FOOD PRICE DYNAMICS IN OECD COUNTRIES – EVIDENCE ON CLUSTERS AND PREDICTORS FROM MACHINE LEARNING

Lisa Höschle, Xiaohua Yu

lisa.hoeschle@uni-goettingen.de

University of Göttingen, Germany

GEWISOLA

2023

Assessing the Changing Role of Food Price Predictors – Evidence from OECD Countries

Lisa Höschle[1], Xiaohua Yu

Since 2020, food prices are on the rise, resulting in an ongoing global food price crisis (Kearns, 2023). Within the Organization for Economic Cooperation and Development (OECD), food prices have reached an all-time high since 1974, peaking at 16,1% compared to the previous year in October 2022 (OECD, 2022). High prices indicate scarcity, reflecting in demand and supply shifts of food items.

Rising food prices not only represent a monetary burden but are directly linked to living standards, nutrition outcomes, and social cohesion (Bellemare, 2015; Meerman & Aphane, 2012, Placzec, 2021) . Households in OECD member countries are confronted with increased costs of living and negative welfare effects due to rising food prices. Surges in food prices are associated with reductions in food consumption and decreased intake of nutritious food in low-income households (Green et al., 2013; Placzek, 2021), elevating the prevalence of food insecurity and adverse health effects within the OECD (Giner & Plazczek, 2022; Placzek, 2021). Between 2018 & 2020, 7,5% of the OECD population is confronted with moderate food insecurity. The figures range between 3% in Switzerland and 35% of the population in Mexico. Severe food insecurity is affecting a share between 0.5% and 13% of the OECD population. Consequently, rising prices in the future might exacerbate the prevalence of moderate and severe food insecurity within the OECD.

The OECD unties leading food and agricultural commodity exporting countries and consolidates major consumer markets. To date, the organization has a share of 63% of world market-exchange-based GDP, is accountable for three-quarters of global trade, and consumes more than 50% of total global energy (Office of the United States Trade Representative (USTR), 2023), indicating high levels of economic activity and trade preponderance. Rising food prices within the OECD therefore not only affect member countries but also result in growing export prices of food and agricultural commodities (Brooks, 2014; Dorward, 2012; FAO, 2022a; OECD & FAO, 2022a). Net food importing countries, such as countries in Sub Saharan Africa, are consequently confronted with rising import prices (Demeke et al., 2008). Simultaneously, the relevance of imports in food and agricultural commodities is growing in the developing world due to population growth and resource constraints, intensifying the adverse effects of surging prices (OECD & FAO, 2022b). Trade represents a core pillar of food security in the developing world. Recent increases in food prices have resulted in a growing number of food insecure households in countries of the global south (FAO, 2022b).

Commonly applied policy measures to combat rising food prices are the eradication of export bans or the reduction of import tariffs, the restriction of speculative activities in commodities, the support of the international community in humanitarian help for vulnerable households as well as investments into the agricultural sector that support sustainable growth and rise in productivity (Abbott, 2012; Von Braun et al., 2008). Reductions in taxes and tariffs, the use of domestic grain stocks, or the provision of consumer or producer subsidies and tax reductions are other widely applied measures in light of rising food prices (Abbott, 2012; Zaman et al., 2008). However, mal-designed policies to counteract rising prices have reinforced negative consequences on consumers and exacerbated food insecurity for vulnerable households in the past (Zaman et al., 2008). Export restrictions, for instance, have resulted in an increase in global

---

[1] Georg-August-Universität Göttingen, Platz der Göttinger Sieben 5, 37083 Göttingen, lisa.hoeschle@uni-goettingen.de

food prices with adverse welfare effects both for the imposing country as well as the importing countries (Mitra & Josling, 2009). To refine future policy design in the presence of rising food prices, accurate food price inflation predictions represent a necessary foundation.

As a consequence, the precise prediction of food prices through relevant features represents a key instrument to the design of responsive policy measures that effectively address rises in food prices and protect vulnerable or food-insecure households, both in OECD countries and net food importing countries. Understanding the relative contribution and relevance of food price predictors over time and in a cross-country setting assesses long-term food price dynamics accounting for diverse food inflation experiences between countries. The analysis contributes to a well-informed and precise policy design that is based on time and country-specific core features of relevance rather than on size fits all approaches in light of rising food prices. Through the identification of relevant features of food price prediction, price policies can be contextually adjusted.

In the literature, a series of relevant food price predictors is emphasized. Yet, the relative importance of individual features over time on food inflation is not assessed. Changing marginal contributions to variation in food prices alter the requirements for policy monitoring of stable food prices. Discrepancies in long-term food inflation trends between countries further require tailor-made policy adjustments at the country and/ or cluster level. Most studies assume a linear relationship between food prices and predictors but do not consider potential non-linear relations or the interplay between different predictors. Accordingly, we include a broad selection of previously determined and literature-based relevant drivers of food prices to determine the relative contribution of individual features over time and clusters. Methodological innovations, such as neural networks, achieve improved prediction accuracy of food prices and hence contribute to the understanding of long-term food price dynamics and therefore represent a tool for improved policy design.

