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# Is agricultural globalisation slowing? Evidence from four decades of global trade networks

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# Is agricultural globalisation slowing? Evidence from four decades of global trade networks

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**Abstract**

Economists and institutions have warned that the world may be entering a phase of deglobalization, characterised by weakening trade interdependence, slower economic growth, trade wars, protectionism and nationalism. Global agricultural trade flows may be affected through long-term structural changes in food, feed and biofuel supply chains, potentially prompting strategic realignment of trading networks in response to concerns about food sovereignty and security. Short-term shifts in trading networks may alter the long-term strength, composition and structure of agricultural globalization.

Here, we assess whether agricultural trade globalization remains resilient and analyse changes in globalization patterns from 1986 to 2023 using international trade and ancillary data.

At a global level, we find a continuing, but slowing long-term trend toward agricultural globalization. Early signs of deglobalization are emerging behind global totals, including increasing on- and near-shoring of crop production, rising trade within free trade zones, and growing concentration between a few trading partners for specific crops.

We show that recessions, currency changes and high production costs coincide with short-term shifts (<5yrs) in trade flows, and may have contributed to long-term structural changes (>10yrs). Given current economic uncertainties, a prolonged recession—compounded by persistent supply-demand imbalances and price volatility—could tip the global food system into a period of deglobalization, reshaping food systems and undermining long-term food security.

## Introduction

Globalisation is a widely used context-specific concept with no universally agreed definition. It refers in general to the integration of countries, markets, and societies through flows of goods, capital, information, and people [1–7]. These globalisation processes have profoundly reshaped agricultural systems by linking food production, consumption, and trade across regional and global scales. Agricultural trade now connects producers, consumers, and markets worldwide, shaping food availability, diets, incomes, and rural livelihoods [8].

Key features commonly associated with globalization, including trade interconnectedness, integration, speed, and geographic expansion (Table S1) [1,5,8–14], are also reflected in agricultural trade networks. International trade plays a central role in supplying sufficient, diverse, and nutritious food while supporting agricultural incomes and employment [8]. It also buffers regional production deficits and contributes to global food security.

Over the past decades, agricultural trade has been shaped by consumption demands, trade policies (e.g. agreements, tariffs), trading and production costs (e.g. inputs, transport), and comparative advantage, i.e. the ability of a country to produce goods at lower opportunity cost than its partners [8].

Agricultural trade expanded rapidly during the late twentieth century, particularly during the period of "hyper-globalization" between 1990 and 2008 [12,15]. Since the UN's Food and Agricultural Organisation (FAO) began reporting global trade statistics in 1986, traded agricultural quantities have increased more than fourfold, from 400 Mt to over 1700 Mt in 2023 [16]. Agricultural products now account for 18% of global trade value and 12% of traded commodity mass 17. Over the same period, the share of agricultural production entering international markets increased from 11% in the 1960s to 17% by the early 2000s [17].

Trade in agricultural goods links ecosystems between exporting and importing regions through telecoupling processes[18], increasing demand for land and water resources[19–21]. In recent years, over 20% of global cropland and water resources were used for internationally traded crops[22–24], with widespread negative environmental consequences. Approximately half of tropical deforestation[25] is associated with conversion to agricultural land, and commodity-driven agriculture accounts for roughly one third of tropical deforestation[26]. Most tropical forest loss is driven by pasture expansion and crops such as oil palm, soy, cocoa, rubber, coffee, maize, rice, and cassava imported by regions such as the EU and China[27–29].

Globalisation is not a linear process and can slow or even reverse[30]. This reversal, often termed deglobalization, describes a weakening of international interdependence and integration1. In agricultural trade, deglobalisation may manifest in slower growth or declines in trade volumes, a reduced share of production entering international markets, increasing concentration of trade among fewer trading partners ("friend-shoring"), and shorter supply chains driven by on- or near-shoring. While such changes may be triggered by short-term disruptions, they can lead to longer-term structural changes in global trade networks and geographic trade patterns (Table 1).

Various economists[31–33] and institutions[12–14] suggest the world may be entering a phase of deglobalization, driven by slowing growth, rising costs, declining national benefits, and increasing protectionism and nationalism[34]. At the same time, countries are reducing their reliance on distant suppliers through near- and on-shoring[35]. These changes aim to protect critical infrastructure such as information and communication technology, artificial intelligence and robotics and to reduce exposure to supply chain disruptions. Major events, including the 2008 financial crisis, the COVID-19 pandemic, and the war in Ukraine[33] as well as the ongoing renewable energy transition, are widely seen as key turning points that have accelerated these trends[12–14]. Several studies have indicated a possible break in agricultural trade trends after the 2008 global financial crisis, following decades of hyper-globalization[8,24]. Some reports from the FAO indicate a stagnation in trade since 2008[8,36], with global trade volumes remaining around 800 billion USD[16]. In contrast, organisations such as the OECD[11] argue

that globalization remains largely intact and project agricultural trade to grow by 13% over the next decade.

However, defining and quantifying globalization in agricultural trade remains challenging, and constitutes a key research gap. Existing studies[10,13,14] often lack a comprehensive, harmonized, and long-term assessment of the core dimensions of globalization. It remains unclear whether observed changes represent short-term volatility or enduring long-term structural shifts, particularly because many studies cover limited temporal periods[1,13,14] and lack interdisciplinary perspectives, including links to land use and economics.

Amid ongoing geopolitical tensions and trade disputes[27–29,37], this study has two goals. First, we assess whether globalization in agricultural trade is continuing to grow, slowing down or even declining, based on traded value and weight of agricultural products. Second, we analyse changes in the global trading network using the definition and key characteristics of globalization following Alkharafi & Alsabah (2025)[1] and associated agricultural variables (Table 1) from 1986 to 2023 using international trade and ancillary data. We seek to identify long-term structural changes (spanning over at least a decade) that indicate a change in globalization, analysed through the lens of four key characteristics: interconnectedness, integration, speed, and scope (Table 1).

To explore the situation of globalization in agricultural trade, we pose following research questions:

1) Do we still live in a globalized world for agricultural products?
2) What role do different globalization characteristics (interconnectedness, integration, speed and scope) play in shaping trends of globalization or deglobalization and which ones show evidence of long-term structural changes?
3) What factors may help explain these shifts, and what might this imply for future agricultural trade and global food security?

## Results

### *Absolute agricultural trade by country, income group and product group*

Across the 38-year period of available agricultural trade data, there was an 8-fold increase in value (250B to 2T USD) and more than 4-fold increase in weight (400Mt to 1700Mt) (Fig. 1). Additionally, the share of agricultural trade relative to global domestic production also roughly doubled from 3.6% to 7.5% since 1986 (Supplement Figure S5). During the global recessions (Global Financial Crisis, 2006 to 2009 and COVID-19, 2020 to 2022[38]) and a recession in the Euro-zone around 2012[38], the trade in value increased.

However, periods of stagnation or slower growth in the value of trade, exist during the 1990's and 2010s between major recessions. In contrast, similar patterns are not apparent in terms of weight, which stagnated during recessions. Both the increase in traded value and the slowing of economic activity (by weight) affects the speed of globalization rather on a short-term basis with value being more volatile than weight (Fig. 1, top). However, we do not observe structurally changing long-term trends by this metric. This may suggest that the often-discussed stagnation or "slowbalization" in global trade[12–14,31–33] may partly reflect loosening financial conditions (e.g. money supply) in traded value, rather than changes in the physical quantity of goods.

High-income OECD countries account for 55% of value and 42% of export weight in 2023 (Fig. 1, middle). While the share in value has remained quite stable since 1986 (57% of value) share in weight has decreased from 62%. Remarkably, lower and upper middle-income countries combined, mostly emerging countries such as China, Brazil, India, Indonesia and others (Fig. 1, top panel and Supplement Figure S1) gained a greater share in global exports from 3% of traded value and 6% traded weight in 1986 to 37% and 46% in 2023, respectively. These long-term shifts in the participation of income groups (Table 1) are consistent with continued globalisation.

However, for imports, this large gap in global agricultural trade between lower plus upper middle-income countries, versus OECD high income countries is lower (Supplement Figure S2). Upper and lower middle-income countries had a share of 17% (value) and 25% (weight) in 1986 which increased to 36% and 49% by 2023. This growth reflects their increasing integration into global supply chains as exporters since the late 1980s. This shift occurred at the expense of low-income countries (value and weight ca. 1% in 1986 and 2023) and, to some extent, high-income OECD countries (contribution to globally traded value declined by 5% and in weight by 23% since 1986), marking another structural change that supports the continued globalization narrative.

