Pandemic-Era Inflation Drivers and Global Spillovers*

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Abstract

We estimate a multicountry-multisector macroeconomic model to quantify the drivers of inflation during 2020–2023 and to measure inflation spillovers across countries. This exercise yields four key findings. First, supply shocks arising from constrained domestic labor and imported intermediates sparked inflation in advanced economies initially. Second, aggregate demand shocks created by expansionary fiscal policy widened demand-supply imbalances, intensifying inflation during 2021–2022. Third, reallocation of consumption between goods and service sectors further amplified these imbalances and transmitted inflation across countries through global production networks. Fourth, complementarities in production amplified the impact of energy shocks and tight labor markets on inflation.

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1 Introduction

Advanced countries' inflation rates are running at levels not seen in four decades. Central bankers were critiqued for their slow reaction to inflation in 2021 since they perceived inflation to be a transitory phenomenon. But by the beginning of 2022, advanced economies' central banks reacted to the mounting inflation and started a regime of aggressive rate hikes. At the time of our writing, mid-2023, the U.S. Federal Reserve appears to have turned the corner in its fight on inflation relative to other countries given that it was the first advanced country's central bank to begin a steep tightening campaign. The economic landscape faced by policy makers over 2020–2023 was clearly complex as the world economy was hit by multiple shocks.

We shed light on this period by estimating a global structural macroeconomic network model in order to quantify the different forces that drove the Pandemic-era inflation. Our analysis not only allows us to unpack the relative importance of different shocks hitting the economy but it also enables us to quantify the importance of interconnections across sectors and countries. In particular, we are able to formally quantify the following narrative of different phases in the rise of global inflation. In the early phase of 2020–2021, supply shocks arising from the scarcity in factors of production such as constrained imported intermediates and domestic labor, which was created by pandemic-induced health issues and lockdowns, sparked inflation most notably across advanced economies. This period was characterized by local and global supply chain bottlenecks together with slack in labor markets. This led to a rise in product prices (absent changes in wages), as also highlighted by Blanchard and Bernanke (2023). During this first phase there were also large fiscal packages aimed at mitigating the economic hardship of higher unemployment. Fiscal impulses in the U.S. came in different phases and lasted into 2022. This aggregate demand shock intensified the original supply chain bottleneck problem by stimulating demand in a low supply world, characterizing rising inflation during the second phase of 2021–2022.[1] The final phase (2022–2023) is characterized by the Russian invasion of the Ukraine further intensifying inflation given the impact on energy prices, particularly in Europe.

A distinguishing feature of our model from the burgeoning literature studying the recent inflation episode is the modeling of supply shocks as a scarcity of inputs to production at the sector level. In this respect, we extend the seminal *closed-economy* contribution of Baqaee and Farhi (2022) to *multiple countries*, where a fall in sector-specific labor supply impacts

[1] As we show in di Giovanni, Kalemli-Özcan, Silva, and Yıldırım (2023), the three fiscal package in the U.S. drives XX percent of the U.S. inflation during 2021–2022. The dates of the U.S. fiscal packages are December 2020, March 2021, December 2021.

aggregate output and inflation both domestically and abroad given international production linkages. This emphasis on factor markets and factor scarcity is combined with several other ingredients: (i) standard aggregate demand shocks (e.g., fiscal stimuli), (ii) sector-specific demand shocks modeled as changes in preferences, (iii) sector-specific TFP shocks which capture the impact of the Russian war on energy prices. This modeling approach allows us us to cleanly identify the contribution of each shock to inflation in a structural framework. Given the short-run complementarity between labor and other factors of production (e.g., Boehm, Levchenko, and Pandalai-Nayar, 2023), any input shortage, labor or other, in a given country will be linked to production in other countries. The model also features nominal rigidities and aggregate demand shocks, as any other model of monetary policy and inflation. Notably, unlike other open-economy models in the literature, we also solve for model-consistent exchanges rates and current accounts. The key economic force at work is the interaction of domestic aggregate demand shocks and nominal rigidities with the global input scarcity in driving inflation.

Our model performs well in matching the observed inflation in the U.S. and Europe together with the euro/USD nominal exchange rate during 2020–2023.

Julian: I WOULD SPELL OUT WHAT THE PAPER DOES AND WHAT IT FINDS. Sebnem: Alvaro and Muhammed, given what you are putting in the paper for model and quantification, can you put this in?

Related literature. There is a debate among academics and policymakers as to whether traditional macroeconomic models and historical episodes are appropriate guides for the current inflationary episode. The discussion has centered around what is the the slope of the Phillips curve and whether or not we have witnessed a move from a historically flat Phillips curve to a steeper one as a result of the large pandemic-era fiscal impulses. For example, Eggertson and Kohn (2023) and Benigno and Eggertsson (2023) develop models with a non-linear Phillips curve that links the slope to labor market tightness as measured by vacancies/unemployment, the metric also used by Blanchard and Bernanke (2023) to quantify the role of labor market tightness on inflation. While Benigno and Eggertsson (2023) find that labor shortages have a major role in driving the inflation, Blanchard and Bernanke (2023) argue that the initial inflation was caused by shocks to product prices absent wage changes. These are standard one-sector linear dynamic models disciplined with the historical data. An alternative non-linear approach is taken by Amiti, Heise, Karahan, and Şahin (2023) and Comin, Johnson, and Jones (2023) who modeling the U.S. as a small open economy with two sectors, tradeable and non-tradeable, under exogenously assumed

supply constraints, such as disutility of labor or sector capacity constraints, as in Boehm and Pandalai-Nayar (2022).[2] There is also empirical work that seeks to identify the different drivers of inflation such as Jordá, Liu, Nechio, and Rivera-Reyes (2022), Shapiro (2022a,b), Jordá and Nechio (2022).

The main advantage of our work over the existing work is the ability to separate four set of shocks given our global network structure where multiple country-sectors are linked via input-output linkages. This model helps us to quantify which shock is important in which phase of inflation during 2020–2023. We can do this thanks to our global general equilibrium model where all sectoral relative prices and exchange rates adjust endogenously to changes in consumption and employment patterns that we directly read from the data. Fully endogenous exchange rates helps us to quantify inflation spillovers. We further allow for current accounts to adjust in model-consistent way.[3]

Outline of the paper. Section 2 outlines the multicountry-multisector model that we use to quantify the drivers of inflation. Section 3 describes the data we use for the analysis. Section 4 presents the quantitative results. Section 6 concludes.

