**D1 Project Description**

**PROJECT TITLE**: Institutional Capacity, Conflict, and Early Warning of Food Crises

**PROJECT AIMS AND BACKGROUND**

**The problem**

Political violence, in some form and to some extent, defines the daily life of people in most low- and middle-income countries. The reasons for political violence vary and can range from insurgency against the local and central governments to people’s protest due to governments’ policies. One common attribute of violence is that it happens—by design or as a side-effect—where people are. A suicide truck bombing in a market of Mogadishu (Somalia), killed more than 500 people on 14 October 2017. This was the deadliest attack in Somalia’s history and the staggering number of causalities and people displaced had an immediately chilling effect on marketplace activity (Burke & Ahmed, 20 December 2017).

People living in poor, marginalised states with dysfunctional institutions often struggle to buy food and other necessities, or to move around their own countries, stymied as they are by conflict, territorial fragmentation, and failures in transport, communications, and market enforcement. In the wake of such adversities, the markets appear to be surprisingly resilient. Commenting on the resilience of Mogadishu after the truck bomb, one Somali noted that, “There is a blast in Mogadishu destroying whole buildings and you see the next day people start renovating. Life goes on. Those who died have died. We have to think about those who live now. They need life.” (Burke & Ahmed, 20 December 2017).

This project asks two overarching questions: (i) does conflict affect a proper functionality of food markets across varying institutional contexts? (ii) does conflict alter farmers’ decision to store harvest for the later sale?

A consistent problem in understanding the politics and economics of conflict-affected, marginalised or autocratic states is the lack of good data to measure state capacity, or to track the relationship between institutions, conflict, and development. What effect, for instance, did the al-Shabaab terrorist attack have on food markets across Somalia, or on the ability of Somalis to acquire food and other necessities? How was the effect of the terrorist attack mediated through Somalia’s institutions? This is extremely hard to determine in such states because basic governance data is so often missing or inaccurate (Coggins, 2016; Jerven, 2013).

While many of the standard state capacity measures are unavailable or unreliable in marginalised states that experience high levels of conflict or poverty, micro-data on commodity prices and exchange rates in different markets often *are* available. Movement and co-movement of prices in spatially separated markets can measure the degree of connectedness between the locations. We ask what market integration can tell us about state capacity and institutional strength across territory during distressed and relatively stable times? Moreover, is it possible to use market integration as a backdoor for understanding events and improving conditions within otherwise opaque settings?

**Aims**

First, we will develop an innovative spatiotemporal framework that links market integration with the rule of law and ethnic disparity within and between marginalised or conflict-affected states. Second, we will use this framework to understand the effect of conflict on food security in places that are geographically or ethnically detached from the rest of the country or region. Third, we will apply the framework to elicit early warning signals of food crises and famines in response to elevated levels of conflict and violence moderated by external shocks that disrupt global commodity markets.

**Background**

With efficient movement of goods and information between markets, we would generally expect prices for the same goods to be similar in different cities thus eliminating opportunities for arbitrage. Likewise, with capacity to store non-perishable goods, such as cereal grains for example, we would expect that prices for the same goods to only increase at par with storage costs over the crop marketing year. Any deviations from these “law of one price” states, both in spatial and temporal contexts, would indicate market inefficiencies.

In the spatial context, studies of market integration are oriented to finding the barriers that mean that prices are *not* the same (or do not adapt sufficiently swiftly) within the same countries, or between adjacent countries within a region. The primary suspect as a barrier to market integration and full price transmission are typically borders and distance. Mengel and Cramon-Taubadel (2014) conduct a meta-analysis of 57 market integration studies, and find that markets within countries are 23% more likely to be co-integrated than markets separated by an international border, while markets separated by 1000 kilometers within a country are between 6% and 20% slower to adjust prices and have 7% lower co-integration, while international markets are 13% slower to adjust prices. Distance has negligible effects between international markets. Much of the work on market integration has been done on African countries. In Africa specifically, food prices are generally co-integrated across markets within countries, with distance and road quality determining greater or lesser co-integration (Rashid, Minot, Lemma, & Behute, 2010). Borders do not always or necessarily align with sovereign dividers between countries. Ethnic division, which may segregate smaller regions within a country, or extend a region across two or more countries, may be a more apparent barriers to trade and, therefore, for market integration (Aker et al 2010, 2014). Likewise, distance is not only and necessarily measured in kilometres. For instance, a hundred-kilometre road connecting two cities may be associated with small or large amounts of transaction costs, depending on whether potential perpetrators tend to raid the people—traders in this instance—travelling the road.

In the temporal context, the lack of storage has been an ongoing issue for decades in many low- and middle-income countries [need to add citations].