At the same time, global agricultural trade remains dominated by a small number of countries (See top 5 and top 6-15 in Fig. 1, top panel), which together accounted for roughly 60% in trade value and 67% in traded weight in 2023. This concentration suggests that expanding trade has not been accompanied by an equally broad distribution of market power across countries. These top countries also harvested ca. 59% of the global harvested area[16]. Likewise, five crops alone, namely wheat, maize, rice, soya and palm oil, contributed to roughly 50% of global trade in weight (Fig. 1, bottom panel) although this was only equivalent to 24% in value. There is a noteworthy shift from cereals (-1% in value, -11% in weight) towards oil crops (+6% in value, +9% in weight) during this time (Fig. 1, bottom panel). This large concentration in countries and crops, increasing over time, indicates a low interconnectedness in global agricultural trade.

### *Rate of change in agricultural trade*

Figure 2 illustrates the annual rate of change in global traded value (left) and weight (right)of agricultural products across different aggregated time frames. On an annual basis, the rate of change exhibits high volatility and significant interannual variability. However, when aggregated over longer periods e.g. as 3-year or 5-year averages, a slow but steady decline in growth becomes evident from the start of the time series for both, value and weight.

Notably, following the Global Financial Crisis, the last decade saw a more pronounced deceleration in the interannual growth of traded agricultural products. While the negative trend persists throughout the entire time series, the increased slowdown of growth in value and weight is only observable over a period less than 10 years. Consequently, this observation is not yet defined as a structural long-term change here.

Given the slowing speed in global trade, this characteristic suggests a movement toward deglobalization. Although 5-year average growth remains positive, the decelerating trend aligns with the often-discussed concept of "slowbalisation" in global trade[12–14,31–33] at least for the agricultural sector.

***Relative agricultural trade by country, income group and product group***

Figure 3 shows a redistribution of market shares in global agricultural trade during the hyper-globalisation period. High-income OECD countries started to lose market share around 1990 in value terms and in the mid-1990s in weight-terms. In contrast, lower- and upper-middle-income countries (e.g. Eastern Europe, South America, Southeast Asia, China) and high-income non-OECD countries (e.g. the Middle East) gained shares over the same period.

Among top exporters, the USA, France, and Australia experienced the largest losses, with the USA losing about 15% compared to its 1986 share. Meanwhile, countries such as Brazil gained nearly 10% (Fig. 3, top panel and Supplement Figure S3). Key changes included the collapse of the Former Soviet Union and China's entry into the WTO in 2001[40], alongside economic reforms such as "Green for Grain"[41], which reshaped global production and trade patterns. Overall, emerging regions—Eastern Europe, South America, Southeast Asia, and the Middle East—have grown in importance since 1986. China's imports rose by 8% in value and 18% in weight compared to 1986.

At the same time, the composition of traded crops shifted: main exports from Western Europe, Australia, and the USA declined in value and weight for products such as beverages and spices (-5%/1%), ruminant goods (-5%/0%), sugar crops (-2%/-2%), other cereals (0%/-4%) and wheat (-1%/-7%), while emerging economies expanded exports of oil crops such as soya (+2%/+4%), oil palm (+2%/+2%), temperate oilseeds (+2%/+3%) and other products such as fibre crops (+5%/+2%)(Fig. 3, bottom panel). All changes among countries, income groups and product groups are structural long-term changes.

***Regional trade patterns and agricultural trade concentrations***

A regional trade matrix reveals distinct patterns (Fig. 4, left). Europe and Central Asia—dominated by EU countries—trade largely within their own geographic region (e.g. 454 Mt in 2023, over 26% of global agricultural trade by weight, see also Supplement Figure 5 for weights and different years). The Herfindahl-Hirschman Index (HHI), a common measure of market concentration, which measures the size of a features (e.g. country, region crop) relative to the size of the total market they are in[42], shows increasing concentration of trading partners since 1986 (0.26 to 0.61), indicating a growing focus on intra - 'Europe and Central Asia' trade (Fig. 4, right). Spikes in concentration occurred after the Soviet Union's collapse, the Global Financial Crisis, and COVID-19. As the only region with rising HHI and shorter trade distances, this suggests that the EU and its neighbouring countries, indeed concentrate their agricultural trade within the continent. Although the spikes in concentration were for a short-term, the long-term trend is structural in interconnectedness (HHI) and scope (region).

In contrast, East Asia and the Pacific is import-dominated, supplied by regions such as Latin and North America (31% of global trade by weight), reflected in a declining HHI. Similarly, the Middle East & North Africa, South Asia, and Sub-Saharan Africa act as net importers with increasingly diversified suppliers. All four regions reduced their HHI between 1986 and 2023, with East Asia and the Pacific showing the largest drop (0.38 to 0.26). Unlike Europe, these regions rely on more diverse and distant trade partners, indicating continued globalization (interconnectedness and scope).

***Hot spots of agricultural trade***

With Europe and Central Asia and East Asia and Pacific trading globally most agricultural products, we examine their dominant sub-regions, EU27+UK (left) and China+HK (right), in more detail in Figure 5, showing the Herfindahl-Hirschman Index (HHI) alongside currency pairs with the US dollar (top panel), relative changes in imported crops (middle panel), and trade networks (bottom panel). For both regions, HHI shows similar patterns to exchange rates: in the EU27+UK, import concentration rose until 2008 when the Euro was strong, then diversification increased after the Global Financial Crisis as the Euro weakened. A similar pattern appears for China+HK: high import concentration coincided with a strong yuan, while diversification increased after the 1997 Asian Financial Crisis and China's WTO entry in 2001, when the yuan weakened and was subsequently managed closely against the US dollar

Major recessions thus seem to influence exchange rates, which coincides with import concentration. This may reflect that imports become more attractive when local currencies are strong, reducing domestic competitiveness, while a weaker USD can reinforce concentration trends. For China+HK this observation is structural with the fixing the yuan to the US dollar. However, for the EU27+UK, trends in concentration and diversity change over time, contrary to the wider region Europe & Central Asia (Fig. 4, right) suggesting near-shoring after the Global Financial Crisis (e.g. Ukraine or Turkey).

In both regions, these shifts also changed crop imports (Fig. 5, middle). In the EU27+UK, the financial crisis reduced soy imports and increased temporary oil crops, alongside the 2006 Brazilian Soy Moratorium[43]. In China+HK, the crisis and WTO coincides with a ~40% drop in wheat imports and a 40–50% rise in soy imports, making China the world's largest soy importer. Although changes were sudden, they were structural over the long term. Trade networks (Fig. 5, bottom panels) show that EU27+UK trading partners outside Europe were mainly the USA, Brazil, China, Ivory Coast, South Africa, Indonesia, within Europe mostly Ukraine, and EU members. China sourced agricultural imports primarily from Brazil, the USA, Canada, Australia, New Zealand, the EU, Russia, and Southeast Asia.

***Global agricultural trade in relation food production inputs and outputs***

The 2008 Global Financial Crisis, the COVID recession, and Russia's invasion of Ukraine, coincided with major disruptions in energy, fertiliser and food markets [37,44–47] (Fig. 6). Energy and fertilizer prices spiked (Fig. 6b, e, f), and traded agricultural values rose, reflecting higher input costs passed to importers or consumers, as seen in the FAO Food Price Index (Fig. 6c). Foreign direct investments also increased (Fig. 6d), potentially reflecting efforts to secure access to cheaper production abroad [48].

These agricultural inputs and outputs coincide with the last major commodity super-cycle, a prolonged period of rising prices starting in the early 2000s and peaking in 2011[49]. Post-2008, land grabs increased in many developing countries due to the crisis and foreign investments[48]. Between the Global Financial Crisis and COVID, energy prices slowly normalized again, likely due to deflating food prices, agricultural trade values, and investments. Collectively, these factors coincide with years of stagnating trade.

## Discussion

### *Globalization is still intact but slowing*

Our results show that for three globalization characteristics (speed, integration and scope) the overall agricultural trade remains positive and globalization is continuing. However, we also observe a slowing rate of global growth in trade, especially in recent years.