2 Model

We extend the Baqaee and Farhi (2022) model to the open economy by incorporating inter-country inter-industry input output linkages. Our model allows for a rich set of shocks including country-level aggregate demand shocks, country-industry level demand shifts and country-industry level factor supply and productivity shocks.

We assume that all countries are at a steady-state production and consumption level before and after shock periods. In each shock period, the households and producers expect to return this steady-state. We label the variables related to steady state with an asterisk $(*)$.

We denote countries with indices $m, n = 1, \ldots, \mathcal{N}$, where $\mathcal{N}$ is the number of countries. We use $i, j, k = 1, \ldots, \mathcal{J}$ as industry indices. An industry in a country is identified by a pair of indices corresponding to countries and industries, respectively.

[2]Other two-sector models with Keynesian supply shocks but no constraints are Guerrieri, Lorenzoni, Straub, and Werning (2020, 2021), Ferrante, Graves, and Iacoviello (2023).

[3]We prepared a policy piece for the 2022 ECB-Sintra conference using a fixed-exchange rate version of our model.

2.1 Households

We assume Ricardian households with perfect foresight. Households take the shock periods as transitory and expect to go back to steady state levels once the shock is over. The households in country n make their consumption decision by maximizing their inter-temporal utility:

$$\max_{\{C_n, C_n^*\}} (1-\beta_n)\log C_n + \beta_n \log C_n^*, \tag{1}$$

where C_n and C_n^* are the consumption bundles for the shock period and the future, respectively. β_n parameter controls the time preferences of the households. We assume an inter-temporal elasticity of substitution of 1. While optimizing their consumption decision, the households respect their inter-temporal constraints:

$$P_n C_n + \frac{P_n^* C_n^*}{1+i_n} = I_n + \frac{I_n^*}{1+i_n}, \tag{2}$$

where P_n (P_n^*) is the price of the consumption bundle and I_n (I_n^*) is the income (future). i_n captures the interest rate in the shock period.

Households use a Cobb-Douglas aggregator over *sectoral* consumption bundles to create their consumption bundles:

$$C_n = \prod_{j=1}^{\mathcal{J}} C_{n,j}^{\Omega_{n,j}^C} \quad \text{with} \quad \sum_{j=1}^{\mathcal{J}} \Omega_{n,j}^C = 1,$$

where $C_{n,j}$ denotes the sectoral bundle in country n for sector j and $\Omega_{n,j}^C \geq 0$ represents the consumption share of this sector. The sectoral consumption bundles are aggregates of country varieties. Let $C_{n,mj}$ denote the consumption of output of sector j in country m by consumers in country n. Then the consumption bundle is formed by:

$$C_{n,j} = \left[\sum_{m=1}^{\mathcal{N}} \Omega_{n,mj}^{CB} C_{n,mj}^{\frac{1-\xi'}{\xi'}}\right]^{\frac{\xi'}{1-\xi'}} \quad \text{with} \quad \sum_{m=1}^{\mathcal{N}} \Omega_{n,mj}^{CB} = 1,$$

where $\Omega_{n,mj}^{CB} \geq 0$ is the weight of country-sector mj in country n's consumption of sector j. ξ' captures the elasticity of substitution between these varieties.

2.2 Production

Production of goods entails combining the intermediate inputs and factors. We assume sector specific labor and capital are the factors of production and these factors are aggregated to create the *value-added* bundle. Each sector in each country uses goods from other countries to construct their sector specific intermediate bundles.

The production function for sector i in country n, therefore, uses sector specific value-added (VA_{ni}) and intermediate bundle (Z_{ni}) to make the final good via:

$$Y_{ni} = A_{ni}\left[\Omega^{Y}_{ni,\text{VA}}\text{VA}_{ni}^{\frac{1-\theta}{\theta}} + \Omega^{Y}_{ni,Z}Z_{ni}^{\frac{1-\theta}{\theta}}\right]^{\frac{\theta}{1-\theta}} \quad \text{with } \Omega^{Y}_{ni,\text{VA}} + \Omega^{Y}_{ni,Z} = 1,$$

where Y_{ni} denotes the output of this industry and A_{ni} is the sector specific productivity parameter. $\Omega^{Y}_{ni,\text{VA}}$ and $\Omega^{Y}_{ni,Z}$ capture the value-added and intermediate good shares, respectively. θ determines the elasticity of substitution between the value added and the intermediate bundle.

The value-added bundle for country-sector ni consists of sector specific labor and capital. We assume that capital is always fully utilized, therefore the level for capital is at the steady state (K^{*}_{ni}). Labor levels, on the other hand, could potentially fluctuate. The value-added bundle could be written as:

$$\text{VA}_{ni} = \left[\Omega^{\text{VA}}_{ni,L}\left(L_{ni}\right)^{\frac{1-\gamma}{\gamma}} + \Omega^{\text{VA}}_{ni,K}\left(K^{*}_{ni}\right)^{\frac{1-\gamma}{\gamma}}\right]^{\frac{\gamma}{1-\gamma}} \quad \text{with } \Omega^{\text{VA}}_{ni,L} + \Omega^{\text{VA}}_{ni,K} = 1,$$

where γ determines the elasticity of substitution between labor and capital. $\Omega^{\text{VA}}_{ni,L}$ ($\Omega^{\text{VA}}_{ni,K}$) is the weight of value-added that could be attributed to the labor (capital).

Similar to consumption bundles, intermediate bundles are constructed from country specific sector bundles with an elasticity of substitution of ε:

$$Z_{ni} = \left[\sum_{j=1}^{\mathcal{J}}\Omega^{Z}_{ni,j}X_{n,j}^{\frac{1-\varepsilon}{\varepsilon}}\right]^{\frac{\varepsilon}{1-\varepsilon}} \quad \text{with } \sum_{j=1}^{\mathcal{J}}\Omega^{Z}_{ni,j} = 1,$$

where $\Omega^{Z}_{ni,j} \geq 0$ is the weight of sector j in producing country-sector ni. These sectoral bundles are formed by aggregating country varieties through:

$$X_{n,j} = \left[\sum_{m=1}^{\mathcal{N}}\Omega^{X}_{n,mj}X_{n,mj}^{\frac{1-\xi}{\xi}}\right]^{\frac{\xi}{1-\xi}} \quad \text{with } \sum_{j=1}^{\mathcal{N}}\Omega^{X}_{n,mj} = 1,$$

where $X_{n,mj}$ is the amount of output of country-sector mj used by country n and ξ sets the elasticity of substitution between varieties. $\Omega^X_{n,mj}$ sets the weight of country-sector mj in the sector bundle for j in country n.

