Routledge
Taylor & Francis Group

Applied Economics Letters

ISSN: (Print) (Online) Journal homepage: www.tandfonline.com/journals/rael20

The (dis-)equalizing effects of production networks

Leonhard Ipsen & Jan Schulz

To cite this article: Leonhard Ipsen & Jan Schulz (10 Sep 2024): The (dis-)equalizing effects of production networks, Applied Economics Letters, DOI: 10.1080/13504851.2024.2396557

To link to this article: https://doi.org/10.1080/13504851.2024.2396557

APPLIED ECONOMICS LETTERS
https://doi.org/10.1080/13504851.2024.2396557

Routledge
Taylor & Francis Group

The (dis-)equalizing effects of production networks

Leonhard Ipsen[a,b] and Jan Schulz[a]

[a]Economics Institute, University of Bamberg, Bamberg, Germany; [b]Bamberg Research Training Group on Bounded Rationality, Heterogeneity and Network Effects, funded by the Hans Böckler Foundation, Bamberg, Germany

ABSTRACT
We suggest and empirically substantiate that the global production network constitutes an important variable for inflation inequality, as it modulates the impact of cost-push shocks on households. For most price shocks, the production network reduces inflation inequality, however, at the expense of lower-income households. Introducing a synthetic Consumer Price Index indicates lower-income households to be at the losing end of the overall effect of supply-side price shocks.

KEYWORDS
Inequality; inflation; input-output analysis; Europe

JEL CLASSIFICATION
D31; E31; F16; C67

I. Introduction

The nexus of inflation and income inequality remains heavily contested in the empirical literature and specific inflationary periods are found to be either inequality-enhancing or inequality-decreasing (Crawford and Oldfield 2002; Garcimartín, Astudillo, and Martínez 2021; Hobijn and Lagakos 2005). This study proposes and empirically substantiates a novel explanation for this inflation-inequality puzzle, by uncovering how sectoral asymmetries in the global production network lead to substantial differences in the impact of cost-push shocks on the purchasing power of different income groups. While cost shocks are only one of many conceivable drivers of aggregate inflation, they are empirically of particular importance in the recent inflationary surge in Europe (Baba et al. 2024). Related studies have already shown the crucial importance of sectoral asymmetries for determining the overall price level (Weber et al. 2024). Yet, we are the first to systematically analyse their effects on inflation inequality. To do so, we simulate the propagation of sector-level price shocks in the global production network and investigate the income-dependent exposure of households in 21 EU countries to these shocks. We find that for most price shocks, the production network dampens inflation exposure across income quintiles. However, more often than not, it does so at the expense of lower-income households.[1] Finally, introducing a synthetic Consumer Price Index suggests lower-income households to be disproportionately exposed to the overall effects of cost-push shocks in our model. Our results constitute a rich foundation for policies aimed at mitigating adverse distributional effects of current or future cost-push shocks.

II. Data

The analysis is based on three different datasets: First, the World Input-Output Database (WIOD) used to construct the global production network (as of 2014), the sector-specific price shocks (2000 – 2014) as well as the shares of final demand of a country$_i$ in sector$_x$ of country$_c$ (as of 2014) (Timmer et al. 2015). Crucially, the setup allows price shocks to originate and propagate globally. Note that relying only on the final demand shares of the WIOD would be equivalent to assuming one representative household in each country. Thus, a second dataset that provides sector-level data on consumption by purpose expenditure shares for income

CONTACT Jan Schulz jan.schulz-gebhard@uni-bamberg.de Economics Institute, University of Bamberg, Bamberg, Germany

[1]In this study, inflation inequality refers to any situation, where the impact of inflation on different income groups is asymmetric. The production network might dampen or amplify this asymmetry. By contrast, an equalizing (disequalizing) effect refers to a situation where inflation affects richer (poorer) households disproportionately.

Supplemental data for this article can be accessed online at https://doi.org/10.1080/13504851.2024.2396557

quintiles Q1 (low) to Q5 (high) is introduced. The latest data available includes data for 21 EU countries[2] for the year 2020 (Eurostat 2021). Since the COICOP data follows a different classification than the WIOD (COICOP versus ISIC Rev. 4), bridging matrices provided by Cai and Vandyck (2020) are needed, to offset the *expenditures by income shares* with the *final consumption shares* of the WIOD. Doing so gives the consumption share$_{q,i,x,c}$ – the share of consumption expenditure of a respective income quintile$_q$ of country$_i$ in sector$_x$ of country$_c$. Country$_i$ corresponds to a country in the set of the 21 EU countries in the Eurostat sample, while country$_c$ corresponds to a country in the set of 43 countries sampled in the WIOD. Sector$_x$ corresponds to one of the 56 sector classes sampled in the WIOD. Finally, to analyse the sector-level elasticities of inflation exposure with respect to income, mean absolute income values for the income quintiles of the 21 EU countries are used (Eurostat 2021).[3]

III. Empirical strategy

For the empirical analysis, we set up a Leontief price model based on Weber et al. (2024). The model is presented in detail in Appendix A. Its basic mechanism works as follows: sector$_x$ in country$_c$ is exposed to its average input price shock, which is computed as the mean logarithmic difference of its input prices from 2000 – 2014. This price shock propagates linearly downstream and reaches households either directly through increased prices for final goods or indirectly via the production network effect of increased prices for intermediate goods. Eventually, every price shock reaches and is fully absorbed by households. Note the straightforward economic interpretation: The *direct* effect gives the effect of a price shock to a sector as if there was no production network appended to it. The *indirect* effect indicates exclusively the additional effect of the price shock propagating in the production network – the production network effect. Together they give the *total* effect of a price shock to a sector on a given country-income pair. Since the final consumption shares differ across countries and income quintiles, the exposure of households to individual sectors is asymmetric.