Speed: Traded volumes have continued to grow with only slight slowdowns in value between recession and in weight during global recessions (Fig. 1, top), indicating for global totals that deglobalization is continuing in this sector. Kose et al. (2020) attribute the slowdown in traded weight during recession to slowing or declining economic output and demand[38]. Contrary to that, the increase in value during recessions, he attributes to loosening financial conditions (e.g. money supply) and changes in exchange rates related to the USD, in which commodities, like agricultural products, are traded globally and reversal effects during periods of recovery[38]. This may reflect a bias from focusing only on traded value, which is subject to currency valuations; therefore, both value and weight should be assessed together. Further evidence of ongoing globalization includes an eightfold rise in trade value and a more than fourfold increase in traded volume between 1986 and 2023 (Fig. 1). However, on aggregated level (e.g. 5-year average) our results show a weakening of growth in traded agricultural products, while still being positive, both for value and weight (Fig. 2). This slowdown is not yet a structural long-term change, but should the trend continue, it could evolve into one in the next few years and turn into negative growth if the trend continues. One reason for a slowdown could be a saturation effect, in a sense that global agricultural trade cannot grow forever. However, a saturation effect is disputed by nearly 200 years of periodic doubling in economic growth based on continued ingenuity and efficiency gains[50]. Similarly, negative growth would counter this argument accompanied by growing global world population[51], dietary intake[51], agricultural yields[52], and ocean shipping world-wide[53].

Integration: The share of traded agricultural goods relative to global production has doubled, highlighting the increasing importance of exports (Supplement Figure 6). During this period, upper and lower middle-income, such as Brazil, India, China, Indonesia, South Korea, the Middle East Region, were Increasing their share in global trade during this period (Fig. 1 and Fig. 3, middle and top).

Scope: Regions such as East Asia and the Pacific and Sub-Saharan Africa have diversified their trading partners the most (Fig. 4). As many countries in these regions depend on food imports, diversification likely increases resilience to market shocks and food insecurity[8].

### *Signs of deglobalization below global totals*

However, for specific regions and countries, we see a range of characteristics that may indicate first signs for deglobalization. These characteristics seem to be driven by external factors, such as supply or demand shocks during recessions, causing sudden trend changes, but they developed into long term structural changes. In particular:

Interconnectedness: Despite global growth, market concentration among fewer trading partners grew. Europe's and East Asia's agricultural volume within their own region, led by the EU27+UK and China+HK, grew by over 54% since 1986 to well over a third of all global traded volume in 2023. In contrast, the USA and other high-income OECD countries (e.g. Australia) lost remarkable market share (e.g. Fig. 3, top right). For example, the US lost 15% compared to its 1986 share (Fig. 3). Moreover, the EU27+UK increasingly traded within the European Union, reducing diversification outside Europe and near-shoring imports, particularly to Ukraine, which could be an effort to bypass stricter EU regulations while shortening trade distances (Fig. 4 and Fig. 5)[27,33]. Ukraine oilseed exports to the EU increased 10-fold during the 2000s to 10Mt in 2023[16]. Particularly, soybeans exports to the EU increased 7-fold after the Global Financial Crisis to 1.4Mt in 2023 and make today 10% of all EU soybean imports[16]. This supports the near-shoring hypothesis indicated by the HHI for the European region and the EU (Fig. 4 and Fig. 5).

Our results show that stronger currencies (e.g. EUR, CNY) coincide with higher import concentration (Fig. 5 top). The early-2000s commodity super-cycle, driven by Chinese demand and input needs, increased concentration until the 2008 financial crisis[49,53].

Scope: Since 1986, trade has shifted toward oilseeds (+8%) at the expense of staple crops such as rice and wheat (-12%). Five crops—wheat, rice, maize, soy, and palm oil—now account for over 50% of global trade by weight, indicating strong concentration among a few exporters. This highlights the importance of staple crops, traded at very large scale and produced with low profit margins. China, in particular, sourced imports from distant partners such as Brazil but concentrated on a few commodities, especially oilseeds such as soy. In 2025, China sourced three quarter of its soy imports from Brazil[54]. This demonstrates a high crop concentration and low interchangeability of trading partners and product groups, which are characteristics of deglobalization (Table 1). While this support the argument for comparative advantages that are playing out, such high concentrations show strong features of an oligopoly (few sellers, many buyers)[55,56]. These changes are structural long-term developments (Supplement Figure 7).

This growing focus on specific regions and commodities are consistent with deglobalization despite rising volumes. Major recessions, as seen for the EU27+UK and China+HK, have triggered abrupt shifts in trade flows, suggesting that future geopolitical and economic instability may pose risks to global agricultural trade (Fig. 5 top and Fig. 6). Upcoming political and economic turmoil therefore might cause serious threads for global agricultural trade.

Although agricultural inputs and outputs react in a volatile way in the short-term (Fig. 6), due to sharp contractions in real activities during a recession[38], we hypothesise that they have caused long-term structural changes in geographic trade flows (scope) and concentration in countries and crops (interconnectedness), altered speed of agricultural trade, at least temporarily up to decades, and the integration of income groups changing fundamentally the characteristics of globalization below global totals. Kose et al. (2020) highlight that the Global Financial Crisis (2007-2009) was significantly different from all other previous recessions, with uneven recovery[38]. After this recession developed economies were particularly slow in recovery, but emerging countries accounted for the lion's share in global growth afterwards[38]. While in earlier recession developed economies, according to Kose et al. (2020), contributed on average ca. 75% to the recovery, it dropped to only 35% in 2010 to 2012[38], suggesting a long-term structural change in trade flows driven by emerging countries, which we can also see in our data. The COVID-19 recession, however, was not part of their study as data for their study was only available until 2019[38].

***Implications for the future of agricultural trade***

Around the 2024 US election, Donald Trump proposed reducing the US trade deficit by raising tariffs and weakening the USD to promote onshoring and exports [57]. After taking office in January 2025, new tariffs were introduced in April, continuing earlier policies. These tariffs affected trade patterns substantially: China's soybean imports moved strongly toward Brazil (74% in 2025[54] vs. 45% in 2016[16,29]), while the US share fell to 16% (Supplement Figure 7). Relocating production to friendly supplier countries is described as "friendshoring"[33], a term that originates from the US-China trade war. Although escalatory US tariffs and their effects are less than a decade old, it remains to be seen, if current observations turn into irreversible structural long-term changes potentially leading to agricultural globalization by lower interconnectedness, speed and scope of trade.

China is not the only example. Similarly, the EU increased soybean imports from Brazil (38% to 46%) and Ukraine (2.5% to 10%) between 2016 and 2024, while US shares remained stable[16]. Overall, the two major importers, the EU27+UK and China+HK, are concentrating trade away from the US, reducing partner diversity and increasing on- and near-shoring—clear signs of deglobalization. These shifts appear structural, as China now relies heavily on Brazil (Supplement Figure 7).

Farm and food policies also shape trade: as incomes grow, countries tend to support domestic agriculture and shield markets from global price shocks, reinforcing import concentration[58]. Rising input costs (e.g. fertilizers, energy), especially during recessions or commodity cycles, may further accelerate this trend, increasing reliance on fewer partners (Fig. 6). Although agricultural inputs and outputs show strong short-term volatility, we believe they could drive long-term structural changes in geographic trade flows (scope) and in the concentration of countries and crops (interconnectedness), influencing the speed of agricultural trade and fundamentally altering the integration of income groups beneath global aggregates, as shown in the past (Fig. 6).

On a one hand such import concentration may give some countries or regions more resilience against external shocks and support activities, such as food self-sufficiency with positive effects for domestic production, that can be supported by domestic subsidies. On the other hand, if trade is concentrated among very few trading partners (e.g. between China and Brazil) or within one geographical region (e.g. Europe) vulnerabilities are rising with increasing risk of imports concentration. External shocks, such as climate extremes (e.g. heatwaves, droughts, floods) or economic turmoil (e.g. trade wars, conflicts, regional recessions) may negatively impact agricultural production and imports in form of harvest losses, food price increases/fluctuations, and supply chain disruptions. For example, droughts and heatwaves in several EU countries, especially in Southern and Eastern Europe, have already caused significant declines in grain harvests (10-15%[59]) during 2024. Similarly, China and the EU were impacted by tariffs salvos from the USA, a major exporter of soya for feed and biofuels[27,29].

