The University of Adelaide
Faculty of Professions
School of Economics

# Trade and Economic Development: Evidence from Less Developed Countries

a thesis
by

Ngoc Thien Anh Pham

submitted in partial fulfillment of the requirements
for the degree of
Doctor of Philosophy

April, 2016

# Contents

# List of Tables

# List of Figures

# Abstract

Improving living standards is a key priority for both policymakers and researchers. While trade is positively associated with income levels, finding evidence on the causal effect that trade may have on living standards is a challenge because decisions on whether to trade and how much to trade are not random. This thesis offers evidence on the extent to which trade activities can affect economic development in three groups of less developed countries: least developed countries (LDCs), landlocked developing countries (LLDCs), and Sub-Saharan African countries (SSAs).

First, the thesis investigates if a reduction in child mortality can be achieved by increasing trade in 48 LDCs between 1995 and 2012, and whether this effect depends on a country's type of political regime, namely, democracy or autocracy. While trade empirically promotes income levels, whether the benefits of trade activities do trickle down to ordinary citizens is questionable and may be influenced by political institutions. The thesis adopts an instrumental variable approach in a panel country and year fixed effects model to deal with unobserved factors and reverse causality. To do so, the thesis employs a known trade cost indicator that exploits information of bulk dry shipping costs captured by the Baltic Dry Index (BDI). The thesis finds that regardless of political regimes, there is no evidence that under-5 child mortality rate responds to trade arising from a cheaper shipping cost. Indeed, in autocratic LDCs, trade could even cause the child mortality rate to rise. To explore why this is the case, the thesis investigates the effect that trade might have on the environment. Evidently, trade could increase pollution, and this subsequent increase in pollution

in turn relates to an increase in child mortality.

Second, the thesis investigates the effect of trade cost on economic development in 31 LLDCs between 2001 and 2012. Lacking direct sea access, the LLDCs have expensive trade costs for shipping goods, which is considered a major reason for the LLDCs' underdevelopment. Given that the LLDCs may rely on container freight for trade because of the long distances over land, the thesis proposes a new measurement of trade cost by exploiting information from the Harpex index, an international container shipping rate. The thesis employs a recent advancement in panel data estimation - the interactive fixed effect which has the ability to deal with a large class of unobserved confounding information. Consequently, a reduction in trade cost is found to benefit the LLDCs substantially, in such was as higher income levels and better health conditions. The thesis also finds that a trade elasticity of income is roughly 1 for the LLDCs, which is about five times that estimated for the world as a whole, suggesting that trade can be a powerful force for the LLDCs progress.

Finally, the thesis investigates the effect of exports on urbanization in 48 SSAs between 1985 and 2012. As a feature of development, the high rate of urbanization may reflect improvements in living standards in the SSAs. Finding factors contributory to determining urbanization is important to the SSAs, that are among the worlds poorest countries and home to 13% of the worlds population. The thesis adopts a novel estimator, the correlated common effects (CCE) estimator, which employs interactive fixed effects to handle a large class of omitted and potentially confounding variables and cross-sectional dependence. The thesis uses a known instrumental variable for exports, the BDI cost, which is relevant to the SSAs to address the possibility of reverse causality. An expansion in exports is found to increase the urbanization rate, expand the size of primate cities and reduce income levels of these cities. The thesis also finds that an increase in exports can improve the accessibility of water and sanitation facilities for urban residents, but at a cost of expanding an urban-rural gap in water access and sanitation facilities. To explain how exports can affect urbanization, the thesis examines the effect of exports on shaping a country's production in agriculture, manufacturing and services. Evidently, higher exports could expand the size of the services sector, which in turn relates to the urbanization process in the SSAs.

# Acknowledgements

I am specially grateful to my principal supervisor, Dr. Nicholas C.S. Sim, for his generosity to share his research interest on trade and development, to my co-supervisor, Dr. Firmin Doko Tchatoka, for his wisdom on instrumental variables regression, and to my external supervisor, Professor Zudi Lu, for his prompt response to my technical issues. Without their inspiring guidance, continuous support and endless encouragement, finishing this thesis would be impossible.

I would like to thank Dr. Stephanie McWhinnie, Dr. Jacob Wong, Dr. Nadezhda V. Baryshnikova, Dr. Terence C. Cheng, Dr. Florian Ploeckl, Associate Professor Mandar Oak, Professor Ralph Bayer and Professor Binh Tran-Nam for their enlightening research conversations and advice. My special thanks go to Jonie Chang, an ISC advisor, for her support to my self-development, and to my fellow ISC peer mentors for their warm and supportive friendship. My appreciation also goes to all staff and my fellow postgraduate students at School of Economics for their constant support. I gratefully acknowledge financial support from the University of Adelaide.

Finally, I would like to express my debt to my family members for their endless love and encouragement.

# Declaration

I, Ngoc T.A. Pham, certify that this work contains no material which has been accepted for the award of any other degree or diploma in my name, in any university or other tertiary institution and, to the best of my knowledge and belief, contains no material previously published or written by another person, except where due reference has been made in the text. In addition, I certify that no part of this work will, in the future, be used in a submission in my name, for any other degree or diploma in any university or other tertiary institution without the prior approval of the University of Adelaide and where applicable, any partner institution responsible for the joint-award of this degree.

I give consent to this copy of my thesis when deposited in the University Library, being made available for loan and photocopying, subject to the provisions of the Copyright Act 1968.

The author acknowledges that copyright of published works contained within this thesis resides with the copyright holder(s) of those works.

I also give permission for the digital version of my thesis to be made available on the web, via the University's digital research repository, the Library Search and also through web search engines, unless permission has been granted by the University to restrict access for a period of time.

SIGNED: . . . . . . . . . . . . . . . . . . . . . . . DATE: . . . . . . . . . . . . . . . . . . . . . . .

# Chapter 1

# Introduction

Economic development is a key priority faced by both policymakers and economic researchers. Finding determinants of economic development is therefore important from policymaking and research perspectives. As early as Robertson (1940), international trade was considered as an "engine of growth" by means of which a country could achieve its development goals and improve living standards. However, developed countries have dominated the global trade market (Baldwin and Martin, 1999), and low income countries still trade at low levels. The weak participation levels of low income countries has meant that the question of whether trade causes economic development has no straightforward answer. It is possible that the opening up of trade does not bring significant gains to these countries. As discussed by Nurkse (1959), low income countries exported mainly primary commodities the demand for which was generally income inelastic. Thus, the contribution of low income countries to global trade may be slow to change, and this marginal participation in turn will not improve their economies significantly.

This thesis attempts to investigate the extent to which trade activities can affect economic development in less developed countries. By using several measures of economic development and different estimation techniques, the thesis hopes to offer further evidence for discussions on the empirical effect of trade activities on development. The use of several measures of development is taken from observations of Kuznets (1973) that a country that experienced the high growth rates of income per capita could transform its economy and society structures. Therefore, using gross domestic product (GDP) may not be able to paint a full picture of a country's development. This thesis focuses on three groups of countries: least developed countries (LDCs), landlocked developing countries (LLDCs), and Sub-Saharan African countries (SSAs). While these countries show superficial similarities in low levels of income and international trade, each group has its own economic issues that make the analysis challenging.

The first group consists of 48 LDCs as designated by the United Nations (UN). This group is facing with high child mortality. For example, in 2012 the LDCs' average under-5 mortality rate is 8.1%,[1] or approximately sixteen times the mortality rate in OECD countries. Roughly 4 in 10 under-5 deaths in the world occur in the LDCs.[2] The LDCs account for merely 1% of global trade despite sharing 12% of the world's population with 2 in 3 persons there living below the US$ 2 poverty line. To investigate if a reduction in child mortality can be achieved by increasing trade in the LDCs between 1995 and 2012, the thesis adopts an instrumental variable approach in a panel two-way fixed effects model to deal with unobserved factors and reverse causality. The thesis employs a known trade cost indicator that exploits information of bulk dry shipping costs captured by the Baltic Dry Index (BDI). While trade empirically promotes income levels, it is questionable whether the benefits of trade activities do trickle down to ordinary people, and it might be influenced by political institutions, namely, democracy or autocracy. The thesis finds that regardless of political regimes, there is no evidence that under-5 child mortality rate responds

[1] This number is computed by averaging the child mortality rate across the LDCs from the World Development Indicators.

[2] This computation is based on the data on under-five deaths from UNICEF. See `http://www.childmortality.org`.

to trade. However, in autocratic LDCs, trade could even cause the child mortality rate to rise. To explore why, the thesis investigates the effect that trade might have on the environment. Evidently, trade could increase pollution, and this subsequent increase in pollution is associated with an increase in child mortality.

The second group consists of 31 LLDCs which have no direct sea access. Without direct sea access, the LLDCs have faced with high transportation cost for international trade, it can even be twice that of their coastal neighbors (Radelet and Sachs, 1998). The extremely expensive cost of trading has been considered a major reason for the LLDCs' underdevelopment. A half of all people in the LLDCs earn less than US$2 per day on average, and roughly 1 child in 10 is not expected to live beyond its fifth birthday. Although the LLDCs are home to more than 6% of the global population, they only produce 1% of the world's output, which is dwarfed by the 22% of global output produced by the US alone, and account for a meager 1.2% of global trade. Because of this, the UN has made it a Sustainable Development Goal which follows up on its earlier Millennium Development Goal to help improve the LLDCs' access to the world trade. However, the extent to which development in the LLDCs would be aided by the reduction in trade cost is still an open question. Given that the LLDCs might rely on container freight for trade because of the long distances over land, the thesis proposes a new measurement of trade cost by exploiting information from the Harpex index, an international container shipping rate. The thesis employs a recent advancement in panel data estimation - the interactive fixed effect - which has the ability to deal with a large class of unobserved confounding information. In doing so, a reduction in trade cost is found to benefit the LLDCs substantially, in such is as higher income levels and better health conditions. The thesis also finds that a trade elasticity of income is roughly 1 for the LLDCs which is about five times that estimated for the world as a whole, suggesting that trade can be powerful force for the LLDCs' progress.

The third group consists of 48 SSAs which have been urbanizing at the highest rate among main regions in the world. By 2014, at least 37% of the population in the SSAs is living in urban areas, having been below 10% in 1950. As a feature of economic development (Kuznets, 1973), the high rate of urbanization may reflect improvements in living standards in the SSAs. Despite the dramatical urbanization process, the SSAs are still classified as underdeveloped countries. As recent as 2012, real GDP per capita in the SSAs is roughly 1% of the OECD, accounting for 2% of global exports, and 4 in 10 people in this region live below the US$ 1.9 poverty line. Although exports are characterized as a determinant of economic growth, the low levels of the SSAs' exports give rise to the question of whether exports cause urbanization. To advance the analysis, the thesis adopts a novel estimator, the correlated common effects (CCE) estimator, which employs interactive fixed effects to handle a large class of omitted and potentially confounding variables and cross-sectional dependence. The thesis uses a known instrumental variable for exports, the BDI cost, relevant to the SSAs to address the possibility of reverse causality. An expansion in exports due to cheaper trade cost is found to increase the urbanization rate, expand the size of primate cities and reduce income levels of these cities. The thesis also finds that an increase in exports can improve the accessibility of water and sanitation facilities for urban residents, but at a cost of expanding an urban-rural gap in water access and sanitation facilities. To explain how exports can affect the urbanization rate, the thesis investigates the effect of exports on shaping a country's production in agriculture, manufacturing and services. Evidently, higher exports could expand the size of services sector which in turn relates to the urbanization process in the SSAs.

The remainder of this thesis as follows. Chapter 2 investigates the role of trade, institutions and environmental quality in determining child mortality in the LDCs. Chapter 3 examines whether trade cost may affect economic development in the LLDCs. Chapter 4 considers the causal effect of exports on urbanization in the SSAs. Chapter 5 presents some concluding remarks. Chapters 2-4 can also be three stand-alone papers with self-contained references, tables and figures.

# References

Baldwin, R., Martin, P. (1999) "Two Waves of Globalisation: Superficial Similarities, Fundamental Differences," *NBER Working Paper No. 6904*.

Kuznets, S. (1973) "Modern Economic Growth: Findings and Reflections," *The American Economic Review*, 63(3), 247–258.

Nurkse, R. (1959) "Patterns of Trade and Development," in G. Haberler, R. M. Stern eds. *Equilibrium ad Growth in the World Economy*: Cambridge University Press.

Radelet, S., Sachs, J. (1998) "Shipping costs, Manufactured Exports, and Economic Growth," Mimeographed document, Harvard Institute for International Development, Harvard University.

Robertson, D. (1940) *Essays in Monetary Theory*, London: P.S. King and Son.

