Technical Appendix

A cost-of-living crisis: Inflation during an unprecedented terms of trade shock - speech by Swati Dhingra given at the Resolution Foundation, 8 March 2023.

A1. Sensitivity Analysis

Chart A1.1: QoQ Decomposition

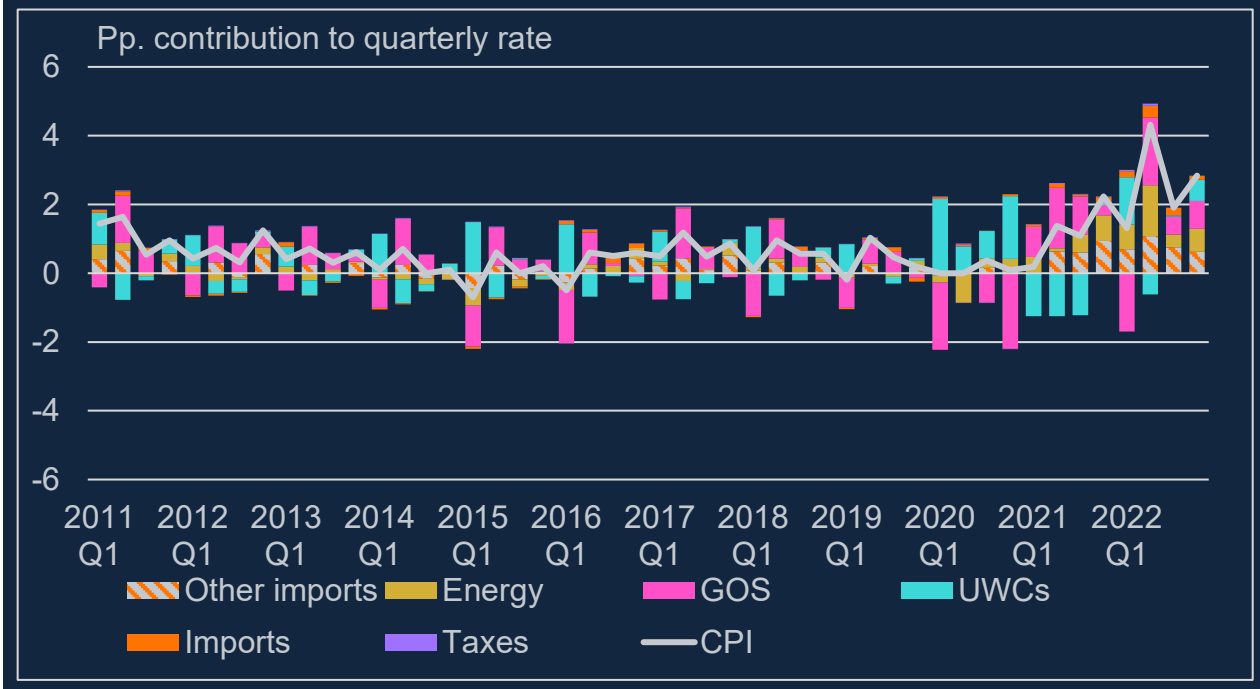


Chart A1.2: 2015 IO Matrix Decomposition