Connecting market integration to institutional and other factors has been more tentative. Market integration of prices across a putative territory is a plausible method of determining whether the markets are operating as if they are within a single country. The prevailing assumption and finding across many studies of states with fragmented, dysfunctional, or non-existent formal economic institutions is that there will be considerable price dispersion in different markets across relatively large distances (Aker, 2010; Aker & Fafchamps, 2014; Aker & Mbiti, 2010). Indeed, the main reasons for lack of market integration in Africa are risk, lack of information, poor infrastructure, and lack of government capacity (Rashid et al., 2010). The lack of market integration in states without robust formal institutions could be for one or several reasons. First, the ability to broadcast power in Africa has been measured by the extent and location of road networks (Herbst, 2000), with the implication that states that are unable to exercise effective control are unable to build or maintain roads across the territory within their internationally defined borders. A lack of roads would increase transaction costs between different markets, resulting in a difference in market prices. Indeed, the cost of transport over low-quality roads is a major consideration in developing countries, and is often a larger source of price dispersion than borders in many landlocked African countries (Dillon & Barrett, 2016; Minten & Kyle, 1999; Versailles, 2012).

Second, political fragmentation and violence mean that different, often hostile actors govern markets in different parts of a country, and that traveling between markets, as well as outsider involvement in markets, is difficult due to poor security and barriers to moving between markets. Moreover, the lack of functioning formal state institutions means that state enforcement of contracts and resolution of disputes is patchy or uneven (Börzel, Hönke, & Thauer, 2012; Krasner & Risse, 2014; Scott, 2010). While there are ways around a lack of state dispute arbitration, these methods do not necessarily scale well, or operate across larger distances or with strangers, including among ethnically diversified groups, making arms-length inter-city trade difficult, and resulting in differential prices (Greif, 1993; Haggard, Lee, & Noland, 2012; Robinson, 2016). Non-political boundaries can also decrease market integration. In Africa, ethnic boundaries serve as a barrier to integration (Aker et al 2010, 2014). Outside of Africa, Schulze and Wolf (2008) find that the Hapsburg Empire had internal "borders decades before" it broke up, with internal border effects delineated by ethnolinguistic groupings rather than political borders.

We build our project on this past research to create a systematic way to link market integration and informal institutions (which often function through non-market means) in marginalised states.

**INVESTIGATORS/CAPABILITY**

The project team’s capabilities are designed to bring theoretical, area studies, and methodological expertise to bear to bring the project to a successful conclusion. As an expert in agricultural economics and non-linear time series econometrics, CI Ubilava has extensively studied regime dependencies in international commodity price behavior, and price co-integration within commodity groups. He will be particularly involved in econometric analysis of time series data. As an expert in East Asia and the Indian Ocean Region, weak and failed states, non-state actors, and informal markets, CI Hastings has researched and published extensively on data-poor countries, including North Korea, Somalia, Nigeria, and parts of Indonesia. Hastings will be particularly involved in providing substantive knowledge of North Korea and Somalia, and of informal markets in the case study countries, as well as developing methods to characterize market integration. As an expert in forecasting and business statistics, with a special interest in forecast combinations and model sensitivity, CI Vasnev will contribute to the assessment of time-series models and their forecasting performance. He will take the lead on managing and delivering the forecasting tool website. All members of the team will be involved in writing up the results for publication. All CIs are well-known and respected on the international level and have a proven capability to build collaborations both within Australia and internationally. All CIs received PhDs overseas and maintain links with overseas institutions. They work with international co-authors across the globe, which has resulted in high-quality widely-cited publications. They regularly present at international conferences and serve as editors and reviewers in top international journals.

**PROJECT QUALITY AND INNOVATION**

**Importance and innovation**

We make several contributions to the study of market integration, conflict, and institutions in conflict-affected or marginalised states. First, we demonstrate the use of readily available data as a way to understand internal dynamics in states with otherwise poor, biased, or non-existent data. Such data offer insights into the political processes that underpin either change or stasis within markets, such as the capacity to enforce rules, uphold contracts, and resolve disputes. Given that market prices are usually collected in daily or monthly increments in individual markets, this approach can also give us much greater granularity in understanding political and economic events in data-poor countries than has previously been the case. Most state capacity measures are on a yearly basis, with a country-level unit of analysis. More generally, governance data are simply often not available for many fragile states, and only states with data are being measured, which leads to an upward bias in data. That is, governance indicators may appear to be higher on average across the globe than they actually are because the lowest performing countries are not included (Coggins, 2016). Moreover, the governance indicators that are available for virtually every country (such as the World Bank Governance Indicators) tend to exist only at the national level. While this is not a problem for countries that have relatively robust central governing institutions, it is a problem for those that do not, precisely because they are also more likely to have internal divisions that can hinder consistent levels of governance being applied across the entire country. Market integration analysis is, therefore, a means of drawing out and measuring intra-country differences in governance.