2.3 Market Clearing

We assume perfect competition in factors and good markets. Goods can be used as final (consumption) goods and intermediate inputs in many countries. Therefore we can write the goods market clearing condition for country-sector ni as:

$$Y_{ni} = \sum_{m \in \mathcal{N}} (C_{m,ni} + X_{m,ni})$$

For the factor markets, we take both labor and capital to be sector-specific. Capital is assumed to be at its steady state level with:

$$K_{ni} = K^*_{ni}.$$

Labor, on the other hand, is subject to shocks. In addition, we assume that there is a downward wage rigidity compared to the steady state. Let's show the amount of available labor for country-sector ni at the time of the shock with $\overline{L}_{ni}$. Because of our sector-specific labor assumption, we know that:

$$\overline{L}_{ni} \leq L^*_{ni}.$$

During the time of the shock, the employment conditions could be slack in this sector due to wage-rigidity:

$$L_{ni} \leq \overline{L}_{ni}.$$

Finally, the downward wage-rigidity necessitates that the wage in this sector (W_{ni}) cannot go below its steady state level (W^*_{ni}):

$$W_{ni} \geq W^*_{ni}.$$

Given the optimality condition, at least one of the two preceding inequalities should be binding:

$$\left(\overline{L}_{ni} - L_{ni}\right)\left(W_{ni} - W^*_{ni}\right) = 0.$$

Note that the nominal wage-rigidity is satisfied for wages in local currencies.

2.4 Monetary Policy, Current Account and Exchange Rates

We do all input-output accounting in terms of a fictitious common (world) currency. At the steady state, we assume the prices are normalized such a way that all exchange rates are equal to 1. During the shock periods, some measures taken by countries would deviate from the common currency. Here, via calculating the Gross National Income both from the expenditures and income sides, we can solve for exchange rate changes from the steady state.

Taking into the account the economic situation pre-Covid shock, we assume all countries ar zero-lower bound in their interest rates ($i = 0$). With this assumption, the inter-temporal budget formulated in Equation 2 becomes:

$$P_n C_n + P_n^* C_n^* = I_n + I_n^*.$$

Maximizing the inter-temporal utility in Equation 1 gives us:

$$I_n = P_n C_n = \underbrace{\frac{1-\beta_n}{\beta_n} I_n^*}_{\text{In local currency}} . \tag{3}$$

Note that this income level is given in the local currency as the inter-temporal budget allocation is done domestically by a change in β_n.

GDP of country n can be calculated by the total value-added (factor income) created in country n. Denoting the rental rate of capital in country-sector ni with R_{ni}, we can calculate the GDP of country n in common currency with:

$$\text{GDP}_n = \sum_i (W_{ni} L_{ni} + R_{ni} K_{ni}^*)$$

At the world level, global expenditures are equal to the global GDP. But for individual countries, because of the trade surpluses and deficits, income could be different than GDP. We calculate GDP and international trade in terms of common currency. Let the exchange rate of country n relative to the common currency be denoted by e_n. For this country, we can express the expenditures in local currency in terms of GDP and trade balance as:

$$I_n / e_n = \text{GDP}_n + \underbrace{\text{Imports}_n - \text{Exports}_n}_{\text{–Current Account}} .$$

To close the model, we assume that the trade balance is financed by partial ownership of production in foreign countries. To calculate this ownership ratio, we define bilateral trade

balance between countries m and n as:

$$D_{nm} \equiv \text{Exports}_{m\to n} - \text{Exports}_{n\to m}.$$

When this trade-balance is positive, it implies that country n is running a deficit vis-a-vis country m. Therefore, it need to own a portion of GDP in country m to finance this trade balance. We define the ownership share of factors / industries of country n in country m as:

$$\chi_{nm} \equiv \begin{cases} \frac{D_{nm}}{\text{GDP}_m} & \text{if } D_{nm} > 0 \\ 0 & \text{otherwise} \end{cases}$$

With this definition, we can write the total income of country n in terms of common currency as:

$$I_n/e_n = \text{GDP}_n - \underbrace{\sum_m \chi_{mn}\text{GDP}_n}_{\text{Owned by foreigners in } n} + \underbrace{\sum_m \chi_{nm}\text{GDP}_m}_{\text{Owned abroad by } n}. \tag{4}$$

Equating the spending from the expenditure side (Equation 3) and the income side (Equation 4), we can determine the exchange rate:

$$e_n \equiv \frac{(1-\beta_n)I_n/\beta_n}{(1-\sum_m \chi_{mn})\text{GDP}_n + \sum_m \chi_{nm}\text{GDP}_m}.$$

With the exchange rate in hand, the downward wage rigidity in common currency is given by:

$$\underbrace{e_n W_{ni} \geq W^*_{ni}}_{\text{In local currency}} \quad \Rightarrow \quad W_{ni} \geq \frac{W^*_{ni}}{e_n}.$$

2.5 Solution

To solve the model, we calibrate the consumption and input weights, GDP shares and expenditure shares using OECD Inter-Country Input-Output (ICIO) Tables. We calibrate the CES functions such that the weights coincide with the input and consumption shares. We normalize all prices, wages and rents to 1 at the steady state. We calculate all the changes in common currency while keeping track of local exchange rates, which enables us to convert price changes to local currency while calculating inflation.

To systematically solve the model, we create an enhanced input-output table, depicted in Figure **??**. Each row, i, in this matrix corresponds to a single CES aggregator with

corresponding elasticity of substitution of σ_i. Then, we can write the price index for each row as:

$$P_i^{1-\sigma_i} = \sum_j \Omega_{ij} P_j^{1-\sigma_i} \qquad \text{if} \quad \sigma_i \neq 1 \tag{5}$$
$$\log(P_i) = \sum_j \Omega_{ij} \log(P_j) \qquad \text{if} \quad \sigma_i = 1,$$

where the second row corresponds to the Cobb-Douglas case.