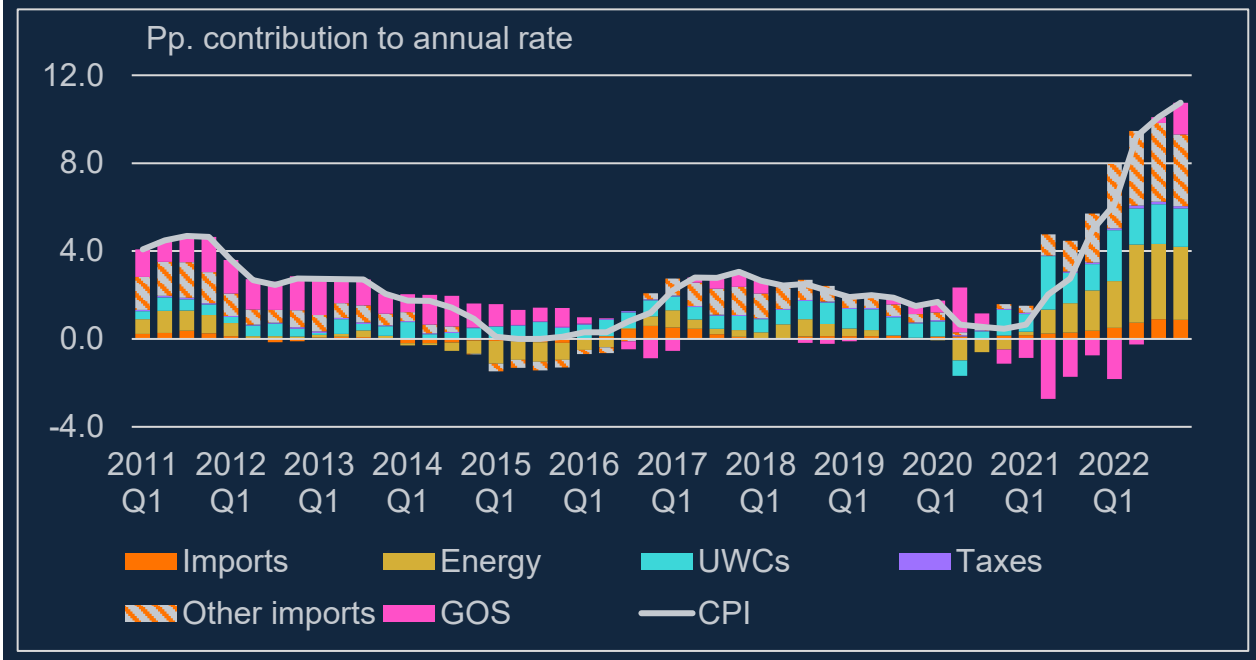


Chart A1.4: Furlough Period Alternative Decomposition

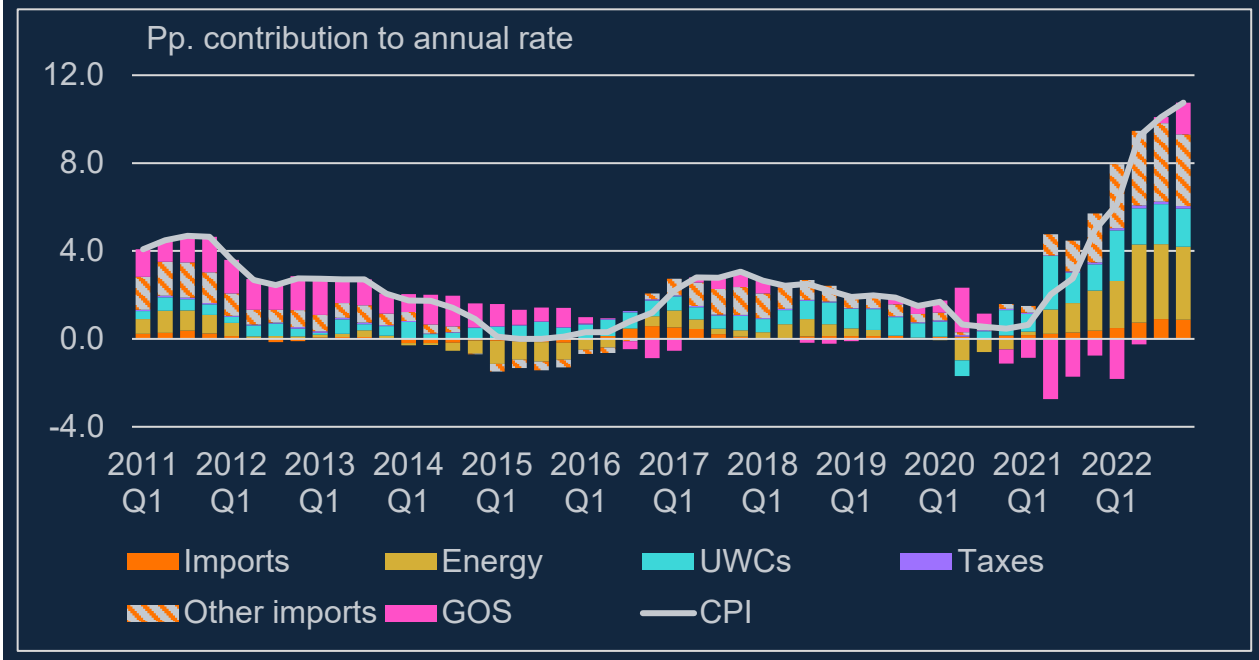
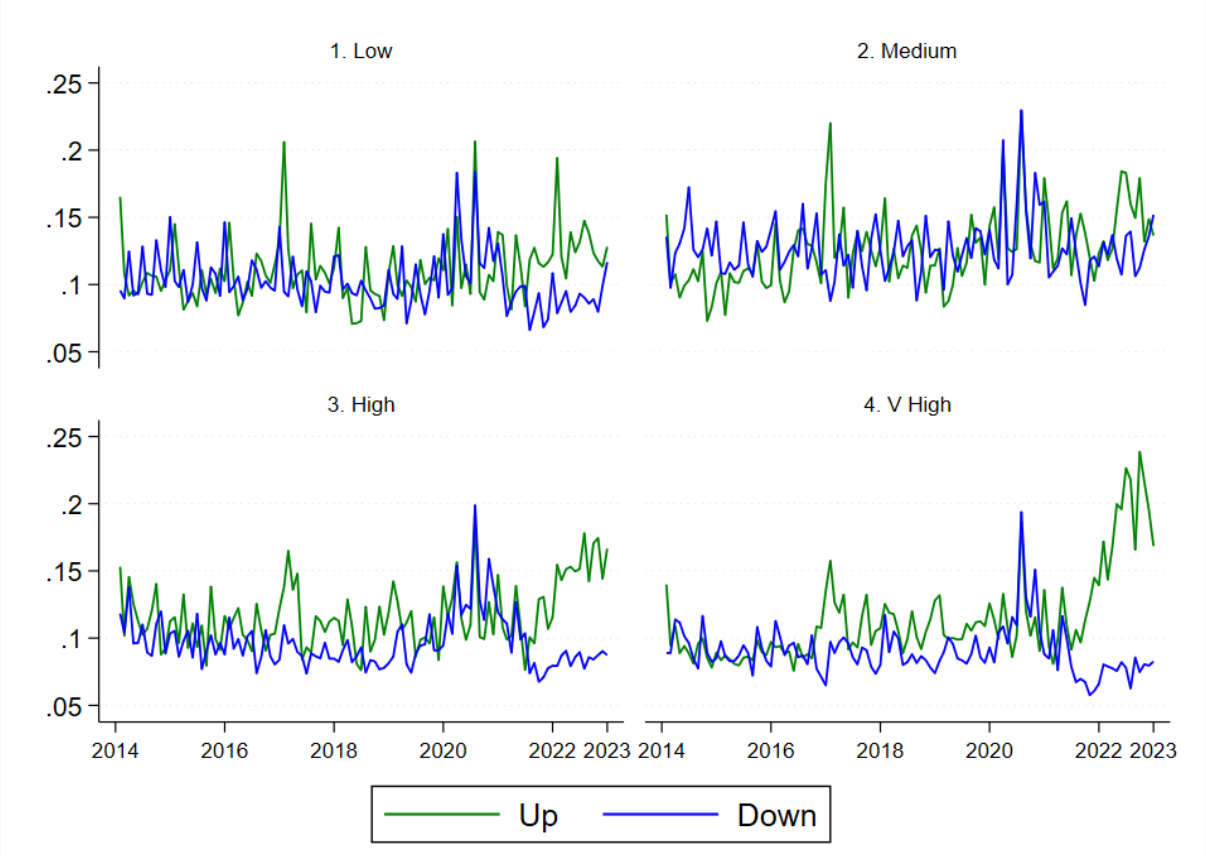