# Chapter 2

# Child Mortality in the LDCs: The Role of Trade, Institutions and Environmental Quality

by

Faqin Lin[a] Ngoc T.A. Pham[b] Nicholas C.S. Sim[b]

*a: School of International Trade and Economics, Central University of Finance and Economics*

*b: School of Economics, University of Adelaide*

# Statement of Authorship

| | |
|---|---|
| Title of Paper | **Child Mortality in the LDCs: The Role of Trade, Institutions and Environmental Quality** |
| Publication Status | ☐ Published ☐ Accepted for Publication ☑ Submitted for Publication ☐ Unpublished and Unsubmitted w ork w ritten in manuscript style |
| Publication Details | Submitted to Oxford Economics Papers in September 2015 as Lin, F., Pham, N. and Sim, N. (2015). " Child Mortality in the LDCs: The Role of Trade, Institutions and Environmental Quality". |

## Co-Author

| | | | |
|---|---|---|---|
| Name of Co-Author (Candidate) | Ngoc T.A. Pham | | |
| Contribution to the Paper | Contributed to literature review, undertook parts of literature review, helped in data collection, interpreted parts of the results, wrote parts of the manuscript. | | |
| Overall percentage (%) | 50% | | |
| Certification: | This paper reports on original research I conducted during the period of my Higher Degree by Research candidature and is not subject to any obligations or contractual agreements with a third party that would constrain its inclusion in this thesis. I am the co-author of this paper. | | |
| Signature | | Date | 2016.1.15 |

## Other Co-Author Contributions

By signing the Statement of Authorship, each author certifies that:

i. the candidate's stated contribution to the publication is accurate (as detailed above);

ii. permission is granted for the candidate in include the publication in the thesis; and

iii. the sum of all co-author contributions is equal to 100% less the candidate's stated contribution.

| | | | |
|---|---|---|---|
| Name of Co-Author | Faqin Lin | | |
| Contribution to the Paper | Contributed to the planning of the article and the methodology, undertook literature review, collected and constructed data, helped in interpretation of the results, wrote parts of the manuscript. | | |
| Signature | | Date | 2016. 1.15 |

| | | | |
|---|---|---|---|
| Name of Co-Author | Nicholas C.S. Sim | | |
| Contribution to the Paper | Contributed to the planning of the article and the methodology, supervised in development of the work, helped in interpretation of the results, wrote the manuscript, acted as corresponding author. | | |
| Signature | | Date | 21 / 01 / 2016 |

## Abstract

Child mortality is a persistent problem for the world's least developed countries (LDCs). While 1 in 4 children (under 5) who died in 1990 were from the LDCs, this ratio has since risen to more than a third today. Given that trade may foster economic development, one possible solution is to raise the currently low levels of trade in the LDCs, but how effective this approach might be, whether the benefits of trade activities do trickle down to ordinary citizens, could be influenced by political institutions. In this paper, we adopt an instrumental variable approach to investigate if a reduction in child mortality can be achieved by increasing trade, and whether this effect depends on a country's type of political regime, namely, democracy or autocracy. To construct an instrument for trade, we exploit information from the Baltic Dry Index (BDI) that reflects the cost of utilizing bulk shipping for transporting primary goods, which are mainly what the LDCs export. Importantly, because the BDI-based instrument contains both cross-sectional and time variation, we are able to use an instrumental variable fixed effects regression approach to study the relationship between trade and child mortality, which to our best knowledge is the first in the literature. Regardless of political regimes, we do not have evidence that an increase in trade can lead to lower levels of child mortality. In fact, in autocratic LDCs, trade could even cause the child mortality rate to rise. To explore why, we investigate the effect that trade might have on the environment. We find that trade could increase pollution, and this subsequent increase in pollution is associated with an increase in child mortality.

**Keywords**: Child Mortality · Trade · Institutions · Environment · Least Developed Countries
**JEL Classification**: I3 · O1· F18 · P16

# 1 Introduction

In 1990, more than 12 million children died before their fifth birthday. Faced with this loss of young lives, the United Nations announced the fourth Millennium Development Goal in 2000 that targeted the reduction of the global under-5 mortality rate. However, in the world's least developed countries (LDCs), high rates of child mortality continue to persist. As recent as 2012, the LDCs have an average under-5 mortality rate of 8.1%, or roughly sixteen times the mortality rate in OECD countries. Moreover, the decline in the rate of child mortality has been much slower in the LDCs than in the rest of the world. In 1990, 1 in 4 children (under 5) who died were from the LDCs.[1] Today, this ratio has risen to more than a third.[2]

Given that trade can foster economic development (see, *inter alia*, Frankel and Romer, 1999; Feyrer, 2009a,b), raising the currently *low levels* of trade in the LDCs could be a way of reducing child mortality in these countries.[3] However, how effective this approach might be, whether the benefits of trade activities do trickle down to ordinary citizens, could be influenced by institutions. For example, in countries with autocratic regimes, an autocrat may capture the economic benefits of trade without facing serious repercussions (see, for example, Acemoglu et al., 2004; Padró-i Miquel, 2007; Besley and Kudamatsu, 2008).[4] Moreover, autocratic countries tend to be less willing to confront pollution and therefore have weaker environmental regulations

[1] This is with respect to the current LDCs (48 of them), which are fewer than the set of LDCs in 1990.

[2] The figures are computed using the World Development Indicators of the World Bank. See `http://databank.worldbank.org`.

[3] The LDCs account for merely 1% of global trade despite having 12% of the world's population.

[4] Unlike a democracy, people living in an autocratic regime do not have a fair electoral process to punish the autocrat if poor living conditions persist. Even if there are elections, individuals living in autocracies may still vote for a corrupt incumbent if they receive private benefits from doing so (Acemoglu et al., 2004) or for fear of punishment if the incumbent is re-elected (Padró-i Miquel, 2007). Therefore, low income households who tend to be the ones outside the "favored" group might persistently face poor living conditions as long as the kleptocrats are still in power (Besley and Kudamatsu, 2008).

(Congleton, 1992; Cao and Prakash, 2012). In this case, trade activities in these countries are likely to be more polluting and harmful to health.

In this article, we examine the effect that trade might have on child mortality in the LDCs and explore if this relationship depends on institutions. Ascertaining if trade causes child mortality is difficult in itself, as child mortality could reverse cause trade and omitted variables could be present. As Levine and Rothman (2006) argued, healthy children tended to become productive adults who might choose to have more trade.[5] It implies causality may run from child mortality to trade. Moreover, trade and health can be driven simultaneously by omitted cross-country heterogeneity such as disease environments (e.g. McArthur and Sachs, 2001), tastes and cultural characteristics (e.g. Feyrer, 2009a,b).

To address these "identification" issues, we employ fixed effects instrumental variable regression based on a panel data of 48 LDCs from 1995 to 2012. To address the problem of omitted variables, we use country and year fixed effects to purge both time invariant cross-country heterogeneity and macroeconomic shocks that may confound the effect of trade on child mortality (if it exists). To deal with reverse causality, we use an instrumental variable for the LDCs' trade proposed by Lin and Sim (2013, 2015). The LDCs are mainly producers and exporters of primary goods. Given that primary goods are typically transported by a class of vessels known as dry bulk carriers, the cost of bulk carrier charter – reflected by the Baltic Dry Index (BDI) – could influence how much the LDCs trade. Based on this insight, we construct an instrument for LDCs' trade as the interaction between the log of the BDI and each LDC's primary goods share of its total trade. The latter reflects the intensity of bulk shipping utilization of an LDC. By interacting it with the BDI to construct our instrument, this captures the idea that the influence of bulk shipping cost is stronger for countries where primary goods trade is important. Crucially,

[5]Moreover, decisions on whether to trade, and how much to trade, are clearly not randomly assigned. Therefore, the regression analysis may be confounded by the feedback going from health, then income, then to trade.

our instrument contains both cross-sectional and time variation and therefore can be employed in panel regressions without being "cleaned out" by country and year fixed effects.

In our regressions, we find no evidence that trade can lead to lower levels of child mortality in the LDCs. In fact, within autocratic LDCs, trade may even be harmful, as we find that a 1% increase in trade per capita is associated with a 0.13% increase in the child mortality rate on average. To explore the underlying mechanism, we consider the role that environmental quality might have in explaining this positive relationship between trade and child mortality. As discussed, environmental regulations tend to be less stringent in autocracies (Congleton, 1992), which suggests that trade activities in these countries are likely to be more polluting. Our regression results are consistent with this idea as we find that within autocratic LDCs, an increase in trade may increase pollution such as the emissions of carbon dioxide ($CO_2$), sulfur dioxide ($SO_2$) and nitrous oxide ($N_2O$). Furthermore, using plausibly exogenous variations in pollution generated by the BDI, we also find that pollution can cause child mortality in autocratic LDCs to rise. These results suggest that environmental quality is a plausible channel for the adverse effect of trade on child mortality that is found in this paper.

## 1.1 Relation to the Literature

Our paper is closest to the seminal work of Levine and Rothman (2006), who examined the effect of trade openness on children's health for both developed and developing countries. Besides focusing on the LDCs, our work contains one significant departure in that we utilize panel data whereas Levine and Rothman (2006) exploited only cross-sectional information. The latter is borne out of necessity as Levine and Rothman (2006) constructed their instrument for trade based on geographical distance, which is incompatible with the fixed effects regression as distance is time invariant.[6] Moreover, given that distance could be correlated with geography-based time invariant factors of development such as cultural characteristics, colonial institutions and disease environments, the instrument used by Levine and Rothman (2006) may not satisfy the required exclusion restriction.[7] In this paper, our instrument for trade contains both cross-sectional and time variation. The time-varying nature of our instrument allows us to implement panel IV regressions with country fixed effects, which to our best knowledge is the first within the topic of trade and child mortality.

Our paper is related to two areas within the literature on trade, globalization and the environment. Firstly, it is related to the literature that focuses on the relationship between trade and health. Although trade liberalization may foster economic development, the evidence on whether trade can improve health has been mixed.[8] In fact, recent evidence suggests that trade may not always lead to better health outcomes (Cao and Prakash, 2006; Ruhm, 2007; Oster, 2012),[9] which is consistent with what we have found in this paper.

Secondly, our work is related to the debate on whether trade can lead to environmental degradation. This is related to the pollution haven hypothesis, which warns that with the rise of trade and globalization, polluting industries will tend to relocate to places where environmental regulations are less stringent. In the "first generation" literature, Antweiler et al. (2001) and Frankel and Rose (2005) found little evidence to support this hypothesis. However, for less developed countries (in particular, non-OECD countries), Managi et al. (2009) found that trade openness

[6]Levine and Rothman (2006) constructed their instrument based on the same approach as Frankel and Romer (1999).

[7]This critique is due to Feyrer (2009a,b).

[8]For instance, there is evidence suggesting that an increase in globalization and trade in the developing world will make people better off not only through increases in income but also through improvements in health (Dollar, 2001; Levine and Rothman, 2006; Owen and Wu, 2007).

[9]For instance, Oster (2012) found that an increase in exports was associated with doubling the incidence of HIV in Sub-Saharan Africa.

could lead to higher $SO_2$ and $CO_2$ emissions. Moreover, examining US multinational firms in foreign countries, Kellenberg (2009) showed that when production activities were located in developing and transition economies, a significant proportion of the US multinational production growth was generated by falling relative levels of environmental stringency and enforcement. These results, together with ours, suggest that the less developed countries could be pollution havens. As such, it is not always clear that trade can lead to improvements in health and reductions in child mortality.

Our paper is also related to the literature that seeks to empirically investigate the "impact of international trade on standards of living" (Frankel and Romer, 1999, p. 379). In this research, the most common measure of living standards is income, and numerous papers, including the landmark contribution of Frankel and Romer (1999), have shown that income can rise with trade.[10] Our paper looks at another dimension of well-being – the child mortality rate – as an indicator of development and welfare. Child mortality is typically a problem of households in the lowest income quantiles.[11] Therefore, the adverse effect of trade on child mortality that we have found for autocratic LDCs suggests that trade might cause the poorer households in these countries to be worse off even if does improve income levels on average.

Finally, to the best of our knowledge, our paper is among the first to offer a unified discussion on the link between trade, pollution, and child mortality, while the existing literature has focused more specifically on the pairwise relationship between

[10]More recently, Feyrer (2009b) used a natural experiment approach by exploiting the closing and re-opening of the Suez canal during 1967–1975 to generate shocks to shipping distance and hence to the variation in trade. Focusing on the LDCs, Lin and Sim (2013) exploited the BDI to construct a time-varying measure of the cost of primary goods trade. These papers, like Frankel and Romer (1999), found that trade had a sizable causal effect on income, where the trade elasticity of income ranged from 0.2 (Feyrer, 2009b) to 0.5 (Lin and Sim, 2013).

[11]For example, within a developing country, Wagstaff (2000) showed that incidence of child mortality could be unevenly distributed across households, where usually, infant and under-5 mortality are significantly higher among the poor (see, also, Victora et al., 2003). In Bangladesh, Halder and Kabir (2008) showed that child mortality tended to be concentrated in households from lower socio-economic groups.

trade and pollution (Antweiler et al., 2001; Cole, 2004; Frankel and Rose, 2005; Kellenberg, 2009; Managi et al., 2009), pollution and child mortality (Franklin et al., 2007; Zhang, 2012; Anand, 2013; Currie, 2013), and trade and child mortality (Levine and Rothman, 2006). Our paper is also among the first to consider how political economy, in particular institutions, may shape the way trade, pollution, and child mortality interact. This complements the literature that looks mainly at the direct effect that institutions may have on child mortality (Ross, 2006), trade (Arezki and Brückner, 2012) and pollution (Congleton, 1992; Cao and Prakash, 2012).