At the same time, biodiversity and lower deforestation rates in tropical countries may be the silent winners in a deglobalization scenario. Cabernard et al. 2024 found that “Almost 80% of recent global land-use change impacts were associated with increased agri-food exports from Latin America, Africa and Southeast Asia + Pacific (excluding China). Conversely, increased imports to China, the United States, Europe and the Middle East accounted for almost 60% of recent global land-use change impacts from a consumption perspective, despite decreasing domestic impacts through restoration.” leading to biodiversity loss. Much of the land-use change and biodiversity loss is caused by outsourced deforestation caused by globalization[27,28,60].

In the near-term, according to the OECD, the global economic outlook remains very fragile[61]. The report concludes further rise in trade-barriers, especially around critical inputs (e.g. energy, fertilizers, raw materials), as highlighted in our analysis, could inflict significant damage on supply chains and global output.

## Tables and Figures

***Table 1:*** *Main characteristics of globalization, related features in agricultural trade and selected variables used in this study (after Alkharafi & Alsabah[1]).*

| Characteristics | Features in agricultural trade | Variables used in this study |
|---|---|---|
| Interconnectedness | e.g. Diversity or concentration of the trading network | • Country<br>• Herfindahl-Hirschman Index (HHI) |
| Integration | e.g. Participation of income groups, global agricultural trade relative to global domestic production | • Income group<br>• Imports<br>• Exports<br>• Trade vs. Domestic production |
| Speed | e.g. Growth in traded value and weight | • Time (annual)<br>• Rate of change (year over year)<br>• Short-term volatility (<5yrs) vs. long-term structural change (>10yrs)<br>• Absolute trade in value<br>• Absolute trade in weight<br>• Relative change in value<br>• Relative change in weight |
| Scope | e.g. Geographic spread, Product (e.g. crop) diversity or concentration, the universalization or interchangeability of trading partners and product groups | • Geographic region<br>• Product type (per crops and livestock type)<br>• Cross-regional trade |

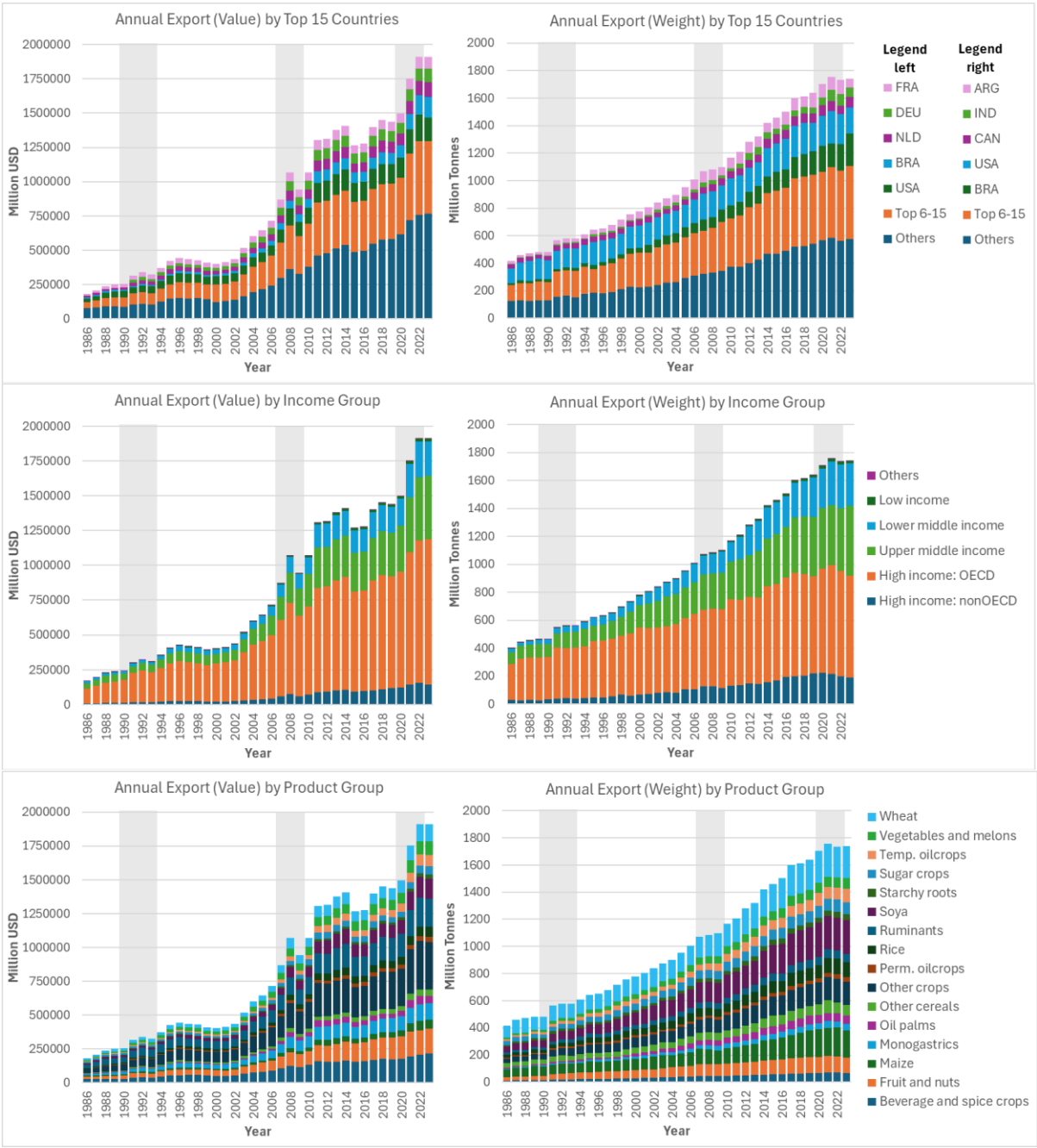



***Fig 1:*** *Agricultural exports in value (left) and weight (right) by (a) top 15 countries; (b) OECD income groups; and (c) product group. Global recessions are shown in the background as grey bars[38,39]. NOTE: Top 6-15 countries are shown separately in Fig. S1. Figure for imports in the supplement figure S2.*