Second, differing levels of market integration are generally seen as the *result* of impediments (such as distance, transport costs, and borders) to the transfer of information, goods, and people between markets. Our innovation is to take market integration as a *measure* of other concepts at work in states that produce low levels of (or poor quality) governance or economic data. Measuring the extent to which markets across a country or between countries are integrated, in terms of the dispersion or convergence of prices for the same items, or in terms of the speed with which prices are transmitted from one market to another, can certainly tell us about the nature, relevance and magnitude of potential barriers to internal or external trade. But it can also tell us, indirectly, how formal and informal institutions within and between countries function in facilitating or hampering commerce. Food prices in markets in particular are good indicators of a population’s welfare, and have been connected to instability and conflict in developing countries (Arezki & Bruckner, 2011; C. Hendrix & Brinkman, 2013; C. S. Hendrix & Haggard, 2015). In addition, in part because food commodities sold in different countries and different markets are often the same goods and are sold on a regular basis, their prices are directly comparable within and between countries.

Third, we take the field in a new direction by systematically linking market integration and informal institutions in states that are typically overlooked in international surveys. Many governance indicators focus on formal institutions – their existence and their proper functioning – which misses the role of informal institutions, norms, and practices in regulating political and economic interactions between people. In terms of markets, while formal institutions can be understood to help to resolve coordination problems, enforce contracts, and resolve business disputes, informal institutions also solve coordination and enforcement problems, although with slightly different mechanisms. These informal institutions have their norms, and their networks of actors who span both the public and private sector (Mahmoud, 2008; Rasanayagam, 2011; Titeca & Flynn, 2014; Titeca & Herdt, 2010). If these informal institutions provide many of the same services that formal institutions, and can do so when formal institutions cannot, informal institutions can sometimes become as pervasive and as legitimate as formal institutions (Bruns, Miggelbrink, & Müller, 2011; Lee, 2015; Rasanayagam, 2011; Rodrigues, 2010). As a result, measures that look only at formal institutions when looking at governance miss not only how institutions actually function but may mischaracterize some states as less functional than they actually are.

This project is, therefore, premised on the suggestion that while the capacity of informal institutions is difficult to measure directly, one can look at the fruits of these informal institutions. In an environment where formal institutions are clearly lacking, the existence of market integration, measured by a relatively high price transmission between cities for the same commodity, suggests that there are other means for traders in markets in different cities to engage in transactions, make and enforce contracts, exchange information, and resolve disputes. We thus offer an alternative lens through which to view emergent political order—and do so in the absence of the political and economic indicators that are typically used to measure a state's effectiveness, given the lack of such data in such states. Our project points to the merits of understanding governance through the lens of informal institutions as they may encourage market integration across a country's territory, and allow internal trade to continue through conflict.

**Approach**

In approaching our problem, we develop and then apply a conceptual framework that links rigorous time series analysis of market integration and forecasting of cereal prices with substantive knowledge of the formal and informal institutions in countries across Africa and Southeast Asia. The framework is part of a four-fold approach.

First, we look at the extent to which markets in each region are integrated across and between the countries. Using market price data, we can track price dispersion across markets, changes in price dispersion over time, and speed of price transmission between markets, all conditional on distance between markets, transport costs, and formal and informal geographic boundaries. In our analysis, we build on previous research on that looks at market integration, both within countries and between countries, as measured by price co-integration, price transmission speeds, or both (Dillon & Barrett, 2016; Goodwin, Holt, & Prestemon, 2011; Hood & Dorfman, 2015). In a world where information about prices and other traders is easily available, where transport prices and costs are low, and where formal institutions provide minimal impediments and are well functioning, we would expect the difference in prices between cities to be low, inasmuch as traders would otherwise use the differences as an opportunity for arbitrage. Distance between markets, the existence of internal and external borders, extreme weather, and terrible transport infrastructure are all likely to impede the smooth flow of people, information, and goods between markets, leading to slowdowns in price transmission, and dispersion of the prices of the same commodities across different markets. Conflict, which is common in fragile states, can pose particularly significant impediments to flows between cities, either because the markets themselves are destroyed, because the market participants are killed or dislocated, or because warring factions create borders between markets that are difficult to cross (Hastings et al. 2022).

Second, we study the evidence of storage by examining within-crop-year patterns of price changes across different locations. Storage theory would suggest a steady increase in prices of storable commodities, such as cereal grains, from the harvest month onward and into the lean season, leading to the next harvest season. Absence of such patterns would imply some deviation from the expectation. Empirical evidence points to such discrepancies (Cardell and Michelson, 2023). Conflict and political violence may play the role in this. If the harvest-time availability of storable crops, such as cereal grains, attracts perpetrators (Ubilava et al. 2023), then it may explain farmers’ incentives to sell their produce at the earliest convenience—which is immediately after harvest. But selling produce, as alluded above, can be associated with a risk of being raided—*en route* to the market, for example. So, we could expect heterogeneity in the patterns, conditional on the prevalence of paramilitary groups in the region, the strength of the state institutions, and the distance of the agricultural region from the nearest city—the likely market for selling the produce.