### 1.2 The Organization of the Paper

The remainder of the paper is as follows. In Section 2, we discuss our data sources and the construction of our instrument for trade. In Section 3, we present our estimating equation and discuss the relevant estimation issues. We then present our regression results in Section 4 and explore environmental quality as a channel in Section 5. Section 6 concludes.

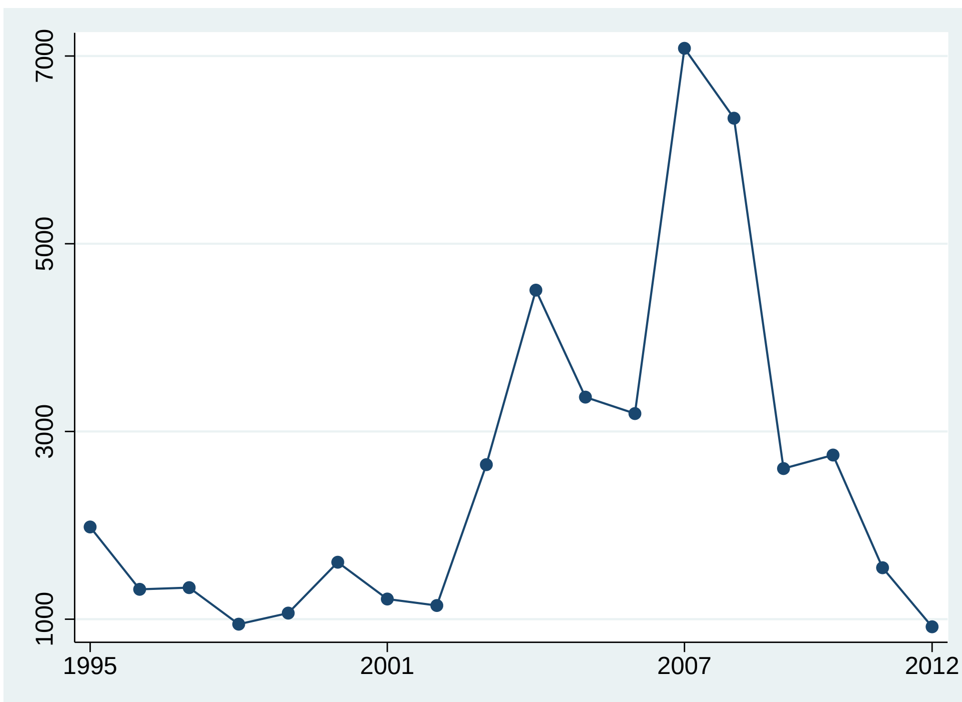
## 2 Data

Our dataset consists of a panel of 48 LDCs from 1995 to 2012. The dataset is constructed from four main sources: the UNCTAD database, the World Development Indicators, the Environmental Performance Index, and the Polity IV database of Marshall and Jaggers (2009). The key variables in our study are described below. The summary statistics are presented in Table A1 and the variable definitions and sources are documented in Table A2 of the Appendix A.

## 2.1 Baltic Dry Index Based Instrument

In this paper, we follow Lin and Sim (2013) to construct an instrument for trade that exploits information from the Baltic Dry Index (BDI), a shipping index from the Baltic Exchange, which is plotted in Figure 1. In 1985, the Baltic Exchange launched the BDI as a general indicator of shipment rates for dry bulk cargoes, which consist of raw commodities such as grain, coal, iron ore, copper and other primary materials. The LDCs are mainly primary goods producers, and as such, are dependent on bulk carriers. This makes the BDI, which reflects the cost of global bulk shipping, a relevant indicator of trade cost faced by the LDCs.

Figure 1: The Baltic Dry Index




To obtain an instrument for LDCs trade using the BDI, we follow Lin and Sim (2013) to construct:

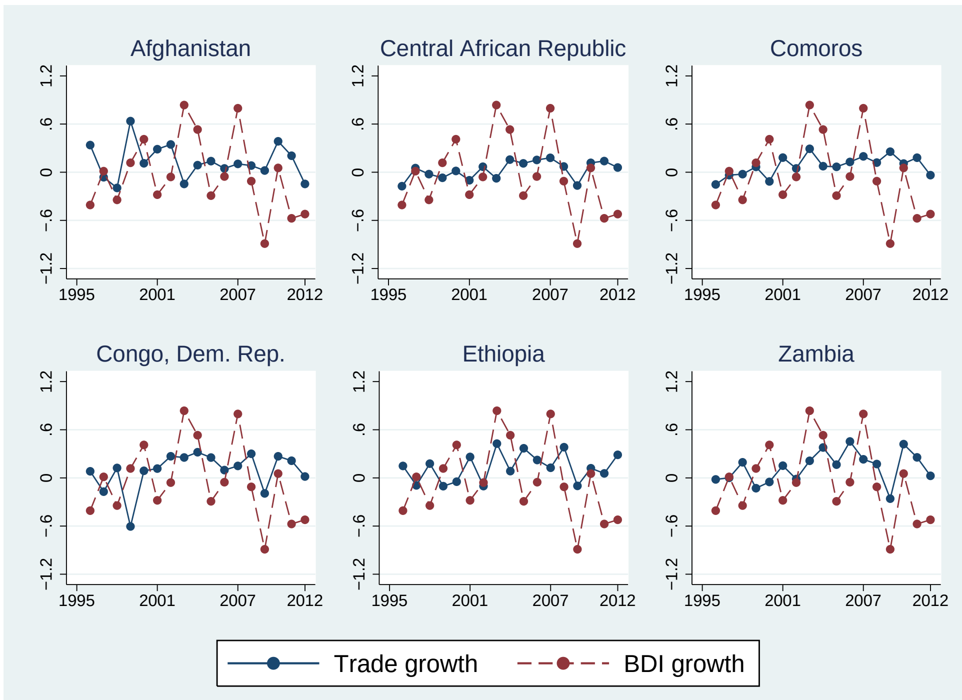
$$Cost_{it} = \theta_{it-1} \log(BDI_t), \tag{1}$$

where $\theta_{it-1}$ is country $i$'s predetermined proportion of total trade that consists of primary commodities trade. Information on primary goods trade is obtained from the UNCTAD Commodity Statistics (UNCTAD, 2014) based on the SITC 0 + 1 + 2 + 4 + 32 + 67 + 68 classification of primary commodities. This classification covers a wide range of primary commodities including iron and steel, but excludes crude oil which is transported by wet (not dry) carriers such as tankers. Intuitively, the primary trade share in Eq. (1) reflects the relative intensity of bulk shipping utilization. Therefore, Eq. (1) captures the idea that the cost of bulk shipping would matter more for countries where primary goods trade is important.

Our instrument $Cost_{it}$ contains both cross-sectional and time variation. Hence, it can be employed in panel regressions without being "cleaned out" by country and year fixed effects. However, Eq. (1) is not the only specification we could use. For example, we could replace the lagged primary trade share (i.e. $\theta_{it-1}$) in Eq. (1) with a fixed primary trade share (i.e. $T^{-1}\sum_{t=1}^{T}\theta_{it}$), although the regression outcomes turn out to be similar. We believe the reason is that the LDCs tend to export a stable proportion of primary goods across time, which might explain why our results are not sensitive to using either the lagged or fixed primary trade share as the interaction term in Eq. (1).

Lin and Sim (2013) argued that the cost of bulk shipping was an exogenous determinant of how much an LDC trade. Collectively, the LDCs are small participants in global trade, accounting for less than 1 percent of world trade in goods and less than 2 percent of global trade in primary goods. Moreover, their economies are very small on the global scale, accounting for less than 2 percent of worldwide GDP. Consequently, each LDC is unlikely to have much influence on the cost of bulk shipping, although an increase in bulk shipping cost can negatively affect how much an LDC trade. To see this, Figure 2 shows that the growth in the BDI (i.e. the growth in bulk shipping cost) was at times accompanied by a slowdown or even contraction in trade. For example, when the BDI increased by 131% from 2002 to 2003, the trade per capita of Central African Republic and Afghanistan, which are both landlocked countries, fell roughly by 7% and 14% respectively. For some coastal countries, the contraction in trade is even more severe. For instance, the trade per capita of Myanmar, Liberia and Eritrea fell by 14%, 21% and 27% respectively during the same period.

Figure 2: The BDI Growth and Trade Growth for a Sample of LDCs




*Note*: This figure plots the growth in the BDI and the growth in trade for a sample of LDCs. The vertical axis measures the growth in the BDI and the growth in trade per capita. The growth variables are constructed as the first difference of their respective values in logs.

Some commentators suggest that the recent movements in the BDI are driven mainly by the growing demand of commodities by large emerging economies, such as China.[12] For instance, in 2002, China replaced Japan as the top iron ore importer in the world. By 2003, China had more than doubled its iron ore imports compared to the levels in 2000.[13] This surge in iron ore demand is a significant event because iron

[12]Jim Buckley, the CEO of the Baltic Exchange, remarked that "To put it in extremely simplistic terms, China is importing huge amounts of raw materials and exporting manufactured goods, and that's drawing ships into the Pacific." See `http://www.stockengineering.com/pictures/090104%20-%20BDI.pdf`.

[13]According to the Chinese Ministry of Commerce, China imported 70 million tons of

ore is by proportion the most important commodity transported by bulk carriers.[14] Besides iron ore, China had transformed itself from being coal exporter to an importer, thus further driving up the demand for bulk carriers and in turn influencing the cost of bulk shipping.

To see the importance of China as a driving force of bulk shipping cost, Figure 3 compares the growth rate of the BDI with China's trade volume and shows that the two series track each other closely.[15] Because the BDI is a measure of trade cost (thus should be negatively associated with trade), the *positive* co-movement between the two could be symptomatic of the endogenous response of the BDI to the demand for trade by China. Note that this tight positive relationship has also been reported for large primary goods producers such as Australia, Brazil, India and Russia (Lin and Sim, 2013).[16] However, for the sample of LDCs, Figure 2 shows that the BDI and trade (in growth) could co-move in the *opposite* direction. The presence of such negative co-movements, which are completely absent for China as well as for Australia, Brazil, India and Russia, suggests that an LDC is unlike large countries that could influence the cost of bulk shipping. Hence, an LDC can be treated as a price taker in the bulk shipping market and the BDI as an exogenous determinant of its trade.

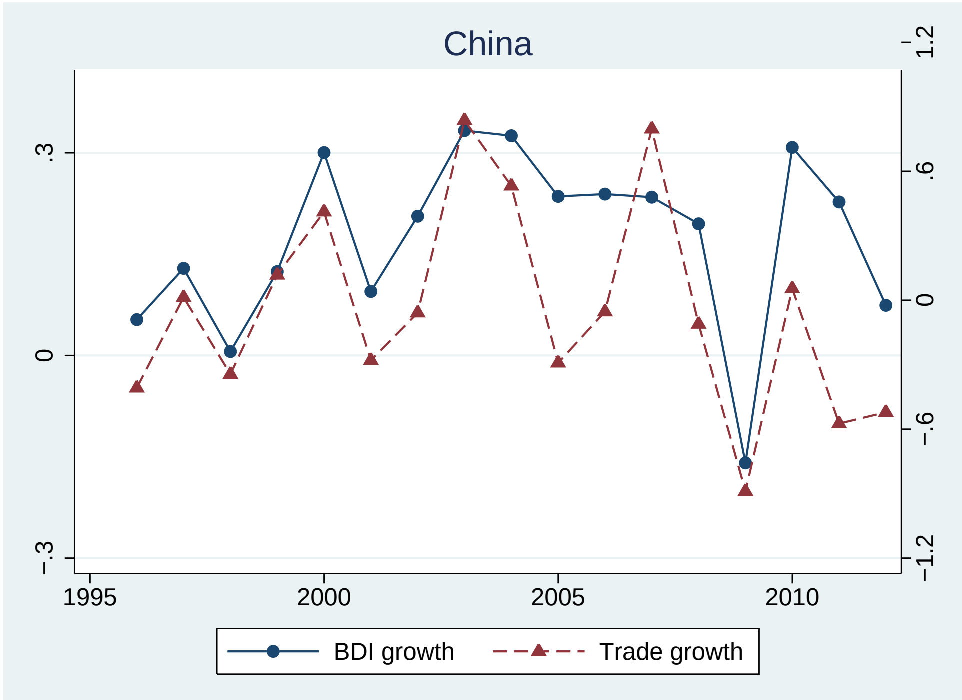
iron in 2000, rising to 148.13 million tons in 2003. This demand for iron ore was driven in turn by the demand for steel, which was used for the construction sector as well as the production of automobiles. China is both the world's largest steel consumer and producer, producing nearly 50 percent of the global steel output according to the World Steel Association.

[14]According to Bornozis (2006), the main commodities that utilized bulk carriers for transportation were iron ore, coal and grain. Iron ore and coal were the two most important bulk commodities, comprising 27% and 26% of total dry bulk trade respectively, followed by grain at 14%. However, iron ore and coal are not the main exports of the LDCs.

[15]It is interesting to note that China's share of world primary trade in 2010 is 17.69%, or around 10 times the share of world primary trade of all LDCs combined.

[16]Lin and Sim (2013) provided these figures for a shorter time period from 1995 to 2007.

Figure 3: The BDI Growth and Trade Growth of China




*Note*: This figure plots the growth in the BDI and the growth in trade of China. The left vertical axis measures the growth in the BDI and the right vertical axis measures the growth in trade per capita. The growth variables are constructed as the first difference of their respective values in logs.