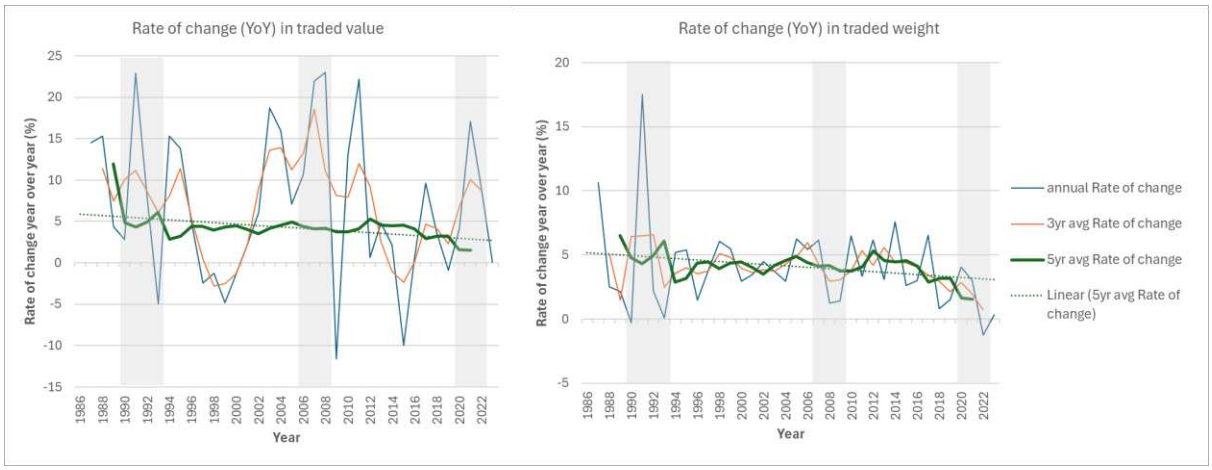
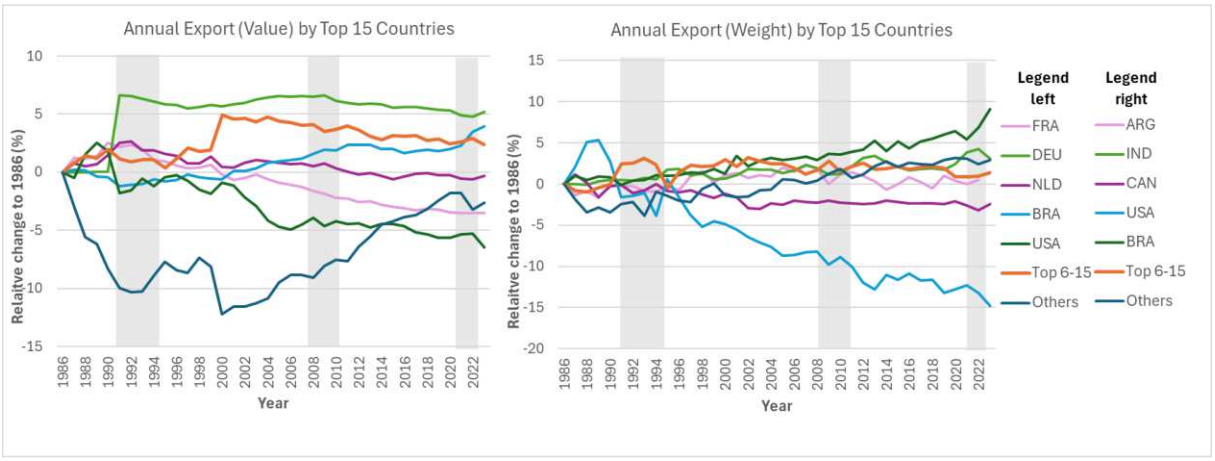
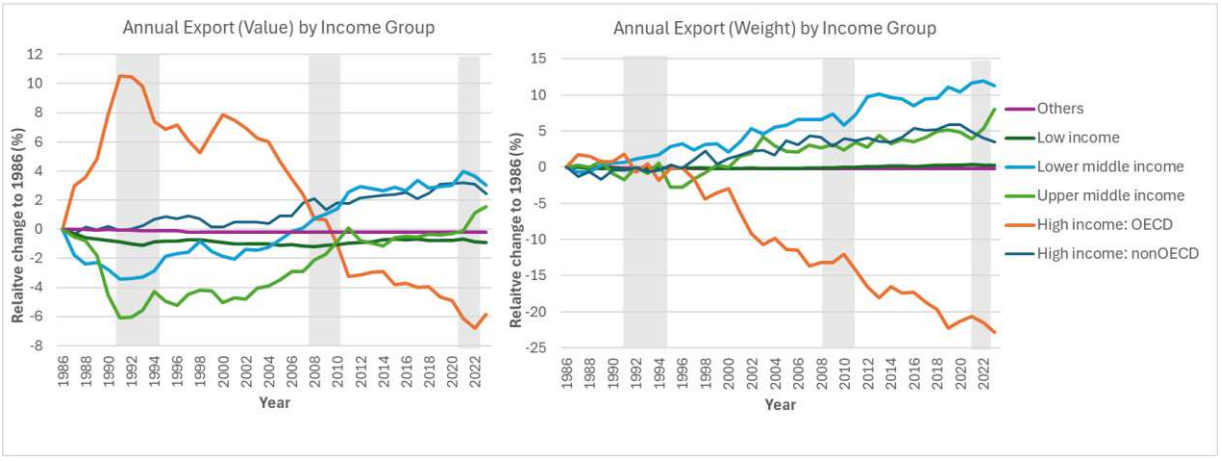


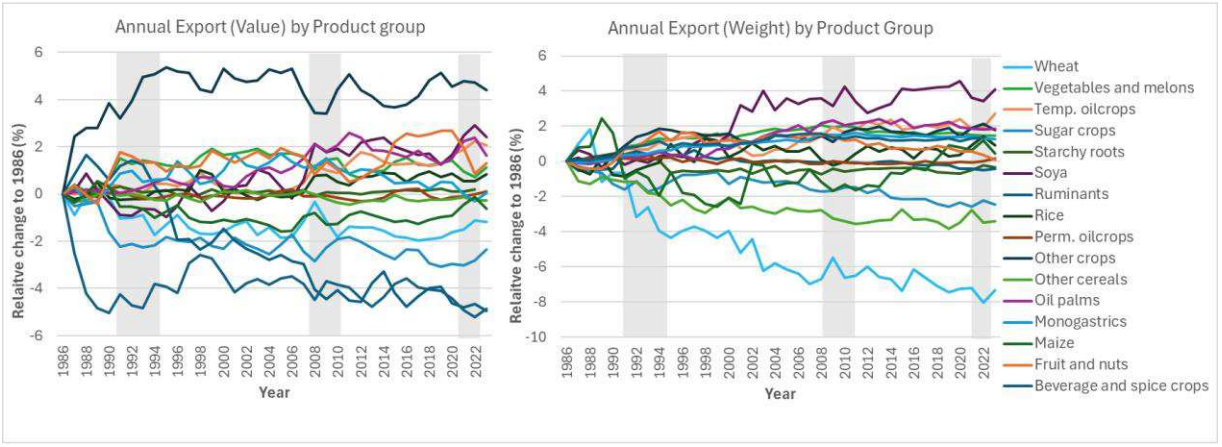

***Fig. 2:*** *Rate of change per year over year (YoY) in global traded agricultural value (left) and weight (right) in percent. Additionally, the 3-year and 5-year averages of the rate of change (YoY) are shown and a linear trend line for the 5-year average rate of change. Global recessions are shown in the background as grey bars[38,39].*




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390 ***Fig. 3****: Relative change in the proportion of total agricultural exports accounted for by top 15 countries*
391 *(top), OECD income group (middle) and product group (bottom), normalized to 1986. Global recessions*
392 *are shown in the background as grey bars[38,39]. NOTE: Top 6-15 countries are shown separately in Fig.*
393 *S3. Figure for imports in the supplement figure S4.*
394

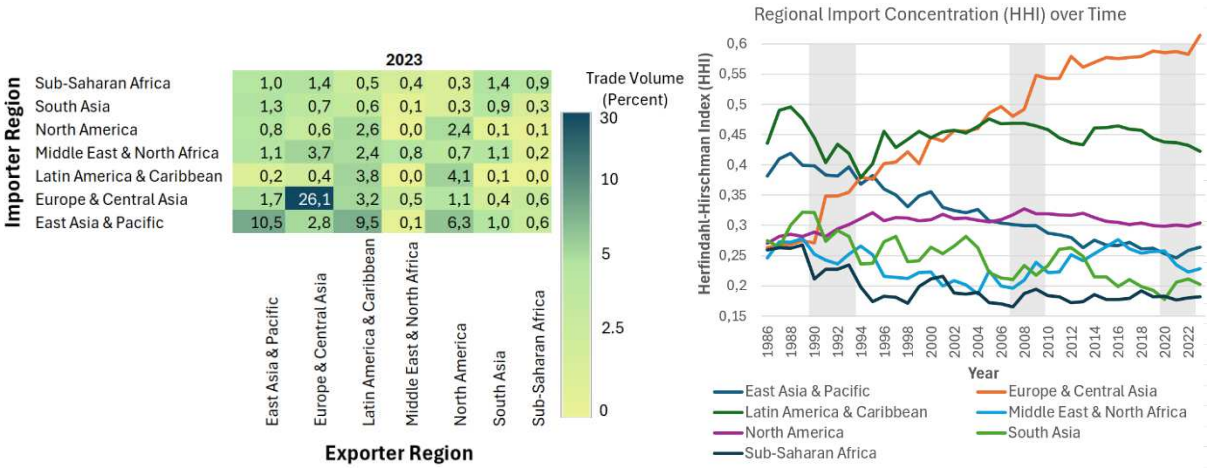



***Fig 4**: Regional trade patterns for 2023 (left). Additional selected years in Fig S5. Regional agricultural trade concentration index – Herfindahl-Hirschman Index (HHI) – including their intra-regional trade (right). Global recessions are shown in the background as grey bars[12,38].*




***Fig. 5**: Import concentration, using the Herfindahl-Hirschman Index (HHI) for the EU27+UK (left) and China+HK (right) for 1986 to 2023 (top). Note EUR/USD Exchange rate only from 2000 to 2023 after Euro introduction; Relative change of product groups for EU27+UK (left) and China (right) for 1986 to 2023 (middle) Global recessions are shown in the background as grey bars[12,38]; Trade networks over 1M EUR for EU27+UK (left) and China (right) for 2023 (bottom). Note: Importers shown in violet circles, exporters in grey circles. The size of the circle represents the size of exports in USD value. Imports are shown in green arrows, exports in blue arrows, and EU intra-trade in pink arrows. A detailed trade network for both regions can be seen here: https://doi.org/10.5281/zenodo.21354892.*