We can write the market clearing condition for each entry using the column information. Output of a sector, a factor or a bundle needs to be used by other industries or for consumption. In the enhanced Ω matrix, these are all different rows and columns. For a given column j, we can write its total output as Y_i and the amount this output used used by row i with X_{ij}. With this definition, we can write the market clearing condition for each row as:

$$P_j Y_j = \sum_i P_j X_{ij} = \sum_i \frac{P_j X_{ij}}{P_i Y_i} P_i Y_i. \tag{6}$$

Because of the CES assumption, we can write the optimal ratio of using j in making i based on the prices:

$$\frac{P_j X_{ij}}{P_i Y_i} = \left(\frac{P_j}{P_i}\right)^{1-\sigma_i}.$$

By dividing both sides of Equation 7 with the global GDP, we can write this in terms of global Domar weights, which are currency-free. Starting with the definition of Domar weights and using the optimal weights for CES functions, we arrive at:

$$\frac{P_j Y_j}{\text{GDP}_W} \equiv \lambda_j = \sum_i \Omega_{ij} \left(\frac{P_j}{P_i}\right)^{1-\sigma_i} \frac{P_i Y_i}{\text{GDP}_W} = \sum_i \Omega_{ij} \left(\frac{P_j}{P_i}\right)^{1-\sigma_i} \lambda_i. \tag{7}$$

Equations 5 and 7 along with market clearing conditions are sufficient to characterize the equilibrium. In particular, since we start with equilibrium prices of 1, our methodologies gives us solutions akin to the hat algebra methodology often used in the trade literature.

2.6 Approximating Inflation

- We can relate the final consumption to production via global Leontieff inverse ($\mathbf{\Psi}$). Denote the total output of all industries globally with $\boldsymbol{Y}$, the total consumption of all

industries with $\boldsymbol{C}$, then:

$$\boldsymbol{Y} = \boldsymbol{\Psi C}$$

- Denote the consumption of country n in all industries globally with $\boldsymbol{C}^n$ and assign the portion of production to country n by

$$\boldsymbol{Y}^n = \boldsymbol{\Psi C}^n$$

- Write the local Domar weights for country n using Y_{mi}^n:

$$\lambda_{mi}^n \equiv \frac{P_{mi} Y_{mi}^n}{I_n}$$

First-order approximation of domestic CPI inflation: open economy

Factor shares are governed by $\boldsymbol{\Omega}^F$. We can define country-level Domar weights for all factors globally as:

$$\boldsymbol{\Lambda^n} \equiv (\boldsymbol{\Omega}^F)^T \boldsymbol{\lambda^n}$$

- Labor shortages, at home and abroad, are inflationary domestically
- Positive productivity changes everywhere, $\mathrm{d}\log \boldsymbol{A}$, are deflationary
- Country n's AD shock includes both domestic AD shock and exchange rate change

Proposition 1. *Then the (local currency) CPI in country n can be written as:*

$$\mathrm{d}\log CPI^n = \underbrace{\mathrm{d}\log \zeta^n}_{AD\ shock} - (\boldsymbol{\Lambda^n})^T \mathrm{d}\log \boldsymbol{L} - (\boldsymbol{\lambda^n})^T \mathrm{d}\log \boldsymbol{A}$$

3 Data and shocks construction

Our empirical exercises require four set of shocks: country-level aggregate demand changes, industry-country level factor supply changes, industry-country level demand changes, and energy price changes. Recall our model is composed of four countries: United States; and four industries: durables, non-durables, services, and energy.

Given that our model is static, we need these shocks to be stationary. We start by describing the data we collect to then turn on how precisely we construct the stationary "shocks" series.

Comments (for appendix details on data)

Euro area is all people between 15 and 64 working full time. wstatus: EMP, worktime: TOTAL.

3.1 Data

3.1.1 Aggregate demand

According to our model, the correct object to measure aggregate demand changes is a measure of expenditure in local currency. Moreover, we require these numbers to be at a quarterly frequency.

United States. We resort to gross national income (codename: `A023RC1Q027SBEA`) available from the Bureau of Economic Analysis (BEA). This data is available at a quarterly frequency from 2010 to 2022.

Euro Area. We collected data on both gross national income and nominal GDP, both from EuroStat. However, data on gross national income is only available at a yearly frequency from 2010 to 2022, while nominal GDP is available at a quarterly frequency from 1995 to 2022. For this reason, we use nominal GDP as a proxy for changes in expenditure. While this is not an innocuous assumption, all we need is something that resembles changes in expenditure relative to trend, as we describe below. To the extent that these deviations are not that different from each other, changes in nominal GDP should provide an accurate description of changes in expenditure.

Russia and Rest of the World. We construct a measure of the rest of the world expenditure by adding up consumption on durables, non-durables and services from the OECD quarterly national accounts for all countries except the United States and those that belong to the Euro Area. Since data for Russia have not been updated for 2022, we use numbers from the rest of the world to construct Russia's aggregate demand.

3.1.2 Industry-country level factor supply: total hours worked

We take the model literally and use changes in total hours worked as our sector-country factor supply shocks.

United States. We use Tables B1 and B2 provided by the Bureau of Labor Statistics. These tables contain information on employment and average weekly hours at a monthly

frequency, respectively. Since hours in Table B2 are at a higher level of aggregation than those for employment in Table B1, we construct measures of L in the model, by multiplying employment in a disaggregated industry by the hours of the aggregate industry. For example, the information sector contains six subsectors in Table B1 but it is only available as an aggregate information sector in Table B2. We thus multiply each subsector employment by the hours of the aggregate sector in Table B2 to get a measure of total hours worked in each of the six subsectors separately. Our final sample contains information from 2006 to 2022 for 66 industries that we collapse to 4 industries.

Euro Area. We collect data from EuroStat, which contains industry level information on both hours (23 industries) and employment ($\approx$ 90 industries) for the entire Euro Area at a quarterly frequency from 2008 to 2022. We follow the same procedure as in the US to construct total hours worked in each industry and aggregate them into 4 industries.