## 2.2 Health

Our primary measure of health is the mortality rate of children (in 1,000 births) under 5. The child mortality rate is informative about national development and welfare for the following reasons. First, child mortality is typically concentrated in the lowest income quintile (Wagstaff, 2000; Halder and Kabir, 2008), hence, the child mortality rate is reflective of the socio-economic environment faced by low-income groups (Gwatkin, 2004).[17] Second, the child mortality rate is a reasonable indicator of living conditions that are difficult to measure, such as the availability of clean water and sanitation, indoor air quality, prenatal and neonatal health services,

[17]This observation may be true even for countries that experience high economic growth or high levels of GDP per capita, since income may not trickle down from the wealthy, which perhaps explains why a large number of proposed programs for improving child mortality are specifically targeted for the poor (Victora et al., 2003).

caloric intake, exposure to diseases vectors, etc. (UNICEF, 1989; Ravallion, 1997; Victora et al., 2003). Third, the definition of under-5 mortality rate is universal, whereas other indicators of wellbeing such as poverty line and literacy rate could be defined differently across countries and years.

Besides child mortality, we also consider infant mortality rate (in 1,000 births) and life expectancy (at birth) as measures of health in our robustness checks.[18] We expect the infant mortality rate to respond in a similar way to trade as the under-5 mortality rate does. Moreover, if trade affects health in general, it could also affect life expectancy, not just child mortality. It should be noted that life expectancy is correlated with infant and child mortality in that changes in infant and child mortality would also affect the calculation of life expectancy. Therefore, we would expect trade to have an influence on life expectancy if it has an influence on infant and child mortality, even though life expectancy is a more general measure of population health.

Our data on the under-5 mortality rate, infant mortality rate and life expectancy are taken from the World Development Indicators.[19] These data could contain imputed information for missing observations.[20] For example, the infant and under-5 mortality rates in the World Development Indicators are provided by the UN Inter-agency Group for Child Mortality Estimation (IGME),[21] whose objective is to estimate trends in child mortality from which infant and neonatal mortality rates are derived.[22] Consequently, the within-country variation of child mortality may contain

[18] Life expectancy (at birth) indicates the number of years a newborn infant would live if prevailing patterns of mortality at the time of its birth were to stay the same throughout its life.

[19] See `http://data.worldbank.org/news/release-of-world-development-indicators-2014`. Note that information on life expectancy at birth data is not available for Tuvalu.

[20] See `http://data.worldbank.org/about/data-overview/methodologies` for more details.

[21] See `www.childmortality.org`.

[22] An entire issue in PLOS Medicine in 2012 is dedicated on the estimation methods of child mortality by the IGME. See `www.plosmedicine.org/attachments/Child_`

interpolated information that has little to do with trade. In this case, the estimated relationship of trade with child mortality, as well as with other health measures, could be weaker than what it actually is.

## 2.3 Political System

Our main measure of political system is the revised combined Polity score (Polity-2) of the Polity IV data base (Marshall and Jaggers, 2009). The Polity-2 score ranges from -10 to +10. Positive (negative) values of Polity-2 are indicative of democracies (autocracies). A score of 10 reflects the most democratic institution, a score of $-10$ reflects the most autocratic one, and a score of zero indicates a political institution that is neither democratic or autocratic.[23] In the literature, the Polity-2 score has been used to distinguish democracies from autocracies. One example is Arezki and Brückner (2012), who examined whether the effect of international price booms of exported commodities on the reduction of external debt was contingent on whether countries were democratic or autocratic. They identified democratic (autocratic) institutions within countries based on strictly positive (negative) values of the Polity-2 score and ran separate regressions of external debt on international commodity price booms for democracies and autocracies. In this paper, we identify democracies and autocracies in the same way and examine the relationship of trade on health separately for democratic and autocratic LDCs.

Mortality_Estimation_Methods.pdf.

[23]For instance, Polity-2 assigns a score of zero (which Polity IV refers to as neutral) to periods where polities cannot exercise effective authority over at least half of their established territory. The Polity IV project refers to such periods as interregnum periods. See http://www.systemicpeace.org/inscr/p4manualv2013.pdf.

## 2.4 Trade and the Environment

We obtain data on nominal trade, measured in million US dollars, from the UNCTAD website.[24] We then deflate it with the US commodity price index for all urban consumers using 2005 as the base year.[25]

Environment quality is measured by both air and water indicators. Our air quality indicators consist of the emissions of carbon dioxide ($CO_2$), nitrous oxide ($N_2O$) and sulfur dioxide ($SO_2$). The information on $CO_2$ (emissions per capita, in kilograms) and $N_2O$ (emission per capita, in kilograms of $CO_2$ equivalent) are taken from the World Development Indicators.[26] Information on $SO_2$ (emissions per capita, in metric tons) is obtained from the Environmental Performance Index, which is produced by the Yale Center for Environmental Law and Policy.[27] Water quality is measured by renewable internal freshwater resources (per capita, in cubic meters), which is taken from the World Development Indicators.[28]

# 3 Methodology

Our main estimating equation relates the log of a measure of health to the log of trade per capita for country $i$ at year $t$ as:

$$\log(health_{it}) = \beta \log(trade_{it}) + \phi' x_{it} + \delta_r t + \mu_i + \mu_t + v_{it}, \tag{2}$$

[24] See `http://unctadstat.unctad.org/wds/ReportFolders/reportFolders.aspx`.

[25] The data comes from `ftp://ftp.bls.gov/pub/special.requests/cpi/cpiai.txt`.

[26] See `http://data.worldbank.org/news/release-of-world-development-indicators-2014`. Data on $CO_2$ is only available over the period 1995-2010. Data for Tuvalu is completely missing, thus information for 47 LDCs is available. The $N_2O$ data is highly incomplete as it is available for four years 2000, 2005, 2008 and 2010 and for 17 countries.

[27] See `http://epi.yale.edu`, the $SO_2$ data is available over the period 1995-2005 for only 17 LDCs.

[28] See `http://data.worldbank.org/news/release-of-world-development-indicators-2014`. Data is available in 1997, 2002, 2007 and 2010 for 44 LDCs. This information is completely missing for Kiribati, Samoa, Tuvalu, and Vanuatu.

where $x_{it}$ is the set of control variables that we vary in our robustness checks, $\mu_i$ and $\mu_t$ are generic representations of country and year fixed effects, and $\delta_r t$ represents a set of region-specific time trends. In this paper, the under-5 mortality rate is our main measure of health but we also consider the infant mortality rate and life expectancy as alternative measures. Our main objective is to examine if trade causes child mortality, which is summarized by the parameter $\beta$. To explore if institution matters, we estimate Eq. (2) for the set of autocratic and democratic LDCs separately.

The econometric specification in Eq. (2) is not new. By focusing on the relationship between child mortality (or health) and trade in levels, Eq. (2) is similar to models found in Levine and Rothman (2006), Owen and Wu (2007) and Bergh and Nilsson (2010). For example, the Levine and Rothman (2006) model looked at the relationship between the log of the child's welfare (such as child mortality) and a measure of trade openness (trade share of GDP) that was motivated from the gravity model. However, because their model was cross-sectional, fixed effects cannot not be used to deal with omitted variables that are time invariant. The Owen and Wu (2007) model looked at a similar (contemporaneous) relationship within a panel regression framework but did not consider instrumenting for trade openness, which might be endogenous due to reverse causality or measurement errors.[29] Similar to Owen and Wu (2007), Bergh and Nilsson (2010) considered a model that captured the contemporaneous relationship between life expectancy and factors associated with globalization. Hence, the model specification in Eq. (2) is in the spirit of past empirical work in the literature on trade and health.

[29] As a robustness check, Owen and Wu (2007) considered a dynamic panel regression specification for their baseline model. To deal with the issue of endogeneity of the lagged dependent variable, they implemented the GMM technique of Arellano et al. (1991) and employed lagged internal instruments.

## 3.1 Estimation Issues

There are certain challenges in identifying $\beta$. First, trade and health could be jointly influenced by unobserved omitted variables such as geography, culture and disease environments.[30] To partial out such cross-country differences, we include country fixed effects ($\mu_i$) in Eq. (2). We also include year fixed effects ($\mu_t$) to control for macroeconomic shocks that might affect all the LDCs in the same manner. Finally, we include a separate region-specific trend for the LDCs in Africa, Asia and the others parts of the world to hopefully partial out any regional macroeconomic confouders that might be present.[31]

Second, although fixed effects are useful for soaking up information that cannot be easily observed or controlled for, it is not a panacea for the problem of reverse causality, which may exist. For example, because traders might avoid malarial regions, decisions on whether to trade, how much to trade, and with whom, could depend on health outcomes themselves. Moreover, healthy children tend to become more productive adults who might later demand more trade.[32] To address this issue, we employ $Cost_{it}$ (see Eq. (1)), which we call "BDI Cost" hereinafter, as an instrument for LDCs trade:

$$\log(trade_{it}) = \gamma Cost_{it} + \psi' x_{it} + \delta_r t + \mu_i + \mu_t + w_{it}. \tag{3}$$

[30]For example, geography is likely to matter for trade and income. McArthur and Sachs (2001) showed that high prevalence of tropical disease could reduce trade and and harm health; Hall and Jones (1999) argued that income was positively related with the absolute value of latitude; Gallup et al. (1999) showed that in the tropics, income was generally lower and human health was adversely affected by tropical climate; Masters and McMillan (2001) showed that winter frost could restrict economic activity and reduce output.

[31]We include two regional time trends, one for African LDCs and the other for Asian LDCs. Because of year fixed effects, we can only include two regional time trends as the third time trend (for non-African and non-Asian LDCs) will be absorbed by the year fixed effects. Our regressions are also not affected by the trend specification. For instance, we obtain very similar results if the squared of the time trends are included into the regressions.

[32]We have borrowed this insight from Levine and Rothman (2006).

An instrumental variable must be unrelated to the outcome except through its link to the variable for which it is serving as an instrument. Here, we have imposed the exclusionary restriction that bulk shipping cost is unrelated to child mortality (or health in general) except through its effect on how much the LDCs trade. As a caveat, our methodology has limitations in dealing with certain types of confounding factors possibly contained in $v_{it}$ of Eq. (2). For example, when modeling the effect of trade on health, there might be macroeconomic shocks affecting the state of health in each LDC *heterogeneously*. The state of health of the LDCs could also be spatially or cross-sectionally dependent, e.g. the spread of diseases from a country to its neighbors. These unobservables, which contain both cross-sectional and time variation, cannot be purged by country and year fixed effects. Ideally, to take care of this issue, we would like to implement panel regressions with cross-sectional dependence such as the method proposed by Pesaran (2006). However, to do so, we need to have a large number of cross-sectional observations (in this case, a large number of countries), which we do not have as we are focusing only on the sample of LDCs. Therefore, our methodology would yield credible point estimates insofar the cost of bulk shipping, and hence *BDI Cost*, is only at best weakly correlated with any unobserved health factors that have a cross-sectionally dependent structure.

# 4 Results

## 4.1 OLS and IV Estimates – Full Sample

Table 1 reports several OLS estimates of the effect of trade on child mortality. From a simple linear regression, Column (1) shows that a rise in trade is accompanied by a fall in the child mortality rate on average. Although the negative correlation between trade and child mortality rate remains, the magnitude and significance of this result quickly reduce when country and year fixed effects are added (Columns (2) and (3)). When country and year fixed effects and regional time trends are included into the regression, the result evaporates totally (Column (4)). If the inclusion of country and year fixed effects and regional time trends has brought us closer to point identification, the OLS results suggest at first pass that trade is unlikely to be beneficial for reducing child mortality.

Table 1: OLS Regression of Trade on Child Mortality

| | (1) | (2) | (3) | (4) |
|---|---|---|---|---|
| *Dependent Variable:* | log(Child mortality rate) | | | |
| log(Trade per capita) | -0.235*** | -0.169*** | -0.030* | -0.001 |
| | (0.021) | (0.021) | (0.016) | (0.016) |
| Regional trend | no | yes | yes | yes |
| Country fixed effects | no | no | yes | yes |
| Year fixed effects | no | no | no | yes |
| Observations | 856 | 856 | 856 | 856 |
| Countries | 48 | 48 | 48 | 48 |

*Note*: Robust standard errors are reported in the parenthesis. Statistical significance at the 10%, 5% and 1% levels are indicated by *, ** and *** respectively.

Table 2 reports the IV estimates using *BDI Cost* as an instrument for the log of trade per capita. Our first stage regression shows that a one standard deviation increase in *BDI Cost* is associated with a 13.6% decrease in trade per capita on average. *BDI Cost* is a relatively strong instrument, as the Kleibergen-Paap first stage F-statistic of 22.88 exceeds the Stock-Yogo critical value of 8.96 for instrument strength.[33] However, the second stage regression result shows that trade does not have a statistically significant effect of reducing child mortality in the LDCs.

[33]To check if *BDI Cost* might be weak instrument for trade, we consider the Kleibergen and Paap (2006) (KP) F-statistic and evaluate it against a critical value, adopted from Stock and Yogo (2005), that corresponds to the notion that 15% is the maximal rejection rate the researcher is willing to tolerate if the true rejection rate is 5%.[34] If the KP statistic exceeds this critical value, this implies that the maximal rejection rate is smaller than 15%, hence the actual size of the test is between the 5% and 15% levels.