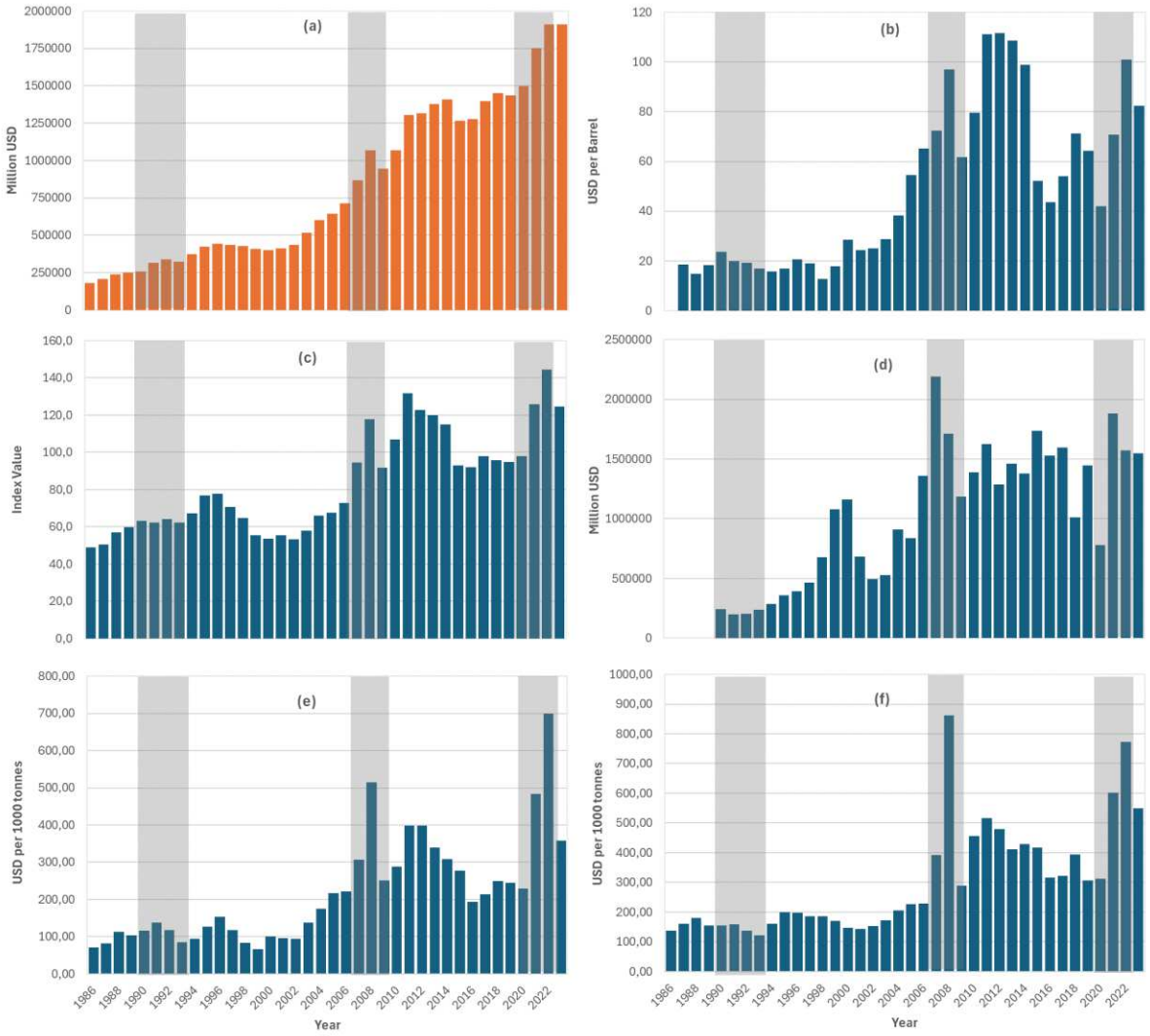



***Fig 6:*** *(a) Global Agricultural Trade; in relation to various food production inputs, like (b) WTI Spot Oil Price; (d) Foreign Direct Investments, (e) fertilizer price for Urea (f) fertilizer price for Diammonium Phosphate (DAP) and production outputs (c) Food Price Index. Note: both nitrogen fertilizers produced by the use of natural gas as input. Urea has a nitrogen content typically of 46% and DAP between 16-18%. All USD values are nominal, global recessions are shown in the background as grey bars* [12,38].

## References


1. Alkharafi, N. & Alsabah, M. Globalization: An Overview of Its Main Characteristics and Types, and an Exploration of Its Impacts on Individuals, Firms, and Nations. *Economies* vol. 13 Preprint at https://doi.org/10.3390/economies13040091 (2025).
2. Chase-Dunn, C., Kawano, Y. & Brewer, B. D. Trade Globalization since 1795: Waves of Integration in the World-System. *Am. Sociol. Rev.* **65**, 77–95 (2000).
3. Rugman, A. M. & Verbeke, A. A perspective on regional and global strategies of multinational enterprises. *J. Int. Bus. Stud.* **35**, 3–18 (2004).
4. Verbeke, A. & Hutzschenreuter, T. The dark side of digital globalization. *Academy of Management Perspectives* **35**, 606–621 (2021).
5. Dreher, A. Does globalization affect growth? Evidence from a new index of globalization. *Appl. Econ.* **38**, 1091–1110 (2006).
6. Norris, P. Global Governance and Cosmopolitan Citizens. in *Governance in a Globalizing World* 155–177 (Brookings Institution Press, 2000).
7. Clark, W. C. Environmental Globalization. in *Governance in a Globalizing World* 86–108 (Brookings Institution Press, 2000).
8. Food and Agriculutre Organization of the United Nations (FAO). *The State of Agricultural Commodity Markets 2022*. *The State of Agricultural Commodity Markets 2022* https://openknowledge.fao.org/server/api/core/bitstreams/5b1d7bed-225a-444b-a041-c0844060a73c/content (2022) doi:10.4060/cc0471en.
9. Gygli, S., Haelg, F., Potrafke, N. & Sturm, J. E. The KOF Globalisation Index – revisited. *Review of International Organizations* **14**, 543–574 (2019).
10. Wang, X., Ma, L., Yan, S., Chen, X. & Growe, A. Trade for Food Security: The Stability of Global Agricultural Trade Networks. *Foods* **12**, (2023).
11. OECD / FAO. *OECD-FAO Agricultural Outlook 2025-2034*. https://www.oecd.org/en/publications/oecd-fao-agricultural-outlook-2025-2034_601276cd-en.html (2025) doi:10.1787/601276cd-en.
12. Keller, C. & Marold, R. Deglobalisation: what you need to know. *World Economic Forum* https://www.weforum.org/stories/2023/01/deglobalisation-what-you-need-to-know-wef23/ (2023).
13. Seong, J. *et al.* Geopolitics and the geometry of global trade: 2025 update. *McKinsey Global Institute* https://www.mckinsey.com/mgi/our-research/geopolitics-and-the-geometry-of-global-trade-2025-update (2025).
14. Seong, J. *et al.* Geopolitics and the geometry of global trade. *McKinsey Global Institute* https://www.mckinsey.com/mgi/our-research/geopolitics-and-the-geometry-of-global-trade (2024).
15. Anderson, E. & Obeng, S. Globalisation and government spending: Evidence for the 'hyper-globalisation' of the 1990s and 2000s. *World Economy* **44**, 1144–1176 (2021).
16. Food and Agriculture Organization of the United Nations. FAOSTATS database. *FAOSTATS* http://www.fao.org/faostat/en/#data (2025).
17. Anderson, K. Globalization's effects on world agricultural trade, 1960-2050. *Philosophical Transactions of the Royal Society B: Biological Sciences* vol. 365 3007–3021 Preprint at https://doi.org/10.1098/rstb.2010.0131 (2010).
18. Liu, J. *et al.* Framing sustainability in a telecoupled world. *Ecology and Society* **18**, (2013).
19. Dalin, C., Wada, Y., Kastner, T. & Puma, M. J. Groundwater depletion embedded in international food trade. *Nature* **543**, 700–704 (2017).
20. Rosa, L., Chiarelli, D. D., Tu, C., Rulli, M. C. & D'odorico, P. Global unsustainable virtual water flows in agricultural trade. *Environmental Research Letters* **14**, (2019).
21. Qiang, W. *et al.* Trends in global virtual land trade in relation to agricultural products. *Land use policy* **92**, (2020).
22. MacDonald, G. K. *et al.* Rethinking agricultural trade relationships in an era of globalization. *BioScience* vol. 65 275–289 Preprint at https://doi.org/10.1093/biosci/biu225 (2015).
23. Hoekstra, A. Y. & Mekonnen, M. M. The water footprint of humanity. https://doi.org/10.1073/pnas.1109936109/-/DCSupplemental doi:10.1073/pnas.1109936109/-/DCSupplemental.