Russia and rest of world. Since sectoral and time series data are not readily avaiable for Russia and ROW for the timespan we analyze, we take an indirect approach to construct total hours worked changes, that we explain in detail in the shocks construction section.

3.1.3 Industry-country level demand: consumption expenditure

We now describe the data sources for industry-country level expenditures.

United States. We use information on personal consumption expenditure from Table 2.3.5U of the Bureau of Economic Analysis version May 2023. This contains disaggregated industry level information on personal consumption expenditures from 1959 to 2022 at a quarterly frequency. In particular, we use durable, non-durable, services, and energy sector consumption from this table.

Euro Area. We use information on durable, non-durables, and services from the OECD quarterly national accounts. This is available from 2010 to 2022 at a quarterly frequency.

Rest of the world. As with the Euro Area, we construct sectoral consumption by the rest of the world on durables, non-durables, and services using the OECD quarterly national accounts. We consider all countries except the United States and those belonging to the Euro Area. These numbers, however, are denominated in local currency for all countries. We convert all series to US dollars using the average exchange rate between 1990 and 2022

per country that we sourced from the IMF. Finally, we aggregate each consumption series across countries. In doing so, note that we assume the rest of the world "fictitous" currency moves with the dollar one-to-one.

Russia. See shocks construction section.

3.1.4 Energy prices

We proxy energy prices using the energy commodity price index constructed by the IMF (code: `PRNG`). This index contains information on crude oil, natural gas, coal price, and propane price indices and is available at a monthly frequency from 1992 to 2022.

3.1.5 Input-Output matrices, factor and consumption shares

Since we assume two sector-specific factors in each sector in our quantitative exercise, labor and capital, we need to compute the respective share in nominal GDP of each of these objects. For our purposes, we only need to construct intermediate input expenditure, factor and consumption shares at some initial equilibrium.

Input-Output matrices. For input-output matrices we use the inter-country input-output tables from OECD at year 2018. Given that these tables contain 45 sectors and X countries, we aggregate these into four countries and four sectors.

Factor shares. To be completed.

To construct the vector of factor shares, we use the 2018 OECD Structural Analysis (STAN) Database. It contains information on labor compensation and gross operating surplus at the sectoral level matching the ICIO sectoral classification for 17 out of the 19 countries (except for Cyprus and Malta) that composed the Euro Area. We add up these items within sectors across Euro Area countries to construct sectoral measures for the Euro Area. We then proceed as in the US and take nominal GDP to be the sum of these two items across sectors. We divide each item by this nominal GDP measure to get our factor shares at the sectoral level.

We also aggregate the sectoral input-output data in the US and the Euro Area into three sectors: durables, non-durables, and services to assess whether these different levels of aggregation matter for our findings.

3.2 Shocks construction

3.2.1 Detrending

As we mentioned earlier, our model is static. Thus, "shocks" need to be stationary in order to be consistent with it. To make series stationary we detrend them following Hamilton (2018). Formally, for any time series y_t, we estimate

$$y_t = \beta_0 + \sum_{p=9}^{12} \beta_p y_{t-p} + \varepsilon_t,$$

Our "shocks" measures are thus

$$\hat{\varepsilon}_t = y_t - \hat{\beta}_0 - \sum_{p=9}^{12} \hat{\beta}_p y_{t-p}$$

These shocks measures are constructed for country-level aggregate demand, industry-country total hours worked, industry-country expenditure and the energy price index. We run regressions for each series separately.

3.2.2 Total hours worked "shocks" for Russia and rest of the world.

Due to the unavailability of total hours worked for Russia and the rest of the world composite, we estimate these numbers as a function of how strict were covid measures between 2020 and 2022. We regress total hours worked "shocks" at the industry level for the US on the US stringency index from Hale et al. (2021) that aimed to capture the strictness of countries' government policies against Covid19. Formally, we run the following specification for the period 2020m1 to 2022m12:

$$\hat{\varepsilon}(hw)^{US}_{st} = \beta_{0s} + \beta_s S^{US}_t + \nu^{US}_{st}$$

where $\hat{\varepsilon}(hw)^{US}_{st}$ are the total hours worked "shocks" (or detrended) in industry s in the United States at time t constructed as we explained in the previous section. From this, we recover the estimated coefficients $(\hat{\beta}_{0s}, \hat{\beta}^{US})$. We then project the stringency index of Russia and Rest of the world using these estimated parameters to get predicted values of total hours worked in each industry for both countries i.e.

$$\hat{\varepsilon}(hw)^{c}_{st} = \hat{\beta}_{0s} + \hat{\beta}_s S^{c}_t$$

where $\hat{\varepsilon}(hw)^c_{st}$ is total hours worked "shocks" in country c, industry s at time t and $c = \{\text{Russia}, \text{ROW}\}$.

For Russia we use the stringency index provided by Hale et al. (2021). For the rest of the world, we take a population weighted average of the stringency index across all available countries except the United States and countries belonging to the Euro Area. Importantly, China appears in the stringency index, as a result our predictions for the rest of the world will contain, to some extent, their strict lockdown policies that were dubbed as causing the early supply chain disruptions in 2020.

4 Results

Baseline plots use the following configuration of elasticities:

$$\epsilon = 0.6, \theta = 0.2, \xi_s = 0.6, \xi_c = 0.6, \eta = 0.6$$

(Complementarity case as a baseline). Where each elasticity is

- ϵ : elasticity of substitution between intermediate inputs and value added.
- θ : elasticity of substitution among intermediate inputs.
- ξ_s : country level sector bundle elasticity of substitution.
- ξ_c : country level consumption bundle elasticity of substitution.
- η: elasticity of substitution across factors

Figure 1. Model versus Data: United States and Euro Area. *Note:* This figure shows annual inflation implied by the model (gray line) relative to the data when feeding the model with all shocks.