The outlined simulation of a price shock propagation is repeated for each of the 2408 sectors in the global production network and with each of the 21×5 country-income pairs on the receiving end. This exercise gives every direct and indirect effect of an average price shock in every sector of all countries$_c$ on all income quintiles$_q$ in all countries$_i$. Based on the log-log-regression equation in (1), the change in exposure towards a sector class with respect to income is estimated. Namely, we use the logarithmic effect $log(E) \in \{\text{Direct Effect}, \text{Indirect Effect}, \text{Total Effect}\}$ of sector$_x$ as our dependent variable and the logarithmic average absolute income of quintile$_q$ of country$_i$, $log\left(Y_{q,i}\right)$, as our independent variable. δ_i is a dummy variable that accounts for country-level fixed effects while $\varepsilon_{x,q,i}$ represents an error term.

$$log\left(E_{x,q,i}\right) = \beta_{0,x} + \beta_{1,x} log\left(Y_{q,i}\right) + \delta_i + \varepsilon_{x,q,i} \quad (1)$$

A negative elasticity coefficient $\beta_{1,x}$ indicates that the inflation exposure of households towards this sector class is reduced with increasing income. The opposite is true for a positive coefficient. Each coefficient corresponds to the percentage change in exposure to a sector class following a one percent increase in income.

IV. Results

Figure 1 presents the sector-level estimates (points) as well as the 95% confidence interval (whiskers) for the direct, production network and total effect. Note that there are fewer sectors in the direct effect estimates than in the indirect effect estimates. This is due to zero or negative values in some instances of the direct effects of these sectors, which leads to the exclusion from the log–log regression.

The production network appears to dampen inflation inequality across income quintiles for

[2]The countries are Austria, Belgium, Bulgaria, Croatia, Cyprus, Denmark, Estonia, Germany, Greece, France, Hungary, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Poland, Romania, Slovenia, Slovakia, and Spain.

[3]As we lack data for the mean absolute income of Q5, we use the following classification: Q1 corresponds to the value of the first percentile, up to Q5 which corresponds to the 80th percentile.

Figure 1. Direct, production network and total effect elasticity estimates (points) and 95% confidence intervals (whiskers) for income-dependent inflation exposure to a given sector class. A positive (negative) estimate reflects increasing (decreasing) exposure with increasing income.

most price shocks as the direct effect estimates show significantly more heterogeneity than in the production network effect estimates. This suggests that shocks tend to propagate from sectors with larger income-dependent consumption differences to sectors with less heterogeneity. Put differently, the production network 'pulls' the estimates closer to the zero line, which marks no income dependence in the inflation exposure towards a sector.

However, this finding does not yet show whether the production network effect is equalizing or disequalizing, i.e. affecting lower- or higher-income households disproportionately. In *absolute* terms, the production network appears to have an equalizing effect: Most indirect effect estimates are significantly positive. However, for most sectors, the indirect effect estimates are substantially smaller than the direct effect estimates. Thus, lower-income households are affected *relatively* more when accounting for the production network than the direct effect estimates would suggest. Consequently, the production network dampens inflation inequality but does so to the detriment of poorer households.

Does this mean that, in absolute terms, higher-income households are disproportionately exposed to both the direct and production network effect of supply-side price shocks? Not necessarily, as we are yet to consider the absolute expenditure weights in sectors – akin to a Consumer Price Index (CPI). Conveniently, the total effect share of a sector class can be seen as a reasonable first-order approximation of its share in a synthetic CPI. Thus, the effect share of inequality enhancing sectors (the ones with negative estimates) in our synthetic CPI can easily be compared to the effect share of inequality-reducing sectors (the ones with positive estimates). These are computed for the direct, indirect, and total effect as

$$\frac{\sum_{i=1}^{I}\sum_{q=1}^{Q}\text{effect inequality enhancing(reducing)sectors}}{\sum_{i=1}^{I}\sum_{q=1}^{Q}\text{effect all sectors}}. \tag{2}$$

Shares are normalized to one since insignificant estimates were omitted, as well as some sectors in the log-log-regression due to zero values. As Table 1 confirms, higher-income households are, in absolute terms, significantly more exposed to the production network effect, with 87% of the average *indirect* effect stemming from inequality reducing sectors. However, even though there are only five inequality enhancing sectors for the *direct* effect, these account for 83% of the overall *direct* inflation exposure of households. In total, lower-income households are in fact slightly more exposed to the total effect of price shocks as the last column shows.