Table 2: IV Regression of Trade on Child Mortality

| | (1) |
|---|---|
| *Second-stage Dependent Variable:* | log(Child mortality rate) |
| log(Trade per capita) | -0.056 |
| | (0.062) |
| *First-stage Dependent Variable:* | log(Trade per capita) |
| BDI Cost | -0.125*** |
| | (0.026) |
| First-stage Kleibergen-Paap F-Stat | 22.88 |
| Stock and Yogo critical value (15%) | 8.96 |
| Regional trend | yes |
| Country FE | yes |
| Year FE | yes |
| Observations | 808 |
| Countries | 48 |

*Note*: BDI Cost is defined in Eq. (1). The Stock-Yogo critical value corresponds to the case where 15% is the maximal rejection rate one is willing to tolerate if the true rejection rate is 5%. Robust standard errors are reported in the parenthesis. Statistical significance at the 10%, 5% and 1% levels are indicated by *, ** and *** respectively.

## 4.2 IV Estimates –Autocracies and Democracies

In this section, we examine the effect of trade on child mortality within two regimes – autocracies and democracies. In Table 3, we report the separate IV regression estimates of Eq. (2) for autocratic LDCs (Column (1)) and democratic LDCs (Column (2)). In Column (1), the first stage F-statistic of 61.82 shows that *BDI Cost* is a powerful instrument for trade with respect to autocratic LDCs. By contrast, *BDI Cost* is not statistically significant for trade in democratic LDCs. This disparity could be due to the fact that trade is considerably less important in democratic LDCs than it is in autocratic LDCs, a surprising phenomenon which has yet to be discussed in the literature. For example, over the sample period, the average trade per capita of democratic LDCs is only about 40% that of autocratic LDCs. Moreover, compared to autocratic LDCs, there is significantly less variation in how much democratic LDCs trade. The coefficient of variation of trade per capita (i.e. the ratio of standard deviation to the mean) is only 1.13 for democratic LDCs. For autocratic LDCs, this coefficient is 3.75. In other words, democratic LDCs trade at much lower and stable levels, which may explain why the influence of *BDI Cost* on trade is weak for these countries.

Table 3: IV Regression of Trade on Child Mortality (Autocracies and Democracies)

| | (1)<br>Autocracy<br>Polity-2<0 | (2)<br>Democracy<br>Polity-2>0 |
|---|---|---|
| *Second-stage Dependent Variable:* | log(Child mortality rate) | |
| log(Trade per capita) | 0.130*** | -2.832 |
| | (0.028) | (10.452) |
| *First-stage Dependent Variable:* | log(Trade per capita) | |
| BDI Cost | -0.357*** | -0.006 |
| | (0.045) | (0.024) |
| First-stage Kleibergen-Paap F-Stat | 61.82 | 0.0630 |
| Stock and Yogo critical value (15%) | 8.96 | 8.96 |
| Regional trend | yes | yes |
| Country FE | yes | yes |
| Year FE | yes | yes |
| Observations | 280 | 402 |
| Countries | 18 | 29 |

*Note*: BDI Cost is defined in Eq. (1). The Stock-Yogo critical value corresponds to the case where 15% is the maximal rejection rate one is willing to tolerate if the true rejection rate is 5%. Robust standard errors are reported in the parenthesis. Statistical significance at the 10%, 5% and 1% levels are indicated by *, ** and *** respectively.

With respect to democratic LDCs, the statistical insignificance of *BDI Cost* in the first stage regression precludes us from drawing conclusions about the relationship between trade and child mortality, an issue we will revisit in Section 4.3. For autocratic LDCs, however, we find that trade may deepen the problem of child mortality, as Table 3 suggests that a 1% increase in trade per capita is associated with a 0.13% increase in the child mortality rate on average. To interpret this result in terms of the actual number of children at risk, we carry out some back-of-the-envelope calculations. For a small autocratic LDC such as Equatorial Guinea, a 1% increase in trade per capita could approximately lead to 17 additional deaths of under-5s. For larger autocracies such as Tanzania and Uganda, the approximate deaths of under-5s resulting from a 1% increase in trade per capita could be as high as 645 and 670 respectively.[35] If we take a conservative perspective by using the two standard deviations lower bound of the 0.13% point estimate, the estimated number of deaths in Tanzania and Uganda would still be 367 and 381 respectively. Considering that the BDI is highly volatile, and that a one standard deviation decrease in the BDI could increase trade per capita by as much as 13.6%, the number of children at risk could be much larger than what is computed here.

Because the importance of primary goods trade differs for each country, the effect of the BDI on trade is heterogeneous across the LDCs. Hence, using the cross-country heterogeneity in primary goods trade, we may estimate the effect that the BDI has on child mortality for each autocratic LDC. To do so, we first estimate the reduced form relationship between child mortality and *BDI Cost*:[36]

$$\log(health_{it}) = \alpha Cost_{it} + \delta_r t + \mu_i + \mu_t + u_{it}. \tag{4}$$

Then based on the estimate of Eq. (4), we construct the absolute time-averaged elasticity of the child mortality rate with respect to the BDI as the absolute value of

$$\frac{1}{T-1}\sum_{t=2}^{T}\hat{\alpha}\theta_{it-1}, \tag{5}$$

where $\hat{\alpha}$ (equals to -0.046) is the estimate of $\alpha$ in Eq. (4) and $\theta_{it-1}$ is period $t-1$

[35]This is computed using 2010 figures for the under-5 population and child mortality rate. For instance, Tanzania's under-5 population and mortality rate are 8,052,680 and 6.16%. Hence, using the elasticity of 0.13, we compute the approximate number of additional deaths as $0.0013 * 0.0616 * 8052680 \approx 645$. The under-5 population data is taken from the United Nations at `http://esa.un.org/wpp/Excel-Data/population.htm`.

[36]Results are available upon request.

primary trade share of country $i$.

Figure 4 plots this absolute average elasticity for a sample of autocratic LDCs.[37] For the LDCs featured in Figure 4, the BDI elasticity of the child mortality rate (in absolute value) is between 0.0039 and 0.0274, suggesting that the child mortality rate would decline by around 0.04% to 0.27% when the BDI increases by 10%. Mauritania's child mortality rate is by far the most sensitive to variations in the BDI. On the other hand, Angola is least affected by the BDI, which makes sense as oil but not primary products is its most important export.[38] Overall, Figure 4 suggests that sharp swings in the BDI are not innocuous – trade booms following large declines in the BDI could significantly increase child mortality in certain autocratic LDCs.

## 4.3 Robustness checks

This section examines the robustness of our baseline instrumental variable estimates. Our first robustness check revisits the issue of whether the relationship between trade and child mortality is contingent on institutional types. While we observe that trade may increase child mortality in autocratic LDCs, we are unable to draw any conclusion for democratic LDCs as *BDI Cost* is statistically insignificant for trade with respect to these countries.

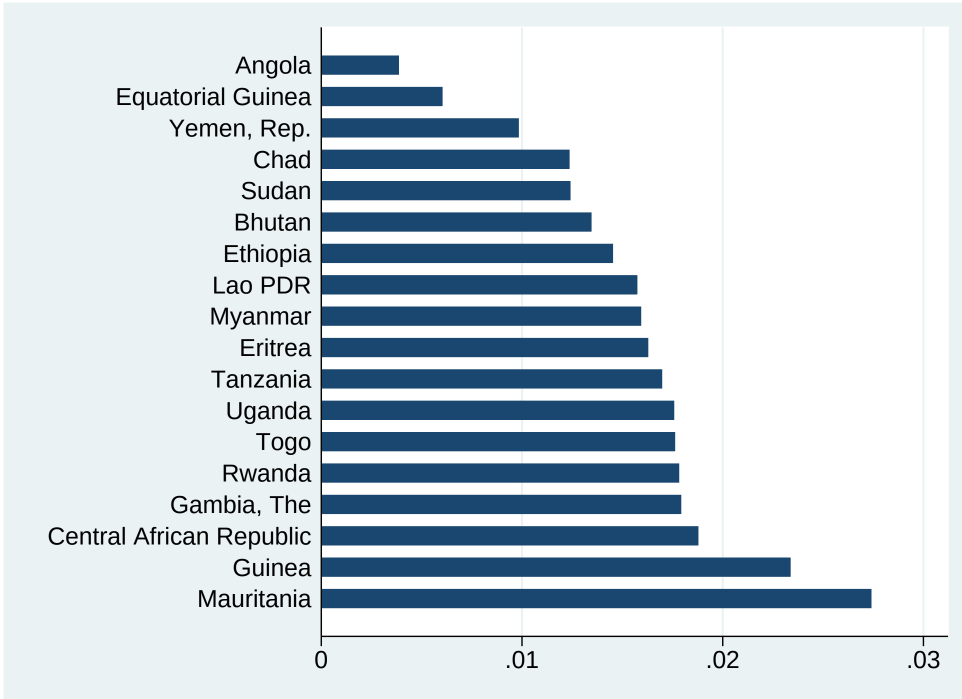
In this exercise, we employ a country-specific commodity price index, proposed by Brückner and Ciccone (2010),[39] as an alternative instrument for trade. Their estimation strategy is based on the idea that international commodity prices are

[37] The autocratic country is chosen based on the principle that they are mainly autocratic (with Polity-2<0 for more than 8 years) during the sample period between 1995 and 2012.

[38] Oil is transported by wet tankers, not by dry ships. Given that Angola is an important oil exporter, this would weaken the effect of the BDI on Angola's trade. Note that Angola, along with Nigeria, are now the top oil exporters in Sub-Saharan Africa. See "Angola rivals Nigeria for top spot in African oil exports", *Reuters*, September 17 2013.

[39] Arezki and Brückner (2012) examined the macroeconomic effects of international commodity price shocks on economic growth using a similar price index.

Figure 4: The (Absolute) Average BDI Elasticity of Child Mortality for a Sample of Autocratic LDCs.




*Note*: This figure plots the absolute value of the (time) average BDI elasticity of child mortality for each LDC that is mainly autocratic, defined as a country with Polity-2<0 for more than 8 years through the sample period 1995-2012. This elasticity is computed based on Eq. (5). It shows the average percentage decline in child mortality rate in each country following a 1% increase in the BDI.

informative about the global demand for commodities.[40] Given that the LDCs are predominantly primary goods producers, the global demand for commodities could influence the demand for the LDCs' exports. In particular, if the exports of certain commodities are more important to an LDC, any variation in the global demand for these commodities (reflected by their international prices) would affect the demand for that country's exports more disproportionately. In this manner, Brückner and Ciccone (2010) argued that international commodity price movements could exert country-specific effects on trade as this specificity depended on how important certain commodity exports are for each LDC.

[40]As an analogy, Kilian and Park (2009) argued that in the context of oil, prices were driven mainly by demand driven shocks than production shocks.

Based on this idea, we construct a country-specific commodity price index to capture the country-specific effect that international commodity prices have on trade:

$$\overline{ComPI}_{it}^{C} = \sum_{c} \theta_{ic} \log(ComPrice_{ct}), \qquad (6)$$

where $\log(ComPrice_{ct})$ is the international price of commodity $c$ in year $t$ (in logs), and $\theta_{ic}$ is the average (time invariant) value of exports of commodity $c$ over the GDP of country $i$. We obtain data on annual international commodity prices for the 1995–2010 period as well as data on the value of commodity exports from UNCTAD Commodity Statistics (UNCTAD, 2011).[41] The commodities included in our index are aluminum, bananas, beef, cocoa, coffee, copper, cotton, gold, iron, maize, lead, oil, pepper, rice, rubber, sugar, tea, tobacco, wheat, wood, and zinc. Whenever multiple prices are listed for the same commodity, we use the simple average of these prices as the price of that commodity in our computation.

Table 4 reports the instrumental variable estimates for autocracies (Column (1)) and democracies (Column (2)) using $\overline{ComPI_{it}}^{C}$ as an instrument of trade. We find that $\overline{ComPI_{it}}^{C}$ is statistically significant instrument for trade in both regimes. Based on this result, we find that trade may increase child mortality for autocracies just as before, but for democracies, the link between trade and child mortality is statistically insignificant. Therefore, these results are consistent with our baseline regressions that trade is not beneficial for reducing child mortality and could even exacerbate it in autocratic LDCs.

Focusing on autocratic LDCs for the rest of the paper, our second robustness check considers two alternative measures of health: the infant mortality rate and life expectancy at birth. If trade is harmful to health, it may also lead to higher rates of infant mortality and shorten life expectancy. Our regressions, reported in Table 5, provide some evidence that this is true. For example, Column (1) shows that

[41]See `http://www.unctad.org/Templates/Page.asp?intItemID=1584&lang=1`.