Third, we bring in the concept of informal institutions. We understand informal institutions, particularly in fragile states, to be mechanisms that constrain or enable behavior but that do so outside of public or officially sanctioned channels (Helmke and Levitsky 2004, 727). This includes the capacity to enforce contracts, resolve disputes, and sanction behavior outside of state-based mechanisms. Non-state institutions can fulfill these roles by providing information about traders to potential and actual counterparties, building reputations for traders so they can minimize transaction costs with people they do not know, and punish defecting traders through damage to their reputations (Clay, 1997; Greif, 1993; Johnson, McMillan, & Woodruff, 2002; McMillan & Woodruff, 1999a, 1999b; Milgrom, North, & Weingast, 1990). They can also more directly punish defection from the group through more violent means, as Chinese traders intimated they did in North Korea to prevent firms from breaking their cartels (Hastings, 2016; Hastings & Wang, 2017). Informal institutions (or more accurately, informal ties that are not captured by formal state-based institutions) can mitigate the problems associated with formal institutions. (Aker, Klein, O'Connell, & Yang, 2014), for instance, in a paper on agricultural prices in Niger and Nigeria find that the interaction between ethnicity and borders can lead to drastic price dispersion: close-by markets on either side of the border showed large price dispersion. This dispersion was mitigated when the cross-border markets were controlled by the same ethnic group. Conversely, markets within Niger controlled by different ethnic groups had the same price dispersion as markets in different countries, suggesting that co-ethnicity can function as an important informal lubricant in market transactions in situations where formal institutions are not strong.

Since it is difficult to measure the functioning of informal institutions directly, we look at whether levels of market integration (or dispersion), or the changes in levels of market integration over time, are more or less than expected given the structural impediments to integration. In cases where price transmission continues to exist across distance, and even across battle lines in the case of conflict. Our pilot project, for instance, finds that price transmission in Somalia is surprisingly robust, which hints at the extent to which informal institutions are functioning, or even obviating formal institutions. A potential explanation for this is that informal institutions that allow Somalis to build trust, exchange information, and enforce contracts have flourished in Somalia in the wake of the collapse of centralized political authority, and that allow Somalis to do business across barriers that retard, but do not completely sever, the movement of information, goods and people between markets. Somalis’ ability to soldier on in the face of conflict is notable.

Finally, in the initial case studies, we bring in qualitative knowledge and data about Somali and North Korean market participants to provide insights into *how* the informal institutions detected through market integration analysis function. Specifically, we build in evidence for how market participants building mechanisms to overcome dysfunctional or absent formal institutions to build trust, establish networks, enforce contracts, and transfer information and goods. We also look at how market participants perceive impediments to trade, such as conflict, corruption, policy changes, and sanctions (which have affected both Somalia and North Korea).

**Methodology**

Using the approach above, we conduct market integration analysis for Africa and Southeast Asia. The two regions, as well as countries within these regions, differ from each other considerably, with widely ranging socio-economic characteristics. The most marginalized of the states do not even make the list of countries ranked by the United Nations Development Programme (UNDP) Human Development Index. And those that do make the list, do not rank very high. We then link the market integration results with quantitative and qualitative data on conflict, border, policy changes, exogenous shocks, and market participants’ perceptions of all these issues.

*Geography and data*

Somalia is widely portrayed in the media as "the world's most utterly failed state" (Economist, 2 October 2008). Measured against most of the indicators used by international development agencies, Somalia is the epitome of a ‘fragile’ state, with extensive conflict, poor transportation infrastructure, and fragmented and dysfunctional institutions. Conflict is detrimental, both because of its direct effects on lives, and because of the disruption it can cause in inter-market exchange, which can become intertwined with food insecurity challenges (Brinkman & Hendrix, 2011; C. Hendrix & Brinkman, 2013; McCann, 2011). Internal conflicts not only devastate people’s lives, but they also negatively affect the ability of markets to function, particularly across battle lines and internal political divisions. Indeed, if there is any country where we might intuitively expect to see disrupted markets, it would be Somalia, given the degree to which its state institutions have been fragmented over decades of intermittent civil war, and fluid lines of internal control. Conflict has frequently come to Somalia's food markets in particular, as the 2017 al-Shabaab attack in Mogadishu shows (Burke & Ahmed, 20 December 2017). Indeed, Brenton, Portugal-Perez, and Régolo (2014) find that Somalia is one of the least domestically integrated countries in terms of rice, maize, and sorghum market prices across cities (only the Democratic Republic of Congo is less integrated domestically), and that there are fairly high border effects, leading to price dispersion, between Somalia and the countries it borders, although distance between cities appears to have a stronger effect on price dispersion than international borders.

