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Chokepoints in global food trade: Assessing the risk

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ABSTRACT

The global disaggregation of food supply chains and just-in-time business models with low inventories mean that governments, traders, producers and consumers are increasingly exposed to unforeseen interruptions to supply and associated volatility in food prices. While considerable research has examined the risk of disturbance in global energy markets resulting from a disruption to physical chokepoints along major trade routes, no comparable analysis has been undertaken for agricultural commodities. Here we present the Chatham House Maritime Analysis Tool (CH-MAT), which estimates the volume and value of staple foods passing through maritime chokepoints. The CH-MAT permits analysis of flows through chokepoints arising from bilateral trade in commodities over the period 2000 to 2015. The value of the CH-MAT is illustrated by a first assessment of global flows via maritime chokepoints. We discuss how such data can be combined with information on inland and overland transport networks, strategic reserves and environmental change, to enhance understanding of the risks associated with disruption to critical infrastructure – owing to weather events, trade restrictions, conflict, congestion, or institutional failures. We consider the applications within risk management frameworks, and governance mechanisms at national, and multilateral level and identify priority measures to enhance global food security.

1. Introduction

Global cereal demand is rising. By 2050, the world's population is expected to have reached 9.8 billion, an increase of 2.2 billion from today (UN DESA, 2017). At the same time, economic growth is stimulating rising global consumption of high-calorie, high-protein foods such as meat and dairy, the production of which is a major driver of demand for cereals (Tilman & Clark, 2015). Overall, an increase in global crop production of at least 100% is needed to meet total demand by the middle of the century (Tilman, Balzer, Hill, & Befort, 2011; Godfray et al., 2010).

While demand grows, yield improvement rates are slowing (Ray, Ramankutty, Mueller, West, & Foley, 2012; Ray, Mueller, West, & Foley, 2013) and competition for land – for urban expansion, biofuel production, carbon sequestration and other services – is heightening (Smith et al., 2010). The tightening supply-demand balance is particularly marked in those regions of the world where rates of population growth are rapid and where a food deficit already exists – notably the Middle East and North Africa (MENA), and many parts of East and Southern Africa (Larson, Lampietti, Gouel, Cafiero, & Roberts, 2012; Fader et al. 2016; Fader, Gerten, Krause, Lucht, & Cramer, 2013). Climate change is expected to exacerbate existing resource stress and yield variability, impacts which are predicted to be especially acute in developing regions where import dependence is already high (Porter et al., 2014; Wheeler & von Braun, 2013; Lobell & Gourdji, 2012; Lobell et al., 2008). As a result of these trends, reliance on imports, both as a source of long-term supply and to weather temporary shortfalls, is expected to increase (Baldos & Hertel, 2015; Porkka, Kummu, Siebert, & Varis, 2013).

1.1. The importance of trade to food security

Increasingly, global food security rests upon the movement of food around the world from a handful of major breadbasket regions to areas of food deficit (Jones & Ejeta, 2016; Bailey et al., 2015; Porkka et al., 2013; D'Odorico, Carr, Laio, Ridolfi, & Vandoni, 2014). Just six countries export 70% of globally traded wheat, maize and rice, three megacrops that provide the majority of global caloric supply (Chatham House, 2017; Benton & Bailey, 2015) (see Fig. 1), while three countries account for 80% of global soybean exports, the basis for three-quarters of livestock feed worldwide (Chatham House, 2017; FAO, 2011) (see Fig. 1). Today's food system is a complex network; in 2014, a total of 41,873 bilateral cereal trade flows (wheat, maize, rice and soybean) were recorded (Chatham House, 2017). Mapping these bilateral trade flows, whether geospatially (see Fig. 2) or as a network diagram (Puma, Bose, Satyajit, Chon & Cook, 2015), offers an indication of the degree of

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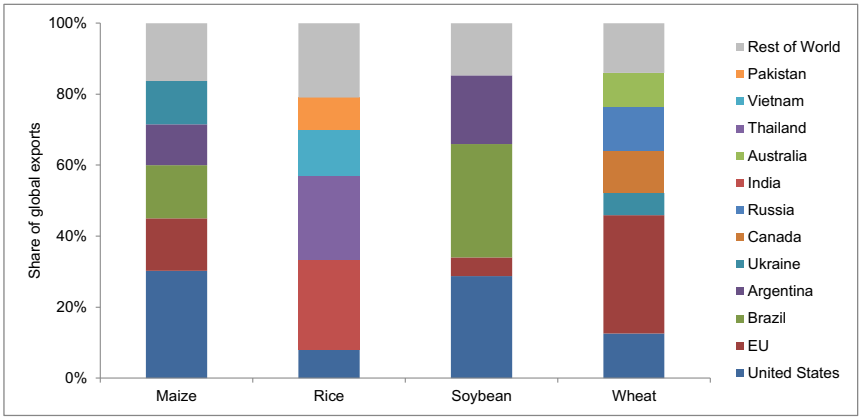

Fig. 1. Countries exporting 5% or more of global exports in maize, rice, soybean and wheat (2014).
Source: Chatham House (2017), resourcetrade.earth (2014 data).

interconnectivity that now defines global cereals trade.