Table 4: Robustness Check 1: Using Commodity Price Index as Instrument for Trade

| | (1)<br>Autocracy<br>Polity-2<0 | (2)<br>Democracy<br>Polity-2>0 |
|---|---|---|
| *Second-stage Dependent Variable:* | log(Child mortality rate) | |
| log(Trade per capita) | 0.907** | -0.213 |
| | (0.413) | (0.180) |
| *First-stage Dependent Variable:* | log(Trade per capita) | |
| Commodity Price Index ($\overline{ComPI}_{it}^{C}$) | 0.942** | 1.005** |
| | (0.374) | (0.430) |
| First-stage Kleibergen-Paap F-Stat | 6.344 | 5.457 |
| Stock and Yogo critical value (15%) | 8.96 | 8.96 |
| Regional trend | yes | yes |
| Country FE | yes | yes |
| Year FE | yes | yes |
| Observations | 201 | 338 |
| Countries | 14 | 25 |

*Note*: Commodity Price Index ($\overline{ComPI}_{it}^{C}$) is defined in Eq. (6). The Stock-Yogo critical value corresponds to the case where 15% is the maximal rejection rate one is willing to tolerate if the true rejection rate is 5%. Robust standard errors are reported in the parenthesis. Statistical significance at the 10%, 5% and 1% levels are indicated by *, ** and *** respectively.

a 1% increase in trade per capita has a statistically significant effect of raising the infant mortality rate by about 0.1% on average, which is similar to the estimate of 0.13% when the under-5 mortality rate is used as a measure of health (see Table 3). Furthermore, Column (2) shows that trade can shorten life expectancy, where a 1% increase in trade per capita is associated with a decline in life expectancy by around 0.03% on average.

Our third robustness check examines the sensitivity of the baseline estimated effect of trade (i.e. 0.13) by varying the set of control variables that might be relevant to child mortality. For this sensitivity exercise, we consider the following control variables – GDP per capita, foreign aid, FDI, population density, urbanization rate,

Table 5: Robustness Check 2: Trade, Infant Mortality and Life Expectancy (Autocracies Only)

| | (1) | (2) |
|---|---|---|
| *Second-stage Dependent Variable:* | log(Infant mortality rate) | log(Life expectancy) |
| log(Trade per capita) | 0.090*** | -0.024** |
| | (0.026) | (0.010) |
| *First-stage Dependent Variable:* | log(Trade per capita) | |
| BDI Cost | -0.357*** | -0.357*** |
| | (0.045) | (0.045) |
| First-stage Kleibergen-Paap F-Stat | 61.82 | 61.82 |
| Stock and Yogo critical value (15%) | 8.96 | 8.96 |
| Regional trend | yes | yes |
| Country FE | yes | yes |
| Year FE | yes | yes |
| Observations | 280 | 280 |
| Countries | 18 | 18 |

*Note*: BDI Cost is defined in Eq. (1). The Stock-Yogo critical value corresponds to the case where 15% is the maximal rejection rate one is willing to tolerate if the true rejection rate is 5%. Robust standard errors are reported in the parenthesis. Statistical significance at the 10%, 5% and 1% levels are indicated by *, ** and *** respectively.

and the prevalence rate of HIV. As discussed in Lin and Sim (2013), trade could affect income, which may reduce child mortality. By holding income fixed, we may then examine purely the effect that trade has on child mortality by shutting down any indirect effect that could come from a rise in income (as a result of trade) (see, also, Owen and Wu, 2007). Besides income, foreign aid and FDI are found to have positive effects on development (Nair-Reichert and Weinhold, 2001; Werker and Ahmed, 2009) and therefore might affect child mortality. In addition, public health can be affected by population density (Root, 1997) and urbanization (Cutler et al., 2006).[42] For example, better access to medical facilities in urbanized areas may reduce child mortality (Leon, 2008; Poel et al., 2007), although overcrowding in

[42]Focusing on Zimbabwe, Root (1997) argued that the transmission of diseases and infections was quicker in high density areas, and found that the child mortality rate was much lower in lower density regions in Zimbabwe.

urban areas may facilitate the transmission of diseases and infections (Cutler et al., 2006; Fay et al., 2005). Finally, the prevalence of HIV can affect child mortality directly as a child may die from the disease, or indirectly if the mother dies (Zaba et al., 2005).

The data sources and the variable definitions for GDP per capita inward FDI flows, foreign aid, population density, urbanization rate, and HIV prevalence rate are provided in Table A2 of the Appendix A. For GDP per capita, inward FDI and foreign aid, we apply the appropriate deflator to obtain real values in million US dollars, then apply log transformation. Here, we use the first lag of the additional variables as controls.[43]

Columns (1)-(6) of Table 6 show that the estimated effect of trade on child mortality is generally robust despite the inclusion of these additional control variables. In Column (1), we find that after controlling for GDP per capita, an increase in trade has a more severe effect in raising the child mortality rate (with an elasticity of 0.273) than what is found in the baseline regression (with an elasticity of 0.13). This may not be surprising as trade may increase income, and this rise in income may mitigate the negative direct effect that trade is found to have on child mortality. From Columns (2)-(6), when the log of foreign aid, log of FDI, or HIV prevalence rate are added separately, the elasticity of the child mortality rate with respect to trade remains close the baseline estimate of 0.13 (see Column (2) of Table 3). The estimated trade elasticity becomes weaker when population density or urbanization rate is controlled for, although this estimate remains statistically significant at the 1% level. Overall, the inclusion of these control variables does not drive away the effect that trade can increase the child mortality rate.

[43]The results are similar when contemporaneous values of these variables are used instead.

Table 6: Robustness Check 3: Additional Control Variables (Autocracies Only)

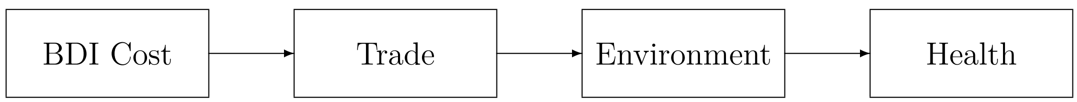
| | (1)<br>GDP per capita | (2)<br>Foreign aid | (3)<br>FDI | (4)<br>Population density | (5)<br>Urbanization rate | (6)<br>HIV | (7)<br>All |
|---|---|---|---|---|---|---|---|
| *Second-stage Dependent Variable:* | log(Child mortality rate) | | | | | | |
| log(Trade per capita) | 0.237*** | 0.138*** | 0.131*** | 0.075*** | 0.095*** | 0.133*** | 0.258*** |
| | (0.065) | (0.031) | (0.033) | (0.023) | (0.029) | (0.039) | (0.087) |
| Additional Control | -0.210*** | -0.022 | -0.013* | -0.004*** | -0.010 | 0.122*** | (omitted) |
| | (0.078) | (0.016) | (0.007) | (0.001) | (0.006) | (0.027) | |
| *First-stage Dependent Variable:* | log(Trade per capita) | | | | | | |
| BDI Cost | -0.198*** | -0.362*** | -0.360*** | -0.347*** | -0.363*** | -0.367*** | -0.183*** |
| | (0.035) | (0.048) | (0.050) | (0.045) | (0.051) | (0.051) | (0.047) |
| Additional Control | 0.867*** | -0.038 | 0.030 | -0.002 | 0.005 | 0.247*** | (omitted) |
| | (0.064) | (0.049) | (0.027) | (0.001) | (0.018) | (0.082) | |
| First-stage Kleibergen-Paap F-Stat | 31.83 | 56.75 | 52.04 | 58.70 | 51.10 | 51.35 | 15.35 |
| Stock and Yogo critical value (15%) | 8.96 | 8.96 | 8.96 | 8.96 | 8.96 | 8.96 | 8.96 |
| Regional trend | yes | yes | yes | yes | yes | yes | yes |
| Country FE | yes | yes | yes | yes | yes | yes | yes |
| Year FE | yes | yes | yes | yes | yes | yes | yes |
| Observations | 280 | 280 | 256 | 280 | 280 | 253 | 229 |
| Countries | 18 | 18 | 18 | 18 | 18 | 16 | 16 |

*Note*: BDI Cost is defined in (1). The Stock-Yogo critical value corresponds to the case where 15% is the maximal rejection rate one is willing to tolerate if the true rejection rate is 5%. Robust standard errors are reported in the parenthesis. Statistical significance at the 10%, 5% and 1% levels are indicated by *, ** and *** respectively.

# 5 The Environmental Channel

At this point, we have yet to explore how an increase in trade can result in higher child mortality rates as was found for autocratic LDCs. Here, we investigate if environmental quality is a possible channel for this effect. If trade causes environmental quality to deteriorate and poor environmental quality is detrimental to health, then trade can affect child mortality through the environment. Schematically, the causal structure we hope to explore is summarized by Figure 5.

Figure 5: The Proposed Causal Chain of Trade, Environment and Health




Trade may affect the environment for several reasons. For instance, environmental regulations in autocratic countries tend to be less stringent (Congleton, 1992), hence, economic activities such as trade could lead to more pollution. Another possible explanation is the pollution haven hypothesis (see, for example, Frankel and Rose, 2005), which posits that large industrialized nations seeking to set up factories abroad are likely to look for countries that are less environmentally stringent. Given that environmental regulations are usually less demanding in developing countries, the LDCs will tend to attract the inflow of polluting activities and become pollution havens for industrialized countries.[44] In fact, the "pollution haven effect" may be more pronounced in autocratic countries as regulatory standards in these countries tend to be lower and more weakly enforced (Cao and Prakash, 2012).

[44]For example, higher pollution regulations in advanced countries render production of pollution intensive goods more costly in domestic markets. Therefore, "dirty" productions are likely to migrate from developed to developing countries (Cole, 2004) where pollution regulations are usually less stringent (Dinda, 2004). To attract more trade flows, industrializing countries may create a downward environment standard by lowering the price of pollution intensive goods (Porter, 1999). Consequently, pollution intensive productions concentrate on less developed countries (i.e. the LDCs) so that their environment bears a higher risk of pollution.

## 5.1 The Effect of Trade on the Environment

We first explore the effect that trade might have on the environment in autocratic LDCs. To measure environmental quality, we consider four indicators of pollution – the levels of sulfur dioxide ($SO_2$), carbon dioxide ($CO_2$), nitrous oxide ($N_2O$), and access to clean, renewable freshwater (see Table A2 for definitions).[45] Table 7 reports the relationship between trade and these pollution indicators. Other than the statistically insignificant relationship between trade and clean water (Column (4)), we find that trade has a negative effect on environmental quality, where Columns (1)-(3) show that a 1% increase in trade per capita is associated with an increase in $SO_2$, $CO_2$ and $N_2O$ emissions by 0.81%, 0.80% and 0.66% on average.

## 5.2 The Effect of the Environment on Health

Next, we examine if environmental quality – in particular, pollution – causes health. To do so, we first obtain what we hope are plausibly exogenous variations in pollution by estimating a reduced form relationship between pollution and *BDI Cost*. Then, we use this pollution variation to estimate the effect that it might have on health. We focus on the levels of $SO_2$ and $CO_2$ emissions as measures of pollution and consider all three health indicators – under-5 mortality, infant mortality, and life expectancy.

[45]These variables have been used as indicators of environmental quality in the literature. For example, Frankel and Rose (2005) consider $SO_2$, $CO_2$ , $N_2O$ emissions and clean water access as indicators of environmental quality, while Managi et al. (2009) look at the level of $SO_2$ and $CO_2$ emissions.

Table 7: Trade and Pollution (Autocracies Only)

| | (1) | (2) | (3) | (4) |
|---|---|---|---|---|
| *Second-stage Dependent Variable:* | log($SO_2$) | log($CO_2$) | log($N_2O$) | log(Water) |
| log(Trade per capita) | 0.811*** | 0.799*** | 0.660* | 0.022 |
| | (0.111) | (0.129) | (0.373) | (0.026) |
| *First-stage Dependent Variable:* | | | | |
| BDI Cost | -0.348*** | -0.395*** | -0.465*** | -0.397*** |
| | (0.048) | (0.045) | (0.130) | (0.078) |
| First-stage Kleibergen-Paap F-Stat | 53.65 | 77.17 | 12.75 | 26.11 |
| Stock and Yogo critical value (15%) | 8.96 | 8.96 | 8.96 | 8.96 |
| Regional trend | yes | yes | yes | yes |
| Country FE | yes | yes | yes | yes |
| Year FE | yes | yes | yes | yes |
| Observations | 70 | 249 | 65 | 31 |
| Countries | 7 | 18 | 18 | 8 |

*Note*: BDI Cost is defined in Eq. (1). The Stock-Yogo critical value corresponds to the case where 15% is the maximal rejection rate one is willing to tolerate if the true rejection rate is 5%. Robust standard errors are reported in the parenthesis. Statistical significance at the 10%, 5% and 1% levels are indicated by *, ** and *** respectively.

Table 8 reports the estimated effect of pollution on health in autocratic LDCs. The first stage regression shows that *BDI Cost* has a negative effect on both $SO_2$ and $CO_2$ emissions, where a one standard deviation increase in *BDI Cost* is associated with a reduction in $SO_2$ and $CO_2$ emissions of about 30% and 34% on average. The second stage regression suggests that pollution can affect health. For example, Table 8 shows a 1% increase in $SO_2$ ($CO_2$) is associated with a 0.10% (0.14%) increase in the under-5 mortality rate and 0.08% (0.10%) increase in the infant mortality rate (Columns (1)-(2) and (4)-(5)). Furthermore, Columns (3) and (6) show that a 1% increase in $SO_2$ or $CO_2$ is associated with a 0.03% decline in life expectancy. To be clear, these results are not sufficient for us to conclude that $SO_2$ and $CO_2$ emissions *per se* are the cause of these poorer health outcomes. Nonetheless, given that $SO_2$ and $CO_2$ emissions are correlated with the overall levels of pollution, we may reasonably infer that pollution (generated by trade) can cause child mortality to rise and public health to deteriorate.[46]

In sum, for autocratic LDCs, we have shown that trade may generate more pollution (Section 5.1) and pollution may increase child mortality and decrease life expectancy (Section 5.2). This suggests that environmental quality is a possible channel through which trade affects health.