24. Kastner, T., Erb, K. & Haberl, H. Rapid growth in agricultural trade : effects on global area efficiency and the role of management. *Environmental Research Letters* **9**, (2014).
25. Curtis, P. G., Slay, C. M., Harris, N. L., Tyukavina, A. & Hansen, M. C. *Classifying Drivers of Global Forest Loss*. https://www.science.org.
26. Pendrill, F. *et al.* Disentangling the numbers behind agriculture-driven tropical deforestation. *Science* vol. 377 Preprint at https://doi.org/10.1126/science.abm9267 (2022).
27. Fuchs, R., Brown, C. & Rounsevell, M. Europe's Green Deal offshores environmental damage to other nations. *Nature* **586**, (2020).
28. Fuchs, R., Raymond, J., Winkler, K. & Rounsevell, M. The EU's new anti-deforestation law has severe loopholes that could be exploited by the forthcoming EU-MERCOSUR trade agreement. *Environmental Research Letters* **19**, (2024).
29. Fuchs, R. *et al.* US – China trade war imperils Amazon rainforest. *Nature* **567**, 451–454 (2019).
30. Witt, M. A. De-globalization: Theories, predictions, and opportunities for international business research. *J. Int. Bus. Stud.* **50**, 1053–1077 (2019).
31. Stiglitz, J. E. Where modern macroeconomics went wrong. *Oxf. Rev. Econ. Policy* **34**, 70–106 (2018).
32. Rodrik, D. Populism and the economics of globalization. *Journal of International Business Policy* **1**, 12–33 (2018).
33. Della Posta, P. The European Union in the age of slowbalisation. *J. Policy Model.* **45**, 833–847 (2023).
34. Van Bergeijk, P. A. G. Deglobalization and Resilience: A Historical Perspective. *Crit. Sociol. (Eugene).* **51**, 849–865 (2025).
35. Abreha, K. & Acevedo, G. L. *Trade Restructuring Assessing Labor Market and Welfare Effects*. *Policy Research Working Paper* http://www.worldbank.org/prwp. (2024).
36. Lehmann, B. *et al. Food Security and Nutrition - Building a Global Narrative towards 2030*. www.fao.org/cfs/cfs-hlpe (2020).
37. Alexander, P. *et al.* High energy and fertilizer prices are more damaging than food export curtailment from Ukraine and Russia for food prices, health and the environment. *Nat. Food* **4**, 84–95 (2023).
38. Kose, M. A., Sugawara, N. & Terrones, M. E. *Global Recessions*. http://www.worldbank.org/prwp. (2020).
39. The World Bank. *FINANCE FOR AN EQUITABLE RECOVERY*. https://openknowledge.worldbank.org/server/api/core/bitstreams/e1e22749-80c3-50ea-b7e1-8bc332d0c2ff/content (2022) doi:10.1596/978-1-4648-1759-5.
40. Chen, Y., Hong, Y. & Sun, Z. China's food and agricultural trade and environmental development - A systematic literature review. *Sustainable Futures* vol. 10 Preprint at https://doi.org/10.1016/j.sftr.2025.101337 (2025).
41. Chen, Y. *et al.* Balancing green and grain trade. *Nature Geoscience* vol. 8 739–741 Preprint at https://doi.org/10.1038/ngeo2544 (2015).
42. Rhoades, S. A. *The Herfindahl-Hirschman Index*. http://fraser.stlouisfed.org/ (1993).
43. Heilmayr, R., Rausch, L. L., Munger, J. & Gibbs, H. K. Brazil's Amazon Soy Moratorium reduced deforestation. *Nat. Food* **1**, 801–810 (2020).
44. Elleby, C., Domínguez, I. P., Adenauer, M. & Genovese, G. Impacts of the COVID-19 Pandemic on the Global Agricultural Markets. *Environ. Resour. Econ. (Dordr).* **76**, 1067–1079 (2020).
45. Maqbool, M. E., Farhan, A. & Qamar, M. A. Global impact of COVID-19 on food safety and environmental sustainability: Pathways to face the pandemic crisis. *Heliyon* vol. 10 Preprint at https://doi.org/10.1016/j.heliyon.2024.e35154 (2024).
46. Massoud, R. & Zoghi, A. The effects of the COVID-19 pandemic on food systems: limitations and opportunities. *Discover Food* vol. 4 Preprint at https://doi.org/10.1007/s44187-024-00183-8 (2024).
47. Friis, C. & Reenberg, A. *Land Grab in Africa: Emerging Land System Drivers in a Teleconnected World*. www.globallandproject.org (2010).
48. Friis, C. & Reenberg, A. *Land Grab in Africa: Emerging Land System Drivers in a Teleconnected World*. www.globallandproject.org (2010).
49. Balatti, M. *Special Focus: Post-Pandemic Commodity Cycles: A New Era?* https://openknowledge.worldbank.org/server/api/core/bitstreams/df73fb01-5f2a-4d4e-aa2e-20d9a6d8dcfb/content (2025).
50. Bruce-Lockhart, A. Can the economy grow for ever? *World Economic Forum and TED-ed* https://www.weforum.org/stories/2022/09/can-the-economy-grow-for-ever/ (2022).

51. Alexandratos, N. & Bruinsma, J. WORLD AGRICULTURE TOWARDS 2030 / 2050 The 2012 Revision. *Food and Agriculture Organization of the United Nations* 146 (2012) doi:10.1016/S0264-8377(03)00047-4.
52. Gerber, J. S. *et al.* Global spatially explicit yield gap time trends reveal regions at risk of future crop yield stagnation. *Nat. Food* **5**, 125–135 (2024).
53. UN Trade and Development. Maritime and other transport - Data Insights. *Data Hub - Empowering development through data and statistics* https://unctadstat.unctad.org/insights/theme/107 (2026).
54. Baecker, M. Today's Commodity Supercycle: What It Is, And Gold's Role In It. *Forbes* https://www.forbes.com/councils/forbesfinancecouncil/2025/03/18/todays-commodity-supercycle-what-it-is-and-golds-role-in-it/ (2025).
55. John, S. A. & Nandy, S. ANALYSIS: Tariff gap likely to keep China's soybean imports anchored to Brazil. *S&P Global* https://www.spglobal.com/energy/en/news-research/latest-news/agriculture/021926-analysis-tariff-gap-likely-to-keep-chinas-soybean-imports-anchored-to-brazil (2026).
56. Becchetti, L., Bruni, L. & Zamagni, S. Chapter 6 - Non-competitive markets and elements of game theory. in *The Microeconomics of Wellbeing and Sustainability* 157–198 (Academic Press, 2020). doi:https://doi.org/10.1016/B978-0-12-816027-5.00006-9.
57. Elsner, W., Heinrich, T. & Schwardt, H. Chapter 7 - Real-World Markets: Hierarchy, Size, Power, and Oligopoly, Direct Interdependence and Instability. in *The Microeconomics of Complex Economies* 157–190 (Academic Press, San Diego, 2015). doi:https://doi.org/10.1016/B978-0-12-411585-9.00007-5.
58. Rooks, T. Could Trump weaken the dollar to curb record trade deficit? *Deutsche Welle* https://www.dw.com/en/mar-a-lago-accord-is-donald-trump-deliberately-tryomg-tp-weaken-us-dollar/a-71972325 (2025).
59. Anderson, K. Agriculture's globalization: Endowments, technologies, tastes and policies. *J. Econ. Surv.* **37**, 1314–1352 (2023).
60. Eurostat. Performance of the agricultural sector - Statistics Explained - Eurostat. https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Performance_of_the_agricultural_sector (2025).
61. Wiebe, R. A. & Wilcove, D. S. Global biodiversity loss from outsourced deforestation. *Nature* **639**, 389–394 (2025).
62. OECD. *OECD Economic Outlook - Resilient Growth but with Increasing Fragilities*. https://www.oecd.org/content/dam/oecd/en/publications/reports/2025/12/oecd-economic-outlook-volume-2025-issue-2_413f7d0a/9f653ca1-en.pdf (2025) doi:https://doi.org/10.1787/9f653ca1-en.
63. The World Bank. World Bank Country and Lending Groups. *The World Bank Knowledge Base* https://datahelpdesk.worldbank.org/knowledgebase/articles/906519 (2026).
64. Food and Agriculture Organization of the United Nations. *Technical Conversion Factors for Agricultural Commodities*. https://www.fao.org/fileadmin/templates/ess/documents/methodology/tcf.pdf (1997).
65. Tradingview. USDEUR. *Tradingview* https://www.tradingview.com/symbols/USDEUR (2026).
66. Tradingview. USDCNY. *Tradingview* https://www.tradingview.com/symbols/USDCNY (2026).
67. U.S. Energy Information Administration. Petroleum and other liquids. *U.S. Energy Information Administration* https://www.eia.gov/dnav/pet/hist/RWTCD.htm (2026).
68. United Nations. *World Investment Report 2024 - FDI Data Explorer by Region and Economy, 1990-2023*. https://unctad.org/publication/world-investment-report-2024 (2024).
69. World Bank Group. Commodity Prices. *World Bank Group* https://www.worldbank.org/en/research/commodity-markets (2026).
70. Food and Agriculture Organization of the United Nations. *World Programme for the Census of Agriculture 2010*. https://www.fao.org/fileadmin/templates/ess/documents/world_census_of_agriculture/appendix3_r7.pdf (2015).