We will source the data on conflict incidents across Somali cities from Armed Conflict Location & Event Data Project (ACLED), which tabulates several categories of daily conflict incidents, such as armed clashes, violence against civilians, changes of territory control, etc. We will use food price data collected by international organizations (e.g., the World Food Program, or the Global Information and Early Warning System) across a number of Somali cities, covering markets of Mogadishu, Southern Somalia, Puntland/Galmudug, and Somaliland. Each can be considered a separate region for the purposes of governance, with a relatively distinct, though fluid, border with other regions, particularly during times of conflict. Mogadishu is the capital of the Federal Republic of Somalia (FRS), established in 2012, but the FRS has only exercised actual control over a small portion of the country—mostly Mogadishu and its environs—since the inception of the Transitional Federal Government in 2004. Southern Somalia—the area between Kenya and Galmudug on the central coast—is the region with the greatest amount of conflict, as control has been contested since 2004 by the (transitional and then permanent) Somali federal government and the allied African Union, and the Islamic Courts Union and then al-Shabaab. Galmudug on the central coast and Puntland on the northeastern coast are separate regions which have experienced relatively little internal conflict (with the exception of incursions by Islamist groups) and technical loyalty to the Mogadishu government, although they function as autonomous regions, and both have, as of 2021, pockets of al-Shabaab control. Both Galmudug and Puntland experienced significant levels of piracy between 2005 and 2012, with both regions home to a number of pirate havens (Bahadur, 2011; Bank, 2013). The last region, Somaliland, is a self-declared but officially unrecognized republic in the northwest corner of Somalia that has, for the most part, kept out both pirates and insurgents since the 1990s (S. G. Phillips & Hastings, 2018), although it fought a brief war with Puntland in 2007.

North Korea is an important case of market integration and fragile institutions for both theoretical and empirical reasons. North Korea presents an interesting internal paradox. In studies of African countries, as above, ethnic boundaries, political boundaries, and conflict areas can lead to a lack of integration of prices across different markets, either within countries or across countries. Yet North Korea has no internal cleavages: it is a unitary state with an ethnically homogeneous population and no internal conflicts, which should all lead to market integration across the territory of the country. At the same time, the North Korean state stays in power in part by maintaining strict controls on flows of information, and the movement of people, and goods between cities in North Korea (particularly between Pyongyang and the rest of the country), and between North Korea and the rest of world (Byman & Lind, 2010). The illegality of private property and the lack of autonomous organizations outside of the state also mean that establishing scalable private enterprise or trust networks (across markets or not) is difficult. Thus institutions within North Korea (purposefully) create impediments to market integration.

The North Korean state has an ambivalent stance on markets, which run the gamut from illegal roadside markets to state-approved trading posts and general markets. It has generally sought to control or even destroy them because of their ability to provide economic sustenance outside of the state, but has had to live with them because it is unable to provide for North Koreans on its own, and because the markets indirectly provide revenue to the state (Haggard & Noland, 2007; Hastings, 2016). These shifting attitudes generate substantial policy uncertainty, and in order to function consistently, market participants must resort to high levels of bribery and corruption (Hastings & Wang, 2017). North Korea’s domestic political and economic institutions are so dysfunctional that market participants resort to smuggling even legal goods in order to avoid dealing with them (Hastings & Wang, 2018).

Empirically, the data we present are unique – the data consist of daily prices for four commodities (rice, pork, cabbage, and pollock) at the daily level in both formal and informal markets for six cities over a seven-year period (2010 to 2016), with two currencies (Chinese *yuan* and North Korean *won*) in two cities, leading to approximately 81,000 observations. The cities were chosen to represent a variety of locations and political situations across the territory of North Korea. Pyongyang is the capital, Rason is a special economic zone on in the northeast, bordering on China and Russia, Sinuiju is the main trading point between China and North Korea, Nampo is a port on the west coast (and the main entry point for shipping into North Korea), Wonsan is a port on the east coast, Hamhung is a major industrial city far from the border regions.

Market prices are a state secret in North Korea – we obtained the prices from Chinese investors who wrote the prices down on a daily basis and then took the papers out of North Korea. North Korean market prices have not been analyzed at this level of precision in any previous studies. While there are other sources of North Korean market prices, they are not available at the same level of granularity or the same variety of cities across the country. The World Food Program records a sample of prices for many commodities, but these are surveyed irregularly – at most once a year. Our data will be supplemented by data from the website *DailyNK,* whichhas market prices for rice going back to 2009, but these prices are single price points for Pyongyang and Sinuiju received at irregular periods, and covering periods of up to one month per observation.