(a) United States **(b) Euro Area**

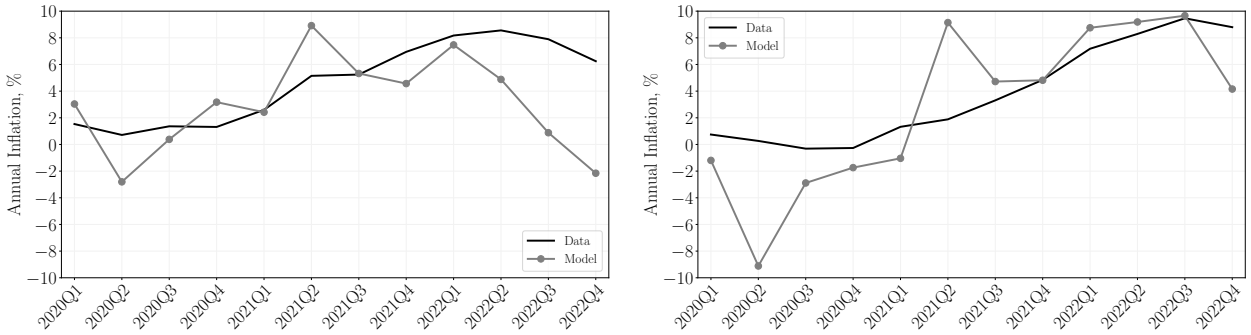


Figure 2. Inflation sources: United States and Euro Area. *Note:* This figure shows annual inflation implied by the model (gray line) relative to the data when feeding the model with all shocks and counterfactual scenarios where we feed in one type of shock at a time.

(a) United States **(b) Euro Area**

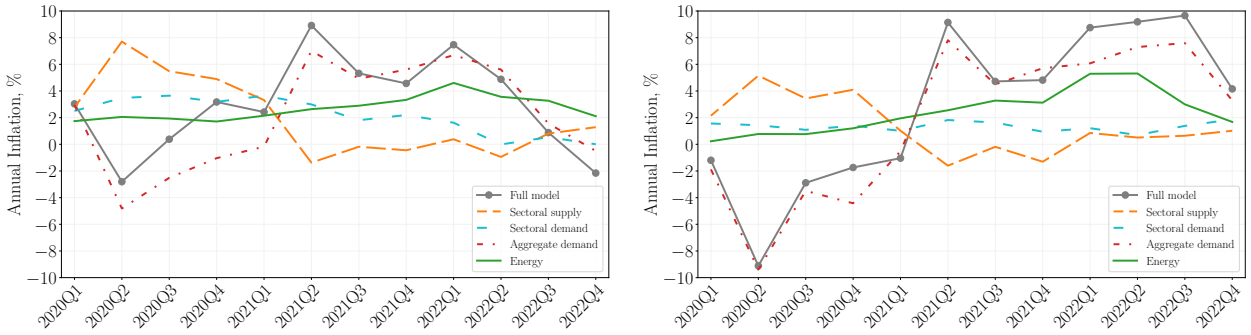
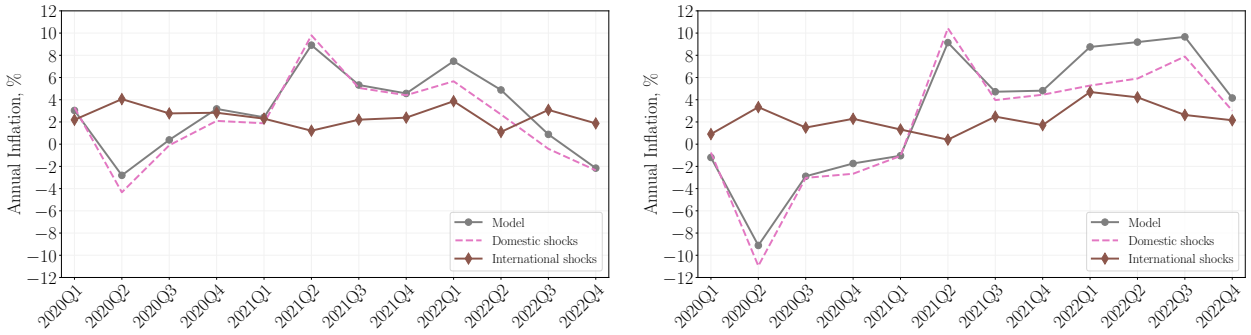


Figure 3. Inflation sources: International versus domestic shocks. *Note:* This figure shows annual inflation implied by the model (gray line) relative to the data when feeding the model with all shocks.

(a) United States **(b) Euro Area**



Shock	Country	Variable	Source	Time Frame	Code
Aggregate Demand	United States	GNI	BEA	2010q1 – 2022q4	A023RC1Q027SBEA
	Euro Area	GNI and nGDP	OECD	2010 – 2022 (GNI), 1995Q1 – 2022q4 (nGDP)	nominal GDP (EUNNGDP)
	Russia	-	-	-	
	Rest of the World (ROW)	OECD Quarterly National Accounts	—	2010Q1 – 2022Q4	—
Industry-level hours worked	United States	Employment and hours worked	Table B1 and B2, BLS	2006m3 – 2022m12	
	Euro Area	Employment and hours worked	EuroStat	2006m3 – 2022m12	Employment database: ESTAT:LFSQ_EGAN22D(1.0); Average Weekly hours database: ESTAT:LFSQ_EWHAN2(1.0)
	Russia	Project stringency index	Our World in Data	2020m1 – 2022m12	
	ROW	Project population weighted stringency index	Our World in Data	2020m1– 2022m12	
Industry-level demand	United States	Personal consumption expenditure	Table 2.3.5U. BEA, MAY2023	1959Q1 – 2022Q4	
	Euro Area		OECD Quarterly National Accounts	2010Q1 – 2022Q4	P311B (durable goods), P313B (non-durable goods), P314B (services)
	Russia	—	—	—	—
	ROW		OECD Quarterly National Accounts	2010Q1 – 2022Q4	—
Energy	-	IMF energy index	IMF	1992m1 – 2022m12	PNRG

Figure 4. Inflation sources: Energy shocks with low and high elastictities of substitution. *Note:* This figure shows annual inflation implied by the baseline model (green solid line) relative to the model with high elasticities of substitution (green dashed line).