Table 1. Average effect sizes for inequality-enhancing and -reducing sectors.

	Average Direct Effect Share (%)	Average Indirect Effect Share (%)	Average Total Effect Share (%)
Inequality-Enhancing Sectors	0.83	0.13	0.52
Inequality-Reducing Sectors	0.17	0.87	0.48
Sum	1.00	1.00	1.00

V. Conclusion

This paper proposes a novel explanation for ambiguous results on income-dependent inflation inequality by uncovering the role of sectoral asymmetries for modulating the distributional impacts of cost-push shocks. Our findings indicate a dampening production network effect on inflation inequality, mostly, however, to the detriment of poorer households. A synthetic CPI furthermore suggests that these households are also disproportionately exposed to the overall effect of price shocks in our model. Policymakers and regulators whose concerns rest with poorer households should pay special attention to price changes in sectors for which our analysis provides negative direct *or* indirect effect estimates, i.e., to the agricultural, energy, construction and housing sectors. Mitigating strategies, such as the potential of buffer stocks to smooth price volatility and supply shortages in the former should be examined. However, policymakers should be aware that poorer households might have become increasingly connected to price shocks in a globally integrated production

network, limiting their leeway to react to the broad diffusion of shocks.

This study comes with a set of limitations. Most notably, the reliability of our results could be improved by more recent and disaggregated data. Moreover, as we focus on consumption differences, other important channels of inflation inequality such as wealth effects are neglected. Despite these limitations, we offer a promising explanation for the ambiguous results on income-dependent inflation inequality. Our results constitute a rich foundation for policies aimed at mitigating adverse distributional effects of current and future cost-push shocks.

Acknowledgements

We thank Frank Westerhoff, Georg Maxton and the participants of the meeting of the Keynes Society in Bamberg in 2024 for their valuable comments at crucial junctions of this investigation. Funding by the Hans-Böckler-Foundation through grant PK045 is gratefully acknowledged.

Disclosure statement

No potential conflict of interest was reported by the author(s).

Funding

The work was supported by the Hans Böckler Stiftung [PK045].

Data availability statement

The data that support the findings of this study are openly available in

- World Input-Output Database, at https://www.rug.nl/ggdc/valuechain/wiod/?lang=en., reference number [9].
- Eurostat: Distribution of income by quantiles, at https://ec.europa.eu/eurostat/databrowser/view/ilc_di01/default/table?lang=en&category=livcon.ilc.ilc_ip.ilc_di, reference number [5].
- Eurostat: Structure of consumption expenditure by income quintile and COICOP consumption purpose, at https://ec.europa.eu/eurostat/databrowser/view/hbs_str_t223/default/table?lang=en&category=livcon.hbs.hbs_struc, reference number [6].
- Inflation Inequality, at https://github.com/ip5490/Inflation-Inequality.

References

Baba, C., R. Duval, T. Lan, and P. Topalova. 2024. "The 2021-22 Inflation Surge in Europe: A Phillips-Curve-Based Dissection." *Applied Economics Letters*: 1–6. https://doi.org/10.1080/13504851.2024.2303383.

Cai, M., and T. Vandyck. 2020. "Bridging Between Economy-Wide Activity and Household-Level Consumption Data: Matrices for European Countries." *Data in Brief* 30:105395. https://doi.org/10.1016/j.dib.2020.105395.

Crawford, I., and Z. Oldfield. 2002. *Distributional Aspects of Inflation*. London, UK: Institute for Fiscal Studies Comment.

Eurostat. 2021. "Distribution of Income by Quantiles [Data Set]." https://ec.europa.eu/eurostat/databrowser/view/ilc_di01/default/table?lang=en&category=livcon.ilc.ilc_ip.ilc_di.

Eurostat. 2021. "Structure of consumption expenditure by income quintile and COICOP consumption purpose [Data set]." https://ec.europa.eu/eurostat/databrowser/view/hbs_str_t223/default/table?lang=en&category=livcon.hbs.hbs_struc.

Garcimartín, C., J. Astudillo, and A. Martínez. 2021. "Inflation and Income Distribution in Central America, Mexico, Panama, and the Dominican Republic." *Review of Development Economics* 25 (1): 315–339. https://doi.org/10.1111/rode.12714.

Hobijn, B., and D. Lagakos. 2005. "Inflation Inequality in the United States." *Review of Income and Wealth* 51 (4): 581–606. https://doi.org/10.1111/j.1475-4991.2005.00170.x.

Timmer, M. P., E. Dietzenbacher, B. Los, R. Stehrer, and G. J. De Vries. 2015. "An Illustrated User Guide to the World Input–Output Database: The Case of Global Automotive Production." *Review of International Economics* 23 (3): 575–605. https://doi.org/10.1111/roie.12178.

Weber, I. M., J. Lara Jauregui, L. Teixeira, and L. Nassif Pires. 2024. "Inflation in Times of Overlapping Emergencies: Systemically Significant Prices from an Input–Output Perspective." *Industrial and Corporate Change* 33 (2): 297–341. https://doi.org/10.1093/icc/dtad080.