In such an interconnected system – underpinned by a complex network of maritime and overland transport corridors –, the possible epicentres of risk and disruption to food supply chains are multiplied, and the mechanisms for their transmission greatly enhanced (Centeno, Nag, Patterson, Shaver, & Windawi, 2015; Lee, Preston, & Green, 2012). Importing countries are increasingly dependent on the uninterrupted flow of food from regions often thousands of miles away, and potentially exposed to the risk of disruption at multiple points along the supply chain (Puma et al., 2015; Bailey et al., 2015; Lloyd's, 2015). A tight global supply-demand balance and just-in-time business models render this global trade system sensitive to localized supply shocks and price fluctuations (d'Amour, Wenz, Kalkuhl, Steckel, & Creutzig, 2016; Wheeler & von Braun, 2013; Interagency Report to the G20, 2011).

1.2. Trade chokepoints and the risk of disruption

Historically, evaluations of food insecurity and global comparative indices such as the FAO's list of Low-Income Food Deficit Countries (FAO, 2013) and the Economist Intelligence Unit's Global Food Security Index (EIU, 2016) have focused on agroclimatic, socioeconomic and political conditions at a national and local level. A number of metrics are used to assess four broad areas of food security – food availability, food access, food utilization and exposure to availability or price shocks (Barrett, 2010; Pangaribowo, Gerber, & Torero, 2013; Coates, 2013).

In the wake of the food price spikes of 2007–08 and 2010–11, and the Arab Spring in 2010–11, there has been a greater focus on the international dimensions of food security, on risks beyond national borders, and on the mechanisms for their transmission through international markets (Ceballos, Hernandez, Minot, & Robles, 2016; d'Amour et al., 2016). As the importance of trade in the global food system has increased, a growing body of literature has emerged that explores systemic, compound and teleconnected risks in interconnected food markets and evaluates the potential for localized shocks to cascade through international supply chains (Benton et al., 2017; Bailey et al., 2015; Lloyd's, 2015; Moser & Finzi Hart, 2015).

What is lacking is an assessment of the strategic importance to food security of maritime 'chokepoints' (see Fig. 3) – key junctures along international transport routes through which high volumes of food trade pass and which, by virtue of their geography or geopolitical value, are liable to obstruction (Bailey & Wellesley, 2017). Since an estimated 80% of global trade – including in agricultural commodities – is seaborne (UNCTAD, 2016), safe, secure and reliable transit along transglobal maritime corridors and through maritime chokepoints is particularly important to the transport of food. But, while the compounding effect of climate change on risks to food production has been widely examined (FAO, 2016a; WEF, 2016; World Bank, 2013), these physical distribution channels on which international trade depends, and their exposure to disruptive threats, remain largely overlooked in food security analysis.

Studies discussing the risk of maritime supply chain interruptions to food trade are scant and, where they exist, region-specific (Gurning, Cahoon, Nguyen, & Achmadi, 2011; Bailey & Willoughby, 2013; Widodo, Perdana, & Riyadi, 2013). National policy interventions to manage food supply risk have tended to prioritize strategies that bolster control over supply – through investing in overseas production, for example, or through the use of state-owned trading houses – while overlooking the residual risk to the secure shipment of imported food posed by maritime chokepoints (Bailey & Wellesley, 2017).

1.2.1. Why maritime chokepoints matter to food security

While underexplored in the field of food security, the reliance of global trade on a small number of international trade routes and the potential risks that this reliance brings are well understood in the context of oil markets. A substantial body of literature has analysed the strategic importance of oil chokepoints. The key concern of analysts with regard to oil trade has been political interruption of trade through these chokepoints, particularly the Strait of Hormuz (through which 30% of global oil traded by sea must journey) and the Straits of Malacca (through which just under 70% of China's oil imports are transported) (EIA, 2014; Preston, Bailey, Bradley, Wei, & Zhao, 2016), together with the geopolitical, economic and security implications of such an interruption (Evers and Gerke, 2006; Nincic, 2002; Bowlus, 2012; Komiss and Huntzinger, 2011). This concern has been heightened by the so-called 'tanker war' between Iran and Iraq in the mid-1980s and repeated threats by Iran to block access to the Strait of Hormuz (Johnson, 2016).

Significant delays at maritime chokepoints are rare - complete closure even more so – but not unprecedented (Bailey & Wellesley, 2017); aside from the difficulties of navigating large dry bulk vessels through straits as narrow as 200 m, a multitude of factors and conditions have the potential to interrupt day-to-day operations at these trade junctures.

Weather-related events of varying severity are the most common cause of disruption. During 2015 and 2016, the Panama Canal, Suez Canal and Turkish Straits all temporarily halted through-traffic: a particularly strong El Niño event in the spring of 2016 brought long periods of dry weather to Central America causing water levels to drop in the Gatún and Miraflores Lakes either side of the Panama Canal and leading to the introduction of depth restrictions that affected nearly a fifth of vessels using the Canal (Canal de Panamá, 2016); a sandstorm forced the closure of the Suez Canal in 2015 (Arutz Sheva, 2015); and high winds prevented tankers from transiting the Turkish Straits in early 2016 (Platts, 2016). Climate change will compound the risk of weather-related disruption to maritime chokepoints, increasing the