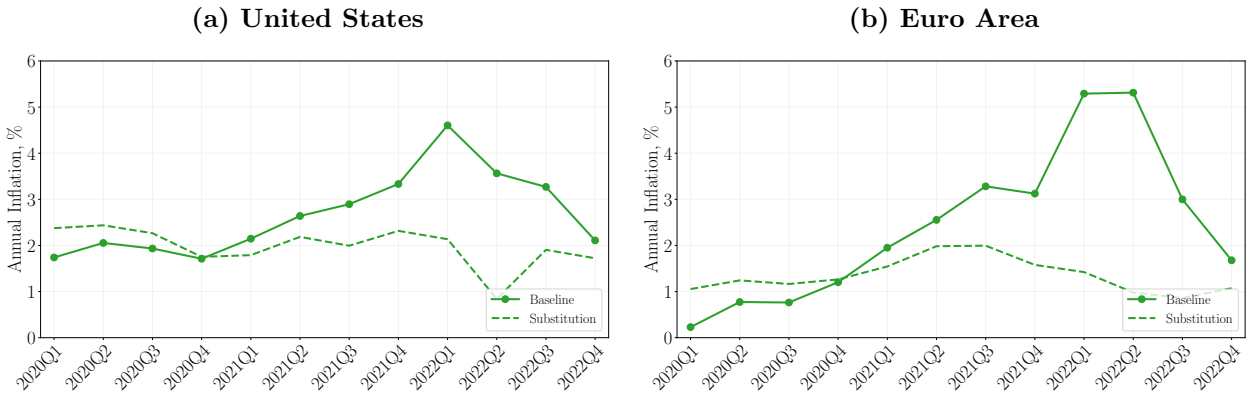
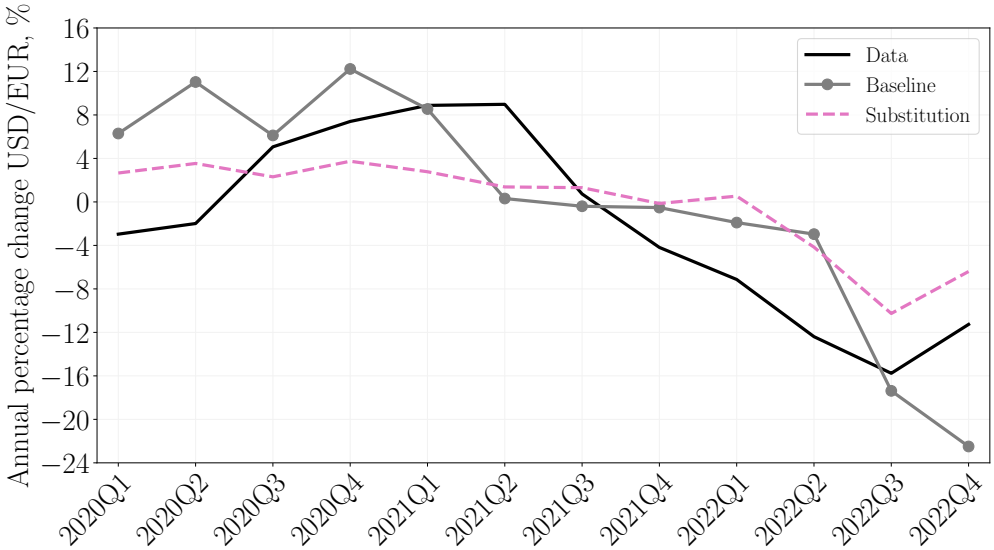


Figure 5. Inflation sources: Exchange rate USD per EUR with low and high elastictities of substitution. *Note:* This figure shows annual change in the exchange rate implied by the baseline model (gray solid line) relative to the model with high elasticities of substitution (pink dashed line). For comparison, we also plot the exchange rate changes as in the data (black solid line)



5 MA Figures

Figure 6. Model versus Data: United States and Euro Area, 4 quarters moving average. *Note:* This figure shows annual inflation implied by the model (gray line) relative to the data when feeding the model with all shocks.

(a) United States **(b) Euro Area**

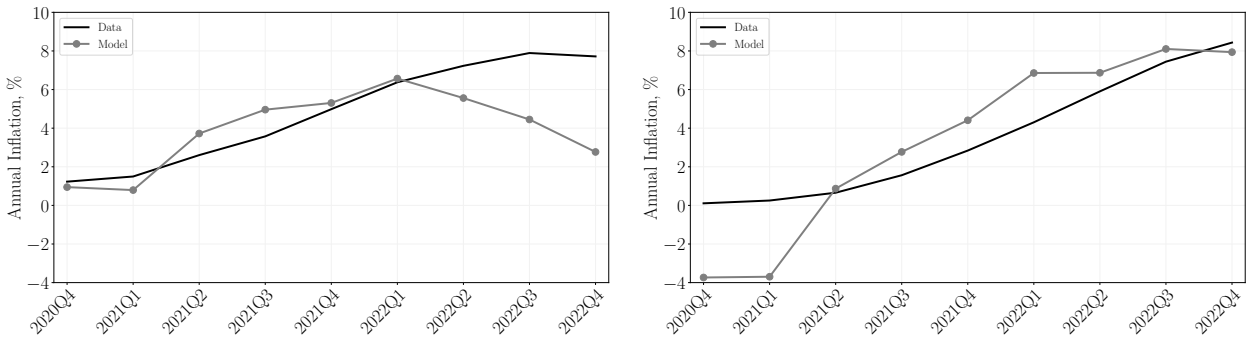


Figure 7. Inflation sources: United States and Euro Area. *Note:* This figure shows annual inflation implied by the full model (gray line) and counterfactual scenarios.

(a) United States **(b) Euro Area**

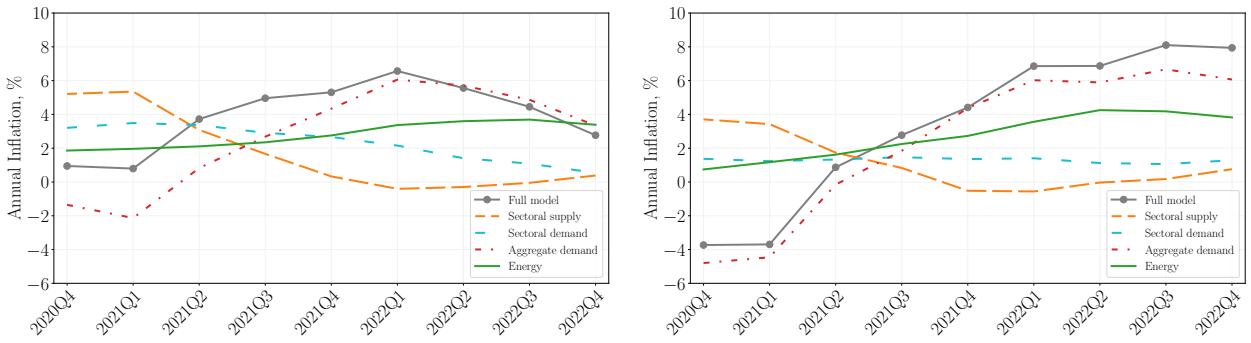


Figure 8. Inflation sources: International versus domestic shocks. *Note:* This figure shows annual inflation implied by the baseline model (gray line), a model with shocks only hitting the domestic economy (pink dashed line) and a model where shocks hit the rest of the world but not the domestic economy (brown line).