[46]This result is consistent with the German-based panel study by Cole (2012) who found that certain air pollutants could cause infants to have lower birth weights and toddlers to develop respiratory problems.

Table 8: Pollution, Child Mortality, Infant Mortality and Life Expectancy (Autocracies Only)

| | (1) | (2) | (3) | (4) | (5) | (6) |
|---|---|---|---|---|---|---|
| *Second-stage Dependent Variable:* | log(CMR) | log(IMR) | log(LE) | log(CMR) | log(IMR) | log(LE) |
| log($SO_2$) in I-III, or | 0.100*** | 0.084*** | -0.028*** | 0.137*** | 0.098*** | -0.028** |
| log($CO_2$) in IV-VI | (0.032) | (0.027) | (0.006) | (0.038) | (0.032) | (0.011) |
| *First-stage Dependent Variable:* | | log($SO_2$) | | | log($CO_2$) | |
| BDI Cost | -0.282*** | -0.282*** | -0.282*** | -0.316*** | -0.316*** | -0.316*** |
| | (0.035) | (0.035) | (0.035) | (0.066) | (0.066) | (0.066) |
| First-stage Kleibergen-Paap F-Stat | 64.14 | 64.14 | 64.14 | 22.60 | 22.60 | 22.60 |
| Stock and Yogo critical value (15%) | 8.96 | 8.96 | 8.96 | 8.96 | 8.96 | 8.96 |
| Regional trend | yes | yes | yes | yes | yes | yes |
| Country FE | yes | yes | yes | yes | yes | yes |
| Year FE | yes | yes | yes | yes | yes | yes |
| Observations | 70 | 70 | 70 | 249 | 249 | 249 |
| Countries | 7 | 7 | 7 | 18 | 18 | 18 |

*Note*: BDI Cost is defined in Eq. (1). The Stock-Yogo critical value corresponds to the case where 15% is the maximal rejection rate one is willing to tolerate if the true rejection rate is 5%. Robust standard errors are reported in the parenthesis. Statistical significance at the 10%, 5% and 1% levels are indicated by *, ** and *** respectively.

# 6 Conclusion

The positive effect that trade has on income levels, hence, on alleviating poverty and improving living standards (Frankel and Romer, 1999), is one of the most important empirical observations concerning international trade. However, in developing countries, trade could be a double-edged sword as it may also harm the environment, resulting in poorer health outcomes. In this paper, we explore if there is a causal link between trade and child mortality in the LDCs. For countries that are autocratic, we find that trade expansions may lead to poorer environmental quality and thus exacerbate the problem of child mortality. Therefore, even though the LDCs are somewhat insular and trade may foster economic development on the whole, the increase in trade may not always be beneficial especially when it comes to combating child mortality – a UN Millennium Development Goal.

Our paper focuses on environmental quality as one possible channel for the effect of trade on health in general. However, other channels could exist as well. For example, trade may increase the amount of contact among people, causing diseases to be transmitted more easily. It may also generate opportunities for individuals in trade-related work to engage in risky activities, the leading example of which is documented in Oster (2012), where an increase in exports was found to increase trucking, a profession that had high prevalence of HIV infections. Therefore, although we have focused on pollution as one possible channel linking trade with health, there could be other channels which themselves are interesting to explore for future research as well.

# References

Acemoglu, D., Robinson, J., Verdier, T. (2004) "Kleptocracy and Divide-and-Rule: A Model of Personal Rule," *Journal of the European Economic Association*, 2(2-3), 162–

192.

Anand, P. (2013) "Climate Change and Water: Impacts to Human Health and Consumption," *Asia-Pacific Human Development Report Background Papers Series 2012/15*, UNDP.

Antweiler, W., Copeland, B., Taylor, M. (2001) "Is Free Trade Good for the Environment?" *American Economic Review*, 91(4), 877–908.

Arellano, M., , Bond, S. (1991) "Some Tests of Specification for Panel data: Monte Carlo evidence and an application to Employment equations," *Review of Economic Studies*, 58, 277–297.

Arezki, R., Brückner, M. (2012) "Commodity Windfalls, Democracy, and External Debt," *Economic Journal*, 122, 848–866.

Bergh, A., Nilsson, T. (2010) "Good for Living? On the Relationship between Globalization and Life Expectancy," *World Development*, 38(9), 1191–1203.

Besley, T., Kudamatsu, M. (2008) "Good for Living? On the Relationship between Globalization and Life Expectancy," in E. Helpman ed. *Institutions and Economic Performance*, Cambridge: Harvard University Press.

Bornozis, N. (2006) *Dry Bulk Shipping: The Engine of Global Trade*: Barron's, Oct. 30, 2006.

Brückner, M., Ciccone, A. (2010) "International Commodity Prices, Growth and the Outbreak of Civil War in Sub-Saharan Africa," *Economic Journal*, 120, 519–534.

Cao, X., Prakash, A. (2006) "Health and Wellbeing in Udaipur and South Africa," in D. Wise ed. *Developments in the Economics of Aging*, Chicago: University of Chicago Press for NBER (2009).

——— (2012) "Trade Competition and Environmental Regulations: Domestic Political Constraints and Issue Visibility," *Journal of Politics*, 74(1), 66–82.

Cole, M. (2004) "Trade, the Pollution Haven Hypothesis and the Environmental Kuznets Curve: Examining the Linkages," *Ecological Economics*, 48(1), 71–81.

——— (2012) "Pollution Exposure and Child Health: Evidence for Infants and Toddlers in Germany," *Journal of Health Economics*, 31(1), 180–196.

Congleton, R. (1992) "Political Institutions and Pollution Control," *Review of Economics and Statistics*, 74, 412–421.

Currie, J. (2013) "Pollution and Infant Health," *Child Development Perspectives*, 7(4), 237–242.

Cutler, D., Deaton, A., Lleras-Muney, A. (2006) "The Determinants of Mortality," *Journal of Economic Perspectives*, 20(3), 97–120.

Dinda, S. (2004) "Environmental Kuznets Curve Hypothesis: A Survey," *Ecological Economics*, 49(4), 431–455.

Dollar, D. (2001) "Is Globalization Good for Your Health?" *Bulletin of the World Health Organization*, 79(9), 827–833.

Fay, M., Leipziger, D., Wodon, Q., Yepes, T. (2005) "Achieving Child-Health-Related Millennium Development Goals: The Role of Infrastructure," *World Development*, 33(8), 1267–1284.

Feyrer, J. (2009a) "Trade and Income-Exploiting Time Series in Geography," *NBER Working Paper no. 14910.*

——— (2009b) "Distance, Trade and Income-The 1967 to 1975 closing of the Suez Canal as a Natural Experiment," *NBER Working Paper no. 15557.*

Frankel, J., Romer, D. (1999) "Does Trade cause Growth," *American Economic Review*, 89(3), 379–399.

Frankel, J., Rose, A. (2005) "Is Trade Good or Bad for the Environment? Sorting Out the Causality," *Review of Economics and Statistics*, 87(1), 85–91.

Franklin, M., Zeka, A., Schwartz, J. (2007) "Association Between PM2.5 and All-Cause and Specific-Cause Mortality in 27 US communities," *Journal of Exposure Science and Environmental Epidemiology*, 17(3), 279–287.

Gallup, J., Sachs, J., Mellinger, A. (1999) "Geography and Economic Growth," *International Regional Science Review*, 22(2), 179–232.

Gwatkin, D. (2004) "Are Free Government Services the Best Way to Reach the Poor?", Washington, DC: World Bank.

Halder, A., Kabir, M. (2008) "Child Mortality Inequalities and Linkage with Sanitation Facilities in Bangladesh," *Journal of Health Population and Nutrition*, 26, 64–73.

Hall, R., Jones, C. (1999) "Why Do Some Countries Produce So Much More Output Per Capita than Others?" *Quarterly Journal of Economics*, 114(1), 83–116.

Kellenberg, D. (2009) "An Empirical Investigation of the Pollution Haven Effect with Strategic Environment and Trade Policy," *Journal of International Economics*, 78, 242–255.

Kilian, L., Park, C. (2009) "The Impact of Oil Price Shocks on the U.S. Stock Market," *International Economic Review*, 50(4), 12671287.

Kleibergen, F., Paap, R. (2006) "Generalized Reduced Rank Tests using the Singular Value Decomposition," *Journal of Econometrics*, 133(1), 97–126.

Leon, D. (2008) "Cities, Urbanization and Health," *International Journal of Epidemiology*, 38, 4–8.

Levine, D., Rothman, D. (2006) "Does Trade Affect Child Health?" *Journal of Health Economics*, 25(3), 538–554.

Lin, F., Sim, N. (2013) "Trade, Income and the Baltic Dry Index," *European Economic Review*, 59, 1–18.

——— (2015) "Exports, HIV incidence and the Baltic Dry Index: Further evidence from sub-Saharan Africa," *Economics Letters*, 126, 35–39.

Managi, S., Hibiki, A., Tsurumi, T. (2009) "Does Trade Openness Improve Environmental Quality?" *Journal of Environmental Economics and Management*, 58, 346–363.

Marshall, M., Jaggers, K. (2009) *Polity IV project: Dataset users' manual*, Center for global policy, George Mason University.

Masters, W., McMillan, M. (2001) "Climate and Scale in Economic Growth," *Journal of Economic Growth*, 6(3), 167–186.

McArthur, J., Sachs, J. (2001) "Institutions and Geography: Comment on Acemoglu, Johnson, and Robinson (2000)," *NBER Working Paper, 8114*.

Padró-i Miquel, G. (2007) "The Control of Politicians in Divided Societies: The Politics of Fear," *Review of Economic Studies*, 74(4), 1259–1274.

Nair-Reichert, U., Weinhold, D. (2001) "Causality Test for Cross-Country Panels: A New Look at FDI and Economic Growth in Developing Countries," *Oxford Bulletin of Economics and Statistics*, 63(2), 153–171.

Oster, E. (2012) "Routes of Infection: Exports and HIV Incidence in Sub-Saharan Africa," *Journal of the European Economic Association*, 10(5), 1025–1058.

Owen, A., Wu, S. (2007) "Is Trade Good for your Health," *Review of International Economics*, 15(4), 660–682.

Pesaran, M. (2006) "Estimation and Inference in Large Heterogeneous Panels with a Multifactor Error Structure," *Econometrica*, 74(4), 967–1012.

Van de Poel, E., O'Donnell, O., Van Doorslaer, E. (2007) "Are Urban Children Really Healthier? Evidence from 47 developing countries," *Social Science and Medicine*, 65(10), 1986–2003.

Porter, G. (1999) "Trade Competition and Pollution Standards: "Race to the Bottom" or "Stuck at the Bottom"?" *Journal of Environment and Development*, 8(2), 133–151.

Ravallion, M. (1997) "Famines and Economics," *Journal of Economic Literature*, 35(3), 1205–1242.

Root, G. (1997) "Population Density and Spatial Differentials in Child Mortality in Zimbabwe," *Social Science and Medicine*, 44(3), 413–421.

Ross, M. (2006) "Is Democracy Good for the Poor?" *American Journal of Political Science*, 50(4), 860–874.

Ruhm, C. (2007) "Healthy Economy Can Break Your Heart," *Demography*, 44(4), 829–848.

Stock, J., Wright, J., Yogo, M. (2002) "A Survey of Weak Instruments and Weak Identification in Generalized Method of Moments," *Journal of Business and Economic Statistics*, 20, 518–529.

Stock, J., Yogo, M. (2005) "Testing for Weak Instruments in Linear IV Regression," in D. Andrews, J. Stock eds. *Identification and Inference for Econometric Models: Essays in Honor of Thomas and Rothenberg*, Cambridge: Cambridge University Press.

UNICEF (1989) "Improving Child Survival and Nutrition," The Joint WHO/UNICEF Nutrition Support Programme in Iringa, Tanzania.

Victora, C., Wagstaff, A., Schellenberg, J., Gwatkin, D., Claeson, M., Habicht, J. (2003) "Applying an Equity Lens to Child Health and Mortality: More of the Same is Not Enough," *The Lancet*, 362, 233–241.

Wagstaff, A. (2000) "Child Mortality Inequalities and Linkage with Sanitation Facilities in Bangladesh," *Bulletin of the World Health Organization*, 78(1), 19–29.

Werker, E., Ahmed, C., F.Z.and Cohen (2009) "How is Foreign Aid Spent? Evidence from a Natural Experiment," *American Economic Journal: Macroeconomics*, 1(2), 225–244.