*Research plan*

1. Map out market networks in Africa and Southeast Asia (Year 1)

Using the framework outlined above, we will first run analyses of market integration in Somalia and North Korea. To measure the level of market integration across markets within a country’s territory, and between countries, we rely on the law of one price hypothesis in the spatial context. The basic principle of this hypothesis suggests that prices of the same commodity in two spatially separated markets will co-move if the commodity can be transported between the markets. Otherwise, price dynamics in the two markets are likely to be disentangled. Several factors can disrupt market integration, and therefore price transmission, between two markets. The “usual suspect,” as alluded above, is the cost of transportation. Because of transportation costs, the price dynamics in the two markets can be disentangled episodically. That is, to the extent that transportation costs mitigate the profitable arbitrage opportunities, there can be no arbitrage opportunities unless the price discrepancy between the two markets is “large enough.” This leads to the so-called “transaction costs band” hypothesis. See, for example, Goodwin et al. (2011)

To briefly illustrate the point, consider a pair of markets, denoted by and . Let the prices in these markets in period be and , respectively. For the sake of illustration, suppose the transaction costs are paid in form of a barter. To that end, we can introduce the so-called “leakage” factor, , which is a share of the commodity that is lost during its transportation from to . Thus, the further apart (typically geographically, but also politically, institutionally, etc.) are the two markets, the higher are the transactions costs, and the closer is to one.

The concept of “leakage” is particularly well-suited for conflict-prone states, where the transportation cost may not even be the most substantial component of transactions costs. For example, there is always a chance that a military group can seize some or all the cargo from an arbitrageur, leading to the partial or complete leakage. Regardless of the source of leakage, the per-unit profit of an arbitrageur from to is given by . It follows that the no profitable arbitrage condition is given by . Similarly, the no profitable arbitrage condition from to is given by . In these arbitrage conditions, captures all the transaction costs, including a normal economic return for all the work involved in the process. Combining the two inequalities, and taking natural logarithms gives the transactions costs band: . Thus, if the log price differential, in absolute terms, is less than , it is not worth an effort and a risk for arbitrageurs to engage in trade; otherwise, the trade will happen, and we will observe adjustment in the prices.

This transactions costs band need not be fixed over time. For example, as alluded above, the leakage factor can be a (nonlinearly) increasing function of conflicts. To the extent that the intensity of conflicts can (and does) vary over time, the transaction costs band can expand or shrink accordingly. That is, the same log price differential may or may not prompt the arbitrageurs to engage in trade, depending on the degree of conflict intensity in the region. The corollary is that the possibly asymmetric dynamics of price transmission between two markets can also vary over time.

2. Examine market integration in presence of ethnic linkages and informal institutions (Years 1-2)

We will also use market integration across territory and over time as a means of accounting for the functioning of formal and informal institutions. In the quantitative analysis, we treat factors (both internal and external) that can impede the flows of information, people, and goods between markets as shocks that may slow down price transmission speed or could theoretically temporarily cease price transmission entirely. In the case of Somalia, this would include conflict that has been going on continually since 1991. The data on conflict incidents across Somali cities will be sourced from Armed Conflict Location & Event Data Project (ACLED), available at https://acleddata.com. In terms of the ability of (informal) institutions to function in the face of conflict, however, not all conflicts are the same. Conflict where government or rebel forces are actively attempting to take over territory, as well as different types of armed violence, is anticipated to be more disruptive to the existing linkages among the markets, than protests and riots, that typically are localized in central districts of a city, and often are seen as a consequence rather than the cause of price dispersion among the markets (Bellemare, 2015). Moreover, because the data maintains records of the change of control (either peaceful or due to an armed conflict), by tracing such datapoints, we will be able to recover the timeline of a territory’s control by the central government or the rebel group. This will allow us to identify the subset of regions under common governance, be that formal or informal.

The foregoing complements our goal to map the markets to clan control (using data we already collected for DP130103966) and use clans as an indicator of institutions that can enforce contracts and increase trust among market participants, similar to how Aker et al 2010, 2014 use ethnic boundaries in Niger and Nigeria. Somalis are generally divided into patrilineal clan families, which are in turn divided into sub-clans, and sub-sub clans. The clan structure provides many of the structures necessary for a reasonable level of market certainty, dispute resolution, and civil order (Dua & Menkhaus, 2012; Hoehne, 2015; S. Phillips, 2013), although of course clans are also associated with many conflicts. The clans have strong, and enduring informal norms and understandings that permeate (but do not necessarily determine) most aspects of Somali life. Through these interpersonal connections and norms, social networks provide economic well-being, provide physical security, and constrain individuals' behavior, inasmuch as violating the norms of the networks can lead to severe consequences (Collins, 2009). Therefore, not only will the data allow us to examine regime-dependency in market integration over time (e.g., during the times of war relative to more peaceful times), but also across space (e.g., between locations with similar institutions vs. those without).

In the case of North Korea, shocks would include UN sanctions resolutions (particularly those in 2016 and 2017 that banned trade in some food items), sanctions implementation incidents, when China temporarily slows down or stops trade with North Korea as a signal of its disapproval of North Korean provocations (Hastings and Wang 2018), as happened in 2013 and 2017, political and military crises (such as the 2013 Korean Peninsula Crisis), and North Korean government-imposed trade shocks, such as trade shutdowns due to Kim Jong-il’s death, the purge of high level officials, Ebola and Covid-19-related border closures, and sudden market policy decisions (such as a ban on seafood or mineral exports).