Chart A1.5: Food Price Inflation by Share of EU Imports



Notes: Items are binned by EU exposure. Up to 40%, 40-60%, 60-80% and over 80%. Lines are the proportion of prices rising and falling month-on-month. Source: Updated version from Richard Davies, originally in Bakker, Datta, Davies and De Lyon (2022)

A2. Methodology

Let C be a matrix of Consumer Price Index where rows denote time and columns denote different 2-digit COICOP items. Similarly, M and D are matrices containing 2-digit domestic consumer price indices, import price indices and domestic producer price indices, where the latter two are recorded from price quotes of firms in the economy. The import and domestic producer prices indices have been obtained from the ONS at the 2-digit CPA level, through an FOI request. ONS price indices are derived from price statistics for 2011-2022 at a monthly frequency. Services producer price indices are available quarterly, so the exercise is conducted at a quarterly level. Services import price indices are available for thirteen different categories which are manually matched to the 2-digit services CPA categories. Data for the last period of 2022Q4 is not available at the disaggregate 2-digit level and is projected from the disaggregate statistics for: current price and chain value measures trade in services, and industry GVA. These series are projected using the aggregate growth in aggregate trade in services and aggregate GVA.

The domestic and import shares in final household consumption are denoted by F_d, a diagonal matrix with the diagonal element containing the domestic share of household final consumption of CPI Items. Each row contains the CPI items sequentially. F_m is a diagonal matrix with the diagonal element containing the import share of household final consumption of CPI items. The final household consumption shares are from supply-use tables.

The domestic and import direct use matrices contain the expenditure on factors of production (as a share of the value of output) and are denoted by A_d and A_m for the CPI basket and by B_d and B_m for the entire economy. They are available at the 2-digit CPA level from the supply-use tables. They also include the value of compensation of employees, taxes on products, taxes on production and gross operating surplus for each CPA category. The main analysis uses the latest (2018) direct supply-use tables and the sensitivity analysis uses the 2015 tables. The 2-digit import and domestic producer price indices can be readily mapped to the 2-digit COICOP classification from a mapper provided by the ONS. It enables a mapping from the supply-use tables and import and domestic price indices to the consumer price classification.

Let X^T denote the transpose of matrix X. With this notation in hand, CPI inflation can be decomposed into cost and profit components. We will denote the residual profits of retailers selling consumer products by V. Then the CPI can be written as the sum of all unit costs incurred by the domestic sellers of that item and their residual profit:

$$C^T \equiv A_d^T D^T + A_m^T M^T + V^T \quad (1)$$

Similarly, the domestic producer price index is the sum of all unit costs incurred by the producer and the residual profit that the producer retains in the business:

$$D^T \equiv B_d^T D^T + B_m^T M^T + V_d^T \quad (2)$$

We do not typically have direct measures of residual profits V, V_d. They can however be inferred from the CPI and PPI identities of equations 1 and 2 respectively because we have the other variables in the. Therefore the first step in the decomposition exercise is to infer the matrix of retailer residual profits $V^T \equiv A_d^T D^T + A_m^T M^T - C^T$ and the matrix of domestic supplier's residual profit matrix $V_d^T \equiv B_d^T D^T + B_m^T M^T - D^T$ using data for each CPA 2-digit category from the prices and supply-use tables.

To understand the sources of CPI inflation after accounting for the domestic supply chain, the CPI index needs to be written in terms of primary and imported factors of production. Let $[I - B_d^T]^{-1}$ be the inverse of a matrix that contains the difference between an identity matrix I and the transposed domestic use matrix B_d^T. Then the domestic producer price index can be solved for in terms of the imported prices, import use, domestic use and

residual profits. Taking $B_d^T D^T$ to the LHS and multiplying by the inverse matrix $[I - B_d^T]^{-1}$ on both sides of equation (2) gives the domestic price index for the 2-digit CPA item as:

$$D^T \equiv [I - B_d^T]^{-1} B_m^T M^T + [I - B_d^T]^{-1} V_d^T \quad (3)$$

Having already solved for V_d^T, this second step gives the domestic producer prices in terms of import prices and residual profit margins.