(a) United States **(b) Euro Area**

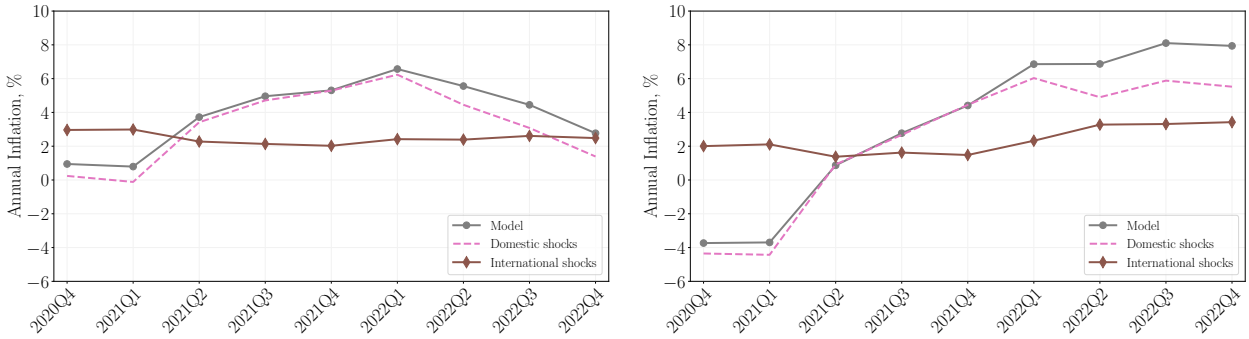


Figure 9. Inflation sources: Energy shocks with low and high elasticities of substitution. *Note:* This figure shows annual inflation implied by the baseline model (green solid line) relative to the model with high elasticities of substitution (green dashed line).

(a) United States **(b) Euro Area**

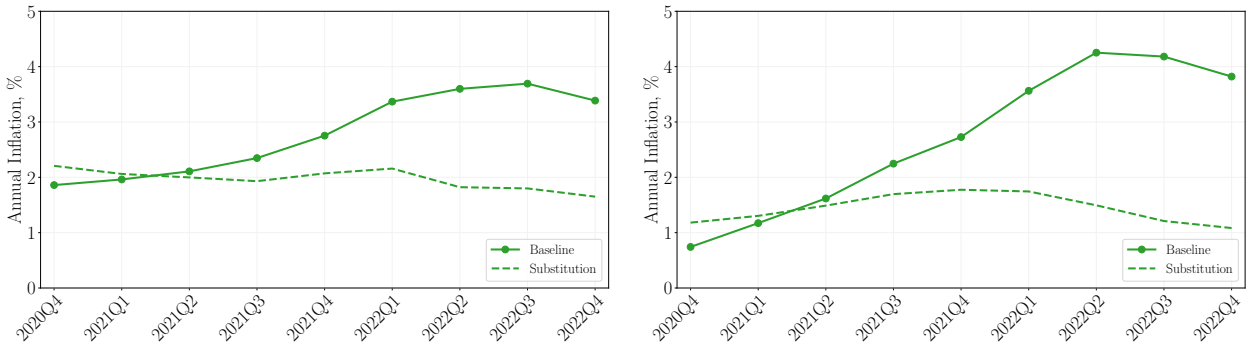
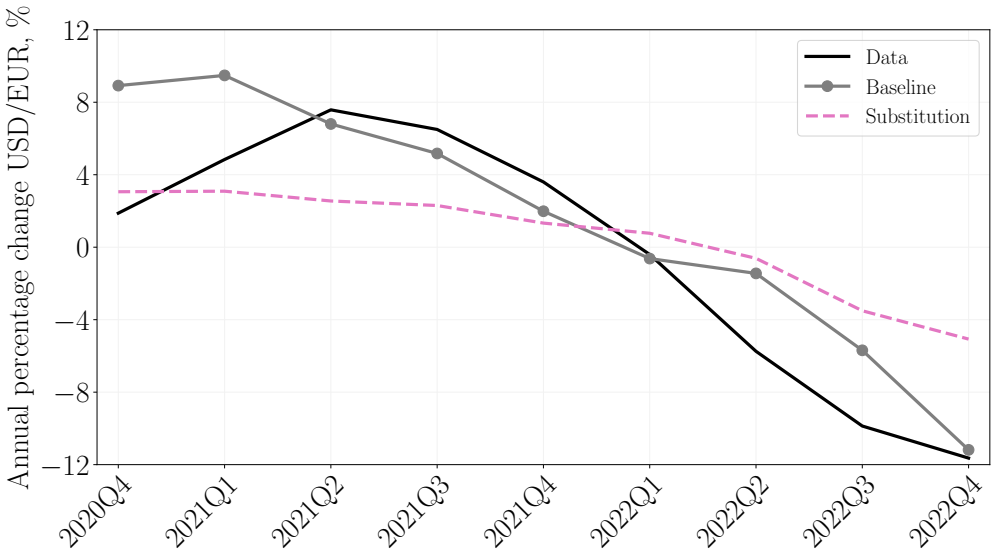


Figure 10. Inflation sources: Exchange rate USD per EUR with low and high elastictities of substitution. *Note:* This figure shows annual change in the exchange rate implied by the baseline model (gray solid line) relative to the model with high elasticities of substitution (pink dashed line). For comparison, we also plot the exchange rate changes as in the data (black solid line)



6 Conclusion

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