In the case of both conflict and policy and sanctions shocks, the effect is essentially to create borders between markets that may or may not be permeable. The extent to which market price integration responds to these shocks (or does not), or continues even across the borders serves as an indicator of the presence and function of informal institutions. To overcome these barriers, social networks, which provide credit, information, and dispute resolution to reduce transactions are perhaps the underlying factor in the functioning of informal institutions. We measure these social networks and mechanisms both quantitatively and qualitatively.

In all cases where data allows, we will measure how forecastable the time series and benchmark it against the markets of the developed economies. The working hypothesis that emerged from the preliminary analysis is that the time series in fragmented states can still be predicted using standard statistical models. Different economic environments can generate prices that exhibit similar statistical properties. To best of our knowledge this analysis was never performed for the fragmented economies.

Another feature of the data in fragmented economies is that the data is often incomplete or insufficient for traditional time-series analysis. We can deal with a small proportion of missing observations using a Kalman filter of Hamilton (1994). For relatively short series we need to extend our modelling to the class of global models. Global models emerged as winners in the recent M4 forecasting competition by Makridakis et al. (2018). They fit a single model for a wide range of the available time series. The model is still univariate, but the parameters are fitted using neural network method to achieve good out-of-sample performance for all series. Once the model is estimated it can be used for forecasting very short time series. Global models have a variety of applications, for example, Amazon DeepAR use them to predict the sales of the new products based on the previous launches of similar products. This methodology had an explosive development in the ‘big data’ era with the recent advances in artificial intelligence and machine learning. To best of our knowledge global models are not yet applied for fragmented economies. The benefits could be enormous as global models will allow prediction using much smaller data than the traditional models. Since data availability is one of the biggest challenges in North Korea and Somalia, the global model will allow us to deal with this challenge in the most effective way.

Finally, we can bring in qualitative data to explore the mechanisms by which market participants decrease costs associated with moving people, goods, and information between markets within the country, and between the country and overseas markets, in the face of dysfunctional formal institutions and the shocks. In the case of North Korea, we will use the data previously collected to connect the market integration results with the strategies that market participants use to build trust and social networks enforce contracts, move between cities, acquire information about prices and policy, and navigate state interventions and shocks. In the case of Somalia, we will use the information on markets, piracy and other illicit activities, and governance collected as part of Hastings’ grant DP130103966. We will also collaborate with Sarah Phillips at Sydney University in writing the Somalia paper. Through her Future Fellowship (FT200100539), she is conducting interviews of Somali elites that will help us to connect the market integration results with people’s perceptions of local conflict and terrorism incidents in Somalia.

*3. Dissemination to stakeholders* (Years 2-3)

Finally, we will disseminate the results to stakeholders in accessible ways designed to maximize uptake of the findings and the framework. For government policymakers and non-governmental organizations in the humanitarian aid and governance sectors, we will develop a briefing and a white paper outlining the results and the framework. For scholars, we will present the findings at international conferences and write journal articles in high-impact journals. And for aid workers themselves, we will develop a forecasting website tool. The team has experience in creating high-quality public websites (ie. Our previous website [business-forecast-lab.com](http://business-forecast-lab.com/)). The website is an intuitive tool that makes the outcomes of this project accessible to the wider community. Anyone with internet access can easily obtain predictions of grain prices and market integration measures together with the uncertainty around them. This feature is especially important for the African population as there are fewer websites that cater for the needs of this part of the world. The website will include classical forecasting models as well as the novel methods developed by the team. The website will visualize and summarize the forecasting results in an easy-to-understand manner. The forecasts will be updated daily to include the latest available information.

**BENEFIT**

**Significance**

This project is significant for several reasons. First, it provides a new way to understand how the political economies of marginalised states with dysfunctional institutions actually function – through informal institutions that are always there, but are often unseen and unmeasured. Much of the international community’s aid for marginalised, developing states is oriented, understandably, toward improving and consolidating formal institutions – courts, law enforcement, finance and trade ministries, customs, and the like. However, in states with high levels of conflict or other impediments to internal governance, buttressing informal institutions – building trust networks, encouraging information flows, and finding informal ways to enforce agreements – may be more immediately effective than programs focused on formal institutions. In addition, improving market functioning is, from our past experience, one of the few topics on which countries like North Korea are willing to engage with outside experts, and as such engaging on market integration and food markets serves as a point of entry for development agencies. Second, the project, which links integration of cereal markets across and between countries with state capacity, and in turn links those with positive and negative outcomes, will be useful to development organizations such as the World Bank, the United Nations Development Program, and the World Food Program in targeting their programs and understanding the connection between market functionality and governance within a country.

