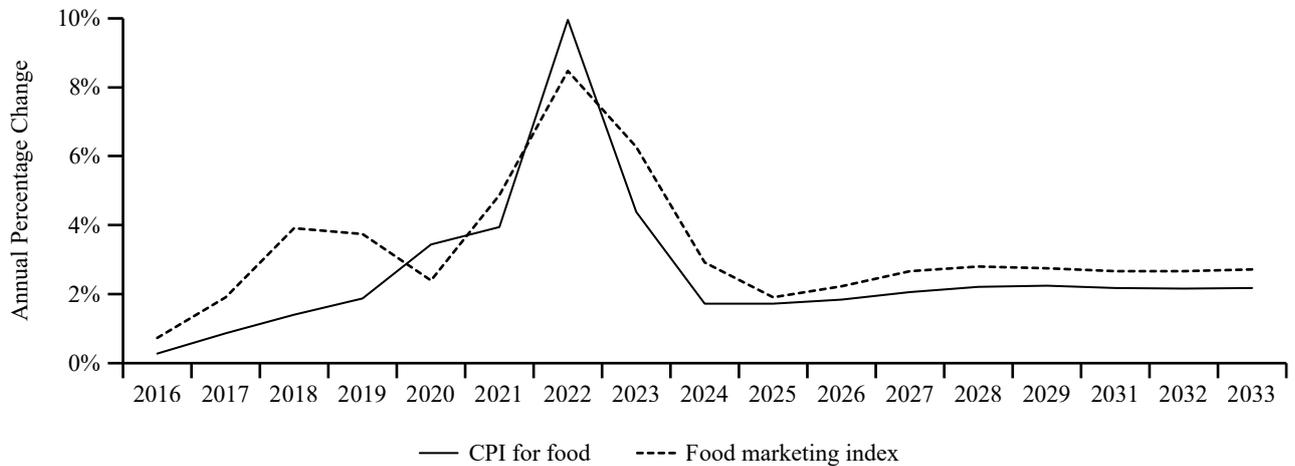
In 2023, food inflation in the U.S., Canada, and Mexico has consistently been falling as shown in figure 4, which indicate that the monetary policies – which include interest rate rises – adopted by these counties are effective.

The food and agricultural policy research institute (FAPRI) predicted in January 2023 that food inflation in the U.S. will gradually recede in the coming years, due to the Federal Reserve's aggressive monetary policy stance. The Fed has increased interest rates 10 times in a row since March 2022 to combat food inflation (Smialek, 2023).



**Figure 4:** Inflation percent change for average consumer prices in among three North American countries.

Source: International Monetary Fund, 2022



**Figure 5:** Long term outlook of the U.S. Food price indices.

Source: FAPRI, 2023

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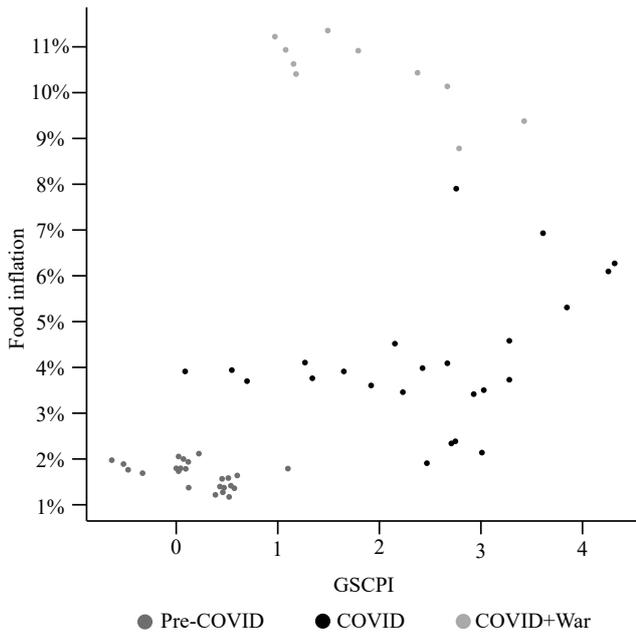
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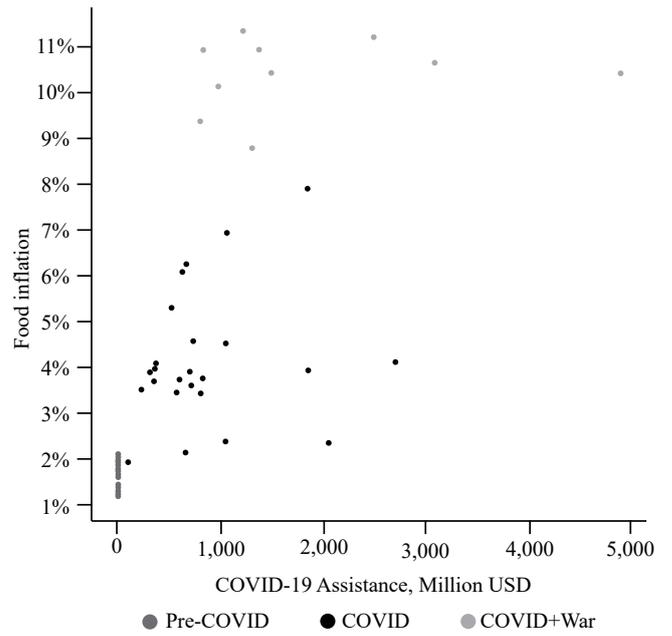
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## Appendix



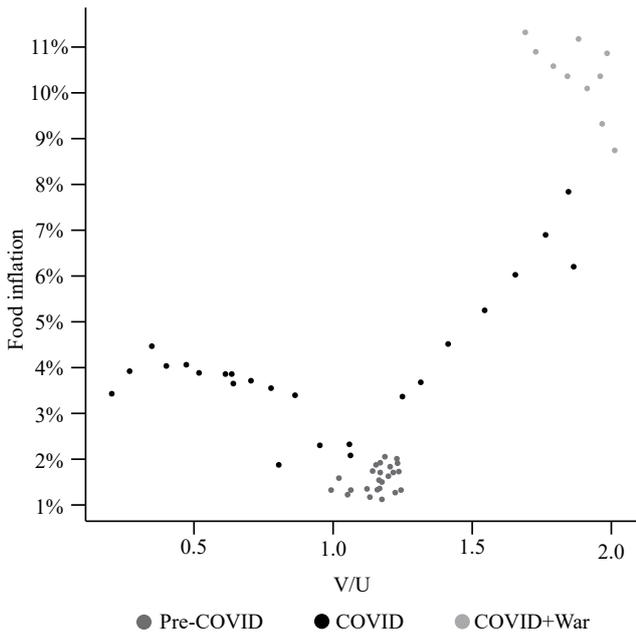
**Figure A1:** The relationship between U.S. food inflation and global supply Chain Price Index (GSCPI) during Pre-COVID, COVID, and COVID+War era.

Source: Own composition



**Figure A2:** The relationship between U.S. food inflation and COVID-19-related assistance during Pre-COVID, COVID, and COVID+War era.

Source: Own composition



**Figure A3:** The relationship between U.S. food inflation and unemployment ratio (U/V) during Pre-COVID, COVID, and COVID+War era.

Source: Own composition