The analysis is based on monthly data of the food consumer price index (CPI) of OECD member states between January 1999 and March 2023. Food CPI is used as a proxy for relative changes in food prices over time. Periodical changes in prices of food with constant quantity and quality evaluate the relative decline in living standards compared to the preceding period (OECD, 2023). A set of economic features, extracted from the literature, is used for the prediction of food prices. Methodologically, time series clustering is realized with Dynamic Time Warping (DTW). Cluster-specific predictors of food prices are identified through long-short term memory (LSTN) neural networks. Subsequently, Shapley values as well as the marginal contribution of identified features over time are calculated.

The results shed light on the global understanding of cross-country food price dynamics. Adopting a long-term perspective, we observe that food prices are driven by a differential set of predictors across clusters, which behave as volatile and transient over time. The policy implications of these results therefore demand for precise policy design, that addresses food price changes at the cluster level and take into consideration time-specific predictors. In other words, price policies need to be highly adaptive to changing circumstances and subject to revision and readjustment to promptly respond to alterations. Cluster-independent one-size fits all policies over several years appear not optimal. Particularly in light of crises, readjustments and evaluations of specific food price predictors should be made due to the changing marginal contribution of predictors to address surges effectively. The overall aim of price policies should hereby be to stabilize domestic food prices, keep the cost of living constant, and avoid negative welfare effects.

References

Abbott, P. C. (2012). Export Restrictions as Stabilization Responses to Food Crisis. *American Journal of Agricultural Economics*, *94*(2), 428–434. https://doi.org/10.1093/ajae/aar092

Bellemare, M. F. (2015). Rising Food Prices, Food Price Volatility, and Social Unrest. *American Journal of Agricultural Economics*, *97*(1), 1–21. https://doi.org/10.1093/ajae/aau038

Brooks, J. (2014). Policy coherence and food security: The effects of OECD countries' agricultural policies. *Food Policy*, *44*, 88–94. https://doi.org/10.1016/j.foodpol.2013.10.006

Demeke, M., Pangrazio, G., & Maetz, M. (2008). *Country responses to the food security crisis: Nature and preliminary implications of the policies pursued*. FAO report. FAO.

Dorward, A. (2012). The short- and medium- term impacts of rises in staple food prices. *Food Security*, *4*(4), 633–645. https://doi.org/10.1007/s12571-012-0210-3

FAO. (2022a). *The State of Agricultural Commodity Markets 2022*. FAO. https://doi.org/10.4060/cc0471en

FAO. (2022b). *In 2023, FAO will require $1.9 billion to reach 48 million people with life-saving and livelihood assistance*. https://www.fao.org/newsroom/detail/in-2023-fao-requires-1.9billion-to-reach-48-million-people-with-life-saving-and-livelihood-assistance/en

Giner, C., & Plazczek, O. (2022). *"Food insecurity and food assistance programmes across OECD countries: Overcoming evidence gaps."* OECD publishing. OECD.

Green, R., Cornelsen, L., Dangour, A. D., Turner, R., Shankar, B., Mazzocchi, M., & Smith, R. D. (2013). The effect of rising food prices on food consumption: systematic review with meta-regression. *BMJ*, *346*(jun17 1), f3703–f3703. https://doi.org/10.1136/bmj.f3703

Kearns, J. (2023). *Global Food Crisis May Persist, With Prices Still Elevated After Year of War*. International Monetary Fund Blog. https://www.imf.org/en/Blogs/Articles/2023/03/09/global-food-crisis-may-persist-with-prices-still-elevated-after-year-of-war

Meerman, J., & Aphane, J. (2012). *Impact of high food prices on nutrition*. FAO report. FAO.

Mitra, S., & Josling, T. (2009). *Agricultural export restrictions: Welfare implications and trade disciplines*. IPC Position Paper Agricultural and Rural Development Policy Series.

OECD. (2020). *OECD share stable at around 50% in PPP terms in 2017*. https://www.oecd.org/sdd/prices-ppp/oecd-share-in-world-gdp-stable-at-around-50-per-cent-in-ppp-terms-in-2017.htm

OECD. (2022). *Consumer Prices, OECD - Updated: 6 December 2022*. https://www.oecd.org/newsroom/consumer-prices-oecd-updated-6-december-2022.htm

OECD. (2023). *Inflation (CPI)*. https://data.oecd.org/price/inflation-cpi.htm

OECD, & FAO. (2022a). *OECD-FAO Agricultural Outlook 2022-2031*. OECD. https://doi.org/10.1787/f1b0b29c-en

OECD, & FAO. (2022b). *OECD-FAO Agricultural Outlook 2022-2031*. OECD. https://doi.org/10.1787/f1b0b29c-en

Office of the United States Trade Representative (USTR). (2023). *Organization for Economic Co-operation and Development (OECD)*. https://ustr.gov/trade-agreements/wto-multilateral-affairs/oecd#:~:text=Today%2C%20OECD%20member%20countries%20account,percent%20of%20the%20world's%20population.

Placzek, O. (2021). *"Socio-economic and demographic aspects of food security and nutrition."*

Von Braun, J., Ahmed, A. U., Asenso-Okyere, K., Fan, S., Gulati, A. , Hoddinott, J., & Von Grebmer, K. (2008). *High food prices: the what, who, and how of proposed policy actions*.

Zaman, H., Delgado, C., Mitchell, D., & Revenga, A. (2008). Rising Food Prices: Are there right policy choices? *Development Outreach*, *10*(3), 6–12.