**Benefit to Australia**

This project falls within the Science and Research Priority of “Food” and addresses the Practical Research Challenge of “Knowledge of global and domestic demand, supply chains and the identification of country specific preferences for food Australia can produce.” As such, the project and its outcomes have several specific benefits for Australia. First, by developing alternative ways of understanding governance and market function in developing countries, the project will improve the ability of the Australian government to target its aid for maximum practical effect, and for maximum influence, in Africa and Asia, particularly Southeast Asia. The framework could equally be applied to countries in the South Pacific, where Australia has recently increased its focus as it faces the challenge of surging Chinese investment in the region.

Second, the project develops an accessible framework to understand cereal market integration within and between countries, and to forecast both cereal market prices and the extent to which a country’s formal and informal institutions are facilitating (or not) trade between internal and external markets. As such, the outcomes, particularly the framework and the forecasting tools will be useful to industry – such as cereal exporters – that wants to understand the demand for Australian cereals in many developing Asian and African countries, and the effects that political and economic risks, such as conflicts, are likely to have on that demand, and the extent to which those countries are integrated into global supply chains. In practical and intellectual terms, this project will burnish Australia’s international development credentials, and improve the ability of the Australian government and industry to build political and economic influence in developing countries, particularly in Africa and Asia.

**FEASIBILITY**

The main feasibility concern with any project dealing with marginalised states is obtaining access to those states, and collecting reliable and accurate data. Maximizing feasibility is baked into the purpose and design of the project. First, the project’s main purpose is to take data that is already relatively widely available in marginalised states – cereal market prices – and apply an innovative framework to provide insights into governance and institutions that would not otherwise be possible due to the nature of the states under study. In this, the poor data environment is an advantage for our project, inasmuch as the value added by our analysis will be greater than for states with better data.

Second, the project is designed to take advantage of data that we have already collected or to which we already have access, obviating problems of data collection that would usually be the case with the study of marginalised states, reducing the susceptibility of the project to travel restrictions, and minimizing the costs associated with data collection and fieldwork. For the quantitative data, the market price data for North Korea was already collected by Hastings during his ARC project DP140102098. Further market data is available from DailyNK, and market data for Somalia and other East African countries is available from the United Nations Food Program and commercial providers. For the qualitative data on market participants’ perceptions of trade impediments such as sanctions, policy changes, and conflict, Hastings already conducted 50 interviews with Chinese traders involved in North Korea as part of his previous ARC project (DP140102098), and has significant documentation and other information on markets and Somali piracy collected as part of another one of his ARC projects (DP130103966).

The implementation of existing methodologies and the use of previously developed tools guarantee the project's feasibility. This will be aided by a Research Assistant with a suitable programming background. In Years 1 and 2, the RA will assist with data sourcing and management, particularly as they relate to “data cleaning” that will facilitate accurate matching of the price and conflict data. In Years 2 and 3, they will integrate and automate new data sources into the existing website structure, as well as implement Machine Learning methods for global models, and the Kalman filter for missing observations. The University of Sydney provides excellent graduates that can be employed on this project, as well as access to the Sydney Informatics Hub. The CIs have drawn on the Hub’s expertise in implementing multiple projects with similar demands.

**Implementation plan**

|  |  |  |  |
| --- | --- | --- | --- |
|  | **2022** | **2023** | **2024** |
| Research | - Framework development  - Market integration analysis of Somalia and North Korea | - Link market integration and institutional capacity | - Write-up |
| Publication and dissemination | - Submit article #1 (Framework) | - Submit articles #2 (North Korea) and #3 (Forecasting)  - Presentations at ISA (Montreal), AAEA (Washington DC), ISF (Beijing)  - Briefing in Canberra | - Submit article #4 (Somalia)  - Presentations at ISA (San Francisco), ISF (TBD)  - White paper distribution  - Briefing in Canberra  - Web tool online |

**COMMUNICATION OF RESULTS**

We will disseminate the results of the project in order to maximize uptake by different stakeholder communities.

1.For academics, we will publish **at least four articles** (one on the framework itself, one on North Korea, and one on Somalia, and one on forecasting)in leading, high-impact political science, economics, and development journals such as *World Development*, *Food Policy*, *American Journal of Agricultural Economics, International Studies Quarterly*, *Political Geography*, and *African Affairs*. All have previously published our work.

2. For policymakers and aid organisations, we will prepare and deliver a **briefing paper** that lays out the framework in accessible terms, presents the results, and gives recommendations for development, targeted aid and foreign policy. In Canberra we will **brief** Australian Aid, and the North Korea and Africa teams at DFAT.

3. For a sustainable benefit to analysts and the wider public, we will write **a series of short pieces** to be published in high-visibility venues, and create a **website** that will automatically import market price data for Africa as they are produced; (2) visualize market price data; (3) forecast grain prices and market integration for different countries based on (4) different modelled scenarios.

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