## Data and Methods

***Data Sources:*** We compiled bilateral agricultural trade flows from 1986 to 2023 using the FAO Detailed Trade Matrix[16]. This dataset records import and export quantities (tonnes) and values (1000 USD) for over 175 agricultural commodities between all trading country pairs. The year 1986 marks the beginning of globally harmonized FAO trade reporting, thus being a natural starting point for our long-term analysis. Each trade flow is reported from both importer and exporter perspectives, with data quality flags indicating whether values are official (A), from international sources (X), imputed (I), or estimated (E).

Country-level attributes were obtained from the World Bank, including income classifications (high-income OECD, high-income non-OECD, upper-middle income, lower-middle income, low income) and geographical regions (Europe & Central Asia, East Asia & Pacific, Latin America & Caribbean, Middle East & North Africa, North America, South Asia, Sub-Saharan Africa)[62]. These classifications attached to individual bilateral trade flows from individual countries enabled us to assess whether trade pattern shifts differ between region or income groups.

The conversion of processed products into original crops, allowed the comparison of trade values and weight in comparison to domestic production reported by the FAO[16], seen in Supplement Figure 3. We mapped processed FAOSTAT products back to their parent/original crop group using the commodity mapping table[63], then aggregated trade flows by that group. Extraction rates were applied to convert processed-product mass into primary-crop-equivalent mass, for example wheat flour/bran/pasta were grouped under wheat. Likewise, oilseed cakes/oils were grouped under the relevant oilcrop.

Additional contextual data included currency exchange rates (EUR/USD[64], CNY/USD[65]), WTI crude oil prices[66], FAO Food Price Index[16], Foreign Direct Investment flows[67], and fertilizer prices for Urea and Diammonium Phosphate (DAP)[68]. These indicators help explain potential drivers of trade pattern changes. Global recession periods were identified following Kose et al. (2020)[38]: 1990-1993 (post-Soviet collapse), 2007-2009 (Global Financial Crisis), and 2020-2022 (COVID-19). These periods are highlighted in figures to examine whether economic downturns coincide with shifts in trade volumes or concentration. Additionally, regional recessions, such as 1997 (Asian Financial Crisis), 2001-2002 (Dot-com crash) and 2011-2014 where mentioned, but not highlighted in the graphs.

***Data processing:*** The 175+ FAO commodity codes were aggregated using the recommended crop type aggregation by the World Programme of the Census of Agriculture issued by the FAO[69]. We aggregated into Tier 1 “Group” level data, further distinguished oilseeds between temporary oilseeds from permanent oilseeds and kept the five most important crops, which make together more than half of global crop production, separately, namely Wheat, Rice, Maize, Soya, Palm Oil. Additionally, we created two more groups for livestock products, namely “Ruminants” and “Monogastrics”. In total, this made 17 analytical groups following FAO classification schemes: Wheat, Maize, Rice, Other cereals, Soya, Temporary Oilcrops, Oil Palm, Permament Oilcrops, Sugar Crops, Starchy Roots, Fruit and Nuts, Vegetables and Melons, Beverage and Spice Crops, Ruminants, Monogastrics, and Others (incl. Fibre crops). This aggregation allowed meaningful comparison across time while preserving distinctions between staple food crops (e.g. wheat, rice, maize) and feed/biofuel crops (e.g. soya, oil palms). The complete mapping of FAO codes to analytical groups is provided in Table S2.
Unit conversions were applied where necessary. Livestock products originally reported in head counts (1000An) were converted to tonnes using commodity-specific conversion rates from FAO technical guidelines[63]. Country codes were harmonized to ISO3 standards for consistent matching with World

Bank classifications. Trade flows where the importer and exporter were the same country were excluded to focus on international trades only.

To reconcile discrepancies between importer-reported and exporter-reported trade values, we applied a flag-based reconciliation procedure. When only one country reported a flow, that value was used. When both reported with different quality flags, the value with the better flag was selected following the hierarchy A>X>I>E. When both reported with equal flags, we used the arithmetic mean. One outlier was identified and corrected: Mozambique 2016 import quantities (element codes 5610 and 5910) appeared to be off by a factor of 10^6 and were adjusted accordingly after validation against adjacent years and cross-checking with partner country reports.

***Analytical methods:*** Trade flows were aggregated at multiple levels to examine patterns by: (1) top 15 countries ranked by total trade volume; (2) income groups; (3) geographical regions; and (4) crop types. Both import and export perspectives were analyzed, with quantities expressed in million tonnes (Mt) and values in Million USD. Relative changes were calculated using 1986 as the baseline year to track shifts in market share over time. For Germany, FAO data report West Germany prior to 1991 and unified Germany thereafter; reported values are used as provided.

To assess trade concentration and diversification, we calculated the Herfindahl-Hirschman Index (HHI) for each importing region[42]:

$$HHI = \Sigma(s_{ij})^2$$

where $s_{ij}$ is the share of region i's total imported weights sourced from region j in a given year. HHI values range from 0 (highly diversified sources) to 1 (single-source dependency). Higher HHI values indicate more concentrated import patterns, suggesting potential vulnerability to supply disruptions from dominant trading partners.

We decided for the HHI, because of its common use, e.g. by the St. Louis Federal Reserve Bank of the United States[42], its simplicity for the calculation, and the small amount of data that are required for the calculation.

To measure regionalization, we calculated the ratio of intra-regional trade to total trade:

$$\text{Regionalization Index} = V_{intra} / (V_{intra} + V_{inter})$$

where $V_{intra}$ is trade volume within the same region and $V_{inter}$ is trade volume between different regions. Higher values indicate more regional (less global) trade patterns. An increasing regionalization index over time would suggest a shift toward on-shoring or near-shoring. We applied LOESS smoothing to identify long-term trends while filtering short-term fluctuations in both indices.

For the EU27+UK and China+HK case studies, we examined HHI trends in relation to regional currency pairs (EUR/USD[64] and CNY/USD[65]) to explore potential relationships between exchange rate movements and import concentration behavior. This analysis focused particularly on periods surrounding global recessions to assess whether economic shocks trigger changes in trading partner selection.

**Data availability**

The source data for all figures can be downloaded at Zenodo:
https://doi.org/10.5281/zenodo.21354892

**Code availability**

The Zenodo repository (https://doi.org/10.5281/zenodo.21354892) also includes the R code and scripts to compile the FAO trade matrix data and html code to visualize the trade netwroks of the EU27+UK and China+HK. The open access code, can be used to reproduce all results of this study.

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**Author contributions**

RF conceptualized the project. JZ and YZ prepared the data and code for further analysis, with support of RF, RP, JR, AS and MR. RF, JZ, RP, JR conducted the primary analysis of data. RF and JZ drafted the initial versions of the manuscript. All authors provided input on methodological approach, validation, on manuscript editing, reviewing and revising.

**Competing interests**

The authors declare no competing interest.

## Supplementary Files

This is a list of supplementary files associated with this preprint. Click to download.

- SupplementaryInformationGlobalizationpaper20260714.pdf