The domestic producer prices can be substituted from equation 3 into the consumer price identity of equation 1. Then the domestic CPI consists of import costs and profit components as shown below:

$$C^T \equiv A_m^T M^T + A_d^T [I - B_d^T]^{-1} B_m^T M^T + A_d^T [I - B_d^T]^{-1} V_d^T + V^T \quad (4)$$

This third step shows that the domestic CPI index is a sum of the direct contribution of imports in the CPI basket (first term on the RHS), the indirect contribution of imports (through domestic inputs that use imported inputs themselves), the residual profits of domestic suppliers (third term) and the residual profits of domestic producers (last term).

The fourth step accounts for differences in the share of imports for final consumption in the CPI basket: $C^T = F_d^T C^T + F_m^T C^T$. The CPI does not distinguish between domestic and imported varieties of consumer items, but we know that about 80 percent of varieties for final consumption are domestically purchased. As long as prices of final import consumption are rising faster than their domestic counterparts, the results provide a lower bound for external factors as a source of inflation.

$$C^T = F_m^T C^T + F_d^T \begin{pmatrix} A_m^T M^T + A_d^T [I - B_d^T]^{-1} B_m^T M^T \\ + A_d^T [I - B_d^T]^{-1} V_d^T + V^T \end{pmatrix} \quad (5)$$

More generally, we can extend the identity to include other factors of production that are in the supply-use tables. These include energy (denoted by e for energy and by E for the price index of energy), imported inputs (other than energy), taxes on products and production (denoted by t for taxes as a share of the value of output and by T for the tax rate), compensation of employees (denoted by w for workers as an input and W as the wage rate). The supply-use table also contain the gross operating surplus for each 2-digit CPA category. This can be used to determine the profit margin from the residual profits because $V^T \equiv A_v^T \Pi^T$ where A_V is the gross operating surplus as a share of the value of the 2-digit CPA output or the profit margin is inferred as $\Pi^T = [A_v^T]^{-1} V^T$. Proceeding similarly, domestic suppliers' profit margins can be inferred as $\Pi^T = [B_v^T]^{-1} V_d^T$ where B_V is the gross operating surplus as a share of the value of the 2-digit CPA produced by the domestic supplier. Mapping the residual profits from step 1 to the profit is the fourth step in the exercise.

Finally, separating out final energy bills of households, the four steps above enable the following CPI decomposition as the final step in the exercise.

$$C^T = F_m^T C^T + F_d^T \begin{pmatrix} F_e^T E^T + A_e^T E^T + A_e^T [I - B_e^T]^{-1} B_e^T E^T \\ + A_m^T M^T + A_d^T [I - B_d^T]^{-1} B_m^T M^T \\ + A_w^T W^T + A_d^T [I - B_d^T]^{-1} B_w^T W_d^T \\ + A_v^T \Pi^T + A_d^T [I - B_d^T]^{-1} B_v^T \Pi_d^T \\ + A_t^T T^T + A_d^T [I - B_d^T]^{-1} B_t^T T^T \end{pmatrix} \quad (6)$$

where the first line contains imported varieties (other than energy) for final consumption by households, the second line is the final, direct and indirect energy and imported inputs' contributions, the third line contains the direct and indirect wage costs, the fourth line contains the inferred profit margins of retailers and domestic suppliers, and the last line is the taxes on products and production. Equation 6 gives the main findings reported in the main text.

Data on domestic energy prices come from the ONS provided 2-digit PPI data and data on imported energy prices come from BEIS. Wage rates are obtained for each 2-digit CPA category (which maps one-to-one to the 2-digit SIC classification). Energy prices and wages are available at a monthly frequency from the ONS.

Tax shares in prices are derived from the price series using the tax share in the supply-use tables. The tax share in the supply-use tables is small compared to the average share of production taxes in the economy, so sensitivity analysis is conducted with the average tax share in the economy, but this makes very little quantitative or qualitative difference to the main findings, so we do not reproduce the analysis here.