Zaba, B., Whitworth, J., Marston, M., Nakiyingi, J., Ruberantwari, A., Urassa, M., Issingo, R., Mwaluko, G., Floyd, S., Nyondo, A., Crampin, A. (2005) "HIV and Mortality of Mothers and Children: Evidence from Cohort Studies in Uganda, Tanzania and Malawi," *Epidemiology*, 16(3), 275–280.

Zhang, J. (2012) "The Impact of Water Quality on Health: Evidence from the Drinking Water Infrastructure Program in Rural China," *Journal of Health Economics*, 31(1), 122–134.

# Appendix A

Table A1: Summary Statistics

| Variable | Obs | Mean | Std. Dev. | Min | Max |
|---|---|---|---|---|---|
| BDI Cost | 808 | 2.680 | 1.091 | 0.156 | 5.862 |
| Child mortality rate under-5 | 864 | 114.6 | 51.59 | 17.80 | 278.9 |
| Infant mortality rate | 864 | 74.08 | 27.67 | 15.30 | 153.1 |
| Life expectancy | 846 | 56.08 | 7.471 | 31.24 | 72.98 |
| log(BDI) | 864 | 7.632 | 0.618 | 6.824 | 8.865 |
| log(Child mortality rate) (log(CMR)) | 864 | 4.616 | 0.547 | 2.879 | 5.631 |
| log($CO_2$) | 729 | -1.751 | 1.067 | -6.358 | 2.359 |
| log(Infant mortality rate) (log(IMR)) | 864 | 4.219 | 0.450 | 2.728 | 5.031 |
| log(Life expectancy) (log(LE)) | 846 | 4.018 | 0.137 | 3.442 | 4.290 |
| log($N_2O$) | 68 | 5.937 | 0.794 | 4.527 | 7.676 |
| log($SO_2$) | 187 | -6.642 | 1.221 | -8.147 | -2.879 |
| log(Trade) | 856 | 6.994 | 1.718 | 1.158 | 11.65 |
| log(Trade per capita) | 856 | -1.477 | 1.184 | -4.010 | 3.599 |
| log(Water) | 176 | 8.245 | 1.719 | 4.501 | 11.95 |
| Polity2 | 753 | 0.641 | 4.981 | -10 | 9 |
| Primary products share of total trade | 856 | 0.351 | 0.142 | 0.0217 | 0.841 |

Table A2: List of Variables, Definitions and Sources

| Variables | Definition | Source |
|---|---|---|
| BDI | General indicator of shipment rates for dry bulk cargoes | The Baltic Exchange |
| $CO_2$ | Carbon dioxide emissions per capita, in kilograms | WDI |
| Child mortality rate | The probability per 1,000 that a newborn baby will die before reaching age five | WDI |
| Commodity Price Index | US CPI for all urban consumers, 2005 as the base year | US Bureau of Labor Statistics |
| FDI | Inward foreign direct investment (million US dollars) | UNCTAD |
| Foreign aid | Net official development aid (million US dollars) | WDI |
| GDP | Gross domestic product | WDI |
| HIV prevalence rate | % of 15-49 year olds infected by HIV | WDI |
| Infant mortality rate | The number of infants dying before reaching one year of age, per 1,000 live births | WDI |
| Life expectancy (at birth) | The number of years a newborn infant would live if prevailing patterns of mortality at the time of its birth were to stay the same throughout its life | WDI |
| $N_2O$ | Nitrous oxide emissions, thousand metric tons of $CO_2$ equivalent | WDI |
| Polity-2 | Ranging from -10 to +10, higher value, more democratic | Polity IV data |
| Population density | Midyear population divided by land area in square kilometers | WDI |
| $SO_2$ | Sulfur dioxide emissions per capita, in metric tons | EPI |
| Trade | Million US dollars trade levels (Nominal) | UNCTAD |
| Water | Renewable internal freshwater resources per capita (cubic meters) | WDI |
| Urbanization rate | Urban population (% of total) | WDI |
| Under-5 population | Population under the age of 5 | UN |

# Chapter 3

# Trade Cost and Economic Development: Evidence from Landlocked Developing Countries

by

Ngoc T.A. Pham    Nicholas C.S. Sim

*School of Economics, University of Adelaide*

# Statement of Authorship

| | |
|---|---|
| Title of Paper | **Trade Cost and Economic Development: Evidence from Landlocked Developing Countries** |
| Publication Status | ☐ Published ☐ Accepted for Publication ☐ Submitted for Publication ☑ Unpublished and Unsubmitted w ork w ritten in manuscript style |
| Publication Details | This paper is written in Publication Style for submission to a journal. |

## Principal Author

| | | | |
|---|---|---|---|
| Name of Principal Author (Candidate) | Ngoc T.A. Pham | | |
| Contribution to the Paper | Contributed to the planning of the article and the methodology, undertook literature review, collected and constructed data, performed analysis, interpreted the results, wrote parts of the manuscript. | | |
| Overall percentage (%) | 80% | | |
| Certification: | This paper reports on original research I conducted during the period of my Higher Degree by Research candidature and is not subject to any obligations or contractual agreements with a third party that would constrain its inclusion in this thesis. I am the primary author of this paper. | | |
| Signature | | Date | 2016. 1. 15 |

## Co-Author Contributions

By signing the Statement of Authorship, each author certifies that:

the candidate's stated contribution to the publication is accurate (as detailed above);

permission is granted for the candidate in include the publication in the thesis; and

the sum of all co-author contributions is equal to 100% less the candidate's stated contribution.

| | | | |
|---|---|---|---|
| Name of Co-Author | Nicholas C.S. Sim | | |
| Contribution to the Paper | Contributed to the planning of the article, supervised in development of the work, helped in interpretation of the results, wrote parts of the manuscript. | | |
| Signature | | Date | 21/01/2016 |

## Abstract

Poor geography, such as landlockedness, is an important reason for why certain countries face persistently high trade cost. In this article, we study the effect that trade cost might have on landlocked developing countries (LLDCs). The LLDCs, which are among the world's poorest, face extremely high trade cost due to their landlocked geography. In order for trade to proceed, goods have to be transported to and from the LLDCs over long distances on land, which often requires the use of container freight. Containerizable trade is an important component of total trade for many LLDCs. As such, we construct our measure of trade cost for the LLDCs, called *Harpex Cost*, using information on container shipping cost summarized by the *Harpex* index of Harper Petersen & Co, and interacting it with each country's containerizable trade share. The containerizable trade share of a country reflects its intensity of containerizable shipping utilization. By interacting the containerizable trade share with the Harpex index, it will then amplify the influence of container shipping cost for the LLDCs that are more involved in containerizable trade. To estimate the effect of trade cost, we employ a recent advancement in panel data estimation – the interactive fixed effect – that has the ability to deal with a large class of unobserved confounding information. The reduction in trade cost can substantially benefit the LLDCs, as we find that a one standard deviation reduction in *Harpex Cost* is associated with a 20% increase in GDP per capita, a 29% increase in satellite night lights per capita, a 4 year increase in life expectancy, and a reduction of 9 infant and 5 under-5 deaths per 1,000 on average. Using *Harpex Cost* as an instrument for trade, we also find that a 1% increase in trade per capita is associated with a 1% increase in GDP per capita. This estimate is about five times the estimates for the world, suggesting that trade can be powerful force for advancing the LLDCs.

**Key Words**: Economic Development · International Trade · Cross-section Dependence · Panel Data · Common Correlated Effects
**JEL Codes**: C13 · C33 · F14 · F15 · O10

# 1 Introduction

Poor geography, such as landlockedness, is an important reason for why certain countries face persistently high trade cost. High trade cost can stifle economic development (Harris, 1954; Hanson, 1996, 2005; Anderson and van Wincoop, 2004; Redding and Venables, 2004; Redding and Sturm, 2008). As such, it may not be surprising that the set of landlocked developing countries (LLDCs), 31 of them in all, are also among the least developed in the world.[1] The LLDCs have an average real GDP per capita of less than US$5 per day,[2] with 1 in 10 children there not expected to survive beyond the age of five. Although the LLDCs are home to more than 6% of the global population (i.e. 428.8 million), they only produce 1% of the world's output,[3] which is dwarfed by the 22% of global output produced by the US alone. Because of their unfavorable geography, the LLDCs are also less open to trade. In 2010, the LLDCs have a trade to GDP ratio of 0.7, compared to a ratio of 1 among the OECD countries. They also account for a meager 1.2% of global trade.[4]

The issue of how trade cost could affect development in the LLDCs has attracted much interest in recent years. Compared with their transit neighbors, the trade cost borne by the LLDCs can be as much as twice (Radelet and Sachs, 1998).[5] Because of this, the United Nations (UN) has made it a Sustainable Development Goal which

[1] From July 2011 onwards, there were 32 LLDCs after South Sudan had gained independence and was added to the sample. However, we decided to exclude South Sudan from our study because of its short time series.

[2] In addition, about half of the population in the LLDCs earn less than US$2 per day on average and the average real GDP per capita among the LLDCs is US$1,464 per year in 2012.

[3] `http://unohrlls.org/custom-content/uploads/2013/09/Landlocked-Developing-Countries-Factsheet-2013.pdf`

[4] The World Development Indicators.

[5] Limao and Venables (2001) found that with respect to the distribution of infrastructure the transportation cost of the median landlocked country were 55 percent higher than that of the median coastal economy, and this difference has been stable over the last decade (World Bank, 2013). Moreover, The United Nations Office of the High Representative for the Least Developed Countries, Landlocked Developing Countries and the Small Island Developing States, UN-OHRLLS (2013) reported that the container shipping cost was, on average, 100 percent higher in the landlocked country compared to the transit country.

follows up on its earlier Millennium Development Goal to help improve the LLDCs' access to world trade,[6] but the extent to which development in the LLDCs would be aided by the reduction in trade cost is still an open question. Although the relevant literature is rapidly expanding, there is much contention on how the effect of trade cost on these countries' development can be estimated credibly. For example, to do so, we must first obtain an appropriate measure of trade cost for the LLDCs, but there is little guidance on how this can be achieved. In addition, a proposed measure of trade cost should ideally be compatible with the use of fixed effects to eliminate all confounding unobserved heterogeneity. This would rule out the hugely popular gravity approach that models trade cost using bilateral trade distances (see, for example, Frankel and Romer, 1999), since distance itself, like many confounding factors such as historical institutions and culture, is time invariant and will therefore be purged by fixed effects.

To estimate the effect of trade cost on development for the LLDCs, we propose a simple measure of trade cost that is relevant for these countries and compatible with fixed effects estimation. One distinguishing feature of the LLDCs is their reliance on containerizable trade. For example, 25 of the 31 LLDCs have containerizable trade shares of at least 50% of total trade, with Lesotho having shares that frequently exceed 90%. Container freight is an important way of hauling goods over land. Because the LLDCs are primarily importers of containerizable manufactured goods, this has encouraged them to adopt containerization technologies for their exports as well, as it is costly for them to return the containers used for imports empty (Arvis et al., 2011; World Bank-United Nations, 2014). Empirically, there is a statistically significant difference in the utilization of containerizable trade between the LLDCs and their transit developing neighbors (higher in the LLDCs) with similar economic structures and natural resources.[7] Furthermore, an LLDC is likely to have larger

[6]This includes investments to improve the transportation infrastructure in the LLDCs.

[7]We perform a t-test on the mean difference in containerizable trade between the LLDCs and their transit neighbors. We find a statistically significant result that the containerizable

containerizable trade the further it is from main sea ports, which is consistent with the notion that the utilization of container shipments is associated with the need to transport goods over long distances on land.[8]

To construct our proposed measure of trade cost for the LLDCs, we use the Harpex index of the Harper Petersen & Co Ltd., a shipbroker based in London. The Harpex index reflects the global cost of container shipping as it is an aggregation of the average weekly earnings for all eight classes of container ships.[9] We interact the log of the Harpex index with each LLDC's share of containerizable trade over its total trade to construct a country-specific measure of container shipping cost, which we call *Harpex Cost*. The containerizable trade share of a country reflects its intensity of containerizable shipping utilization. By interacting the containerizable trade share with the Harpex index, it will then amplify the influence of container shipping cost for the LLDCs that are more involved in containerizable trade.

The country and time specificity of *Harpex Cost* allows us to exploit panel data estimation to address the problem of unobserved heterogeneity. To do so, we implement interactive fixed effects regression based on the common correlated effects (CCE) estimation framework of Pesaran (2006). The CCE estimator is a powerful approach that can address several estimation issues all at once. Firstly, by using interactive fixed effects, the CCE approach can deal with the issue of cross-sectional dependence, which may arise if some countries have influence on others or are spatially dependent. Secondly, it can help to eliminate all macroeconomic factors that have heterogeneous effects on countries and all unobserved global and country-specific policy shocks, regardless of their stationarity properties (Pesaran, 2006; Chudik et al., 2011; Chudik and Pesaran, 2013). Thirdly, because the two-way (country and year) fixed effect is

trade of the LLDCs is larger on average.

[8]We find a positive correlation between containerizable trade and to-sea-port distance from the LLDCs. This positive pairwise correlation, which is statistically significant at 1% level, suggests containerizable trade is higher on average the further the distance from sea ports that goods need to travel.

[9]http://www.dallasfed.org/pages/institute/annual/2010/annual10e.cfm

a special case of the interactive fixed effect, the CCE approach can eliminate all the confounding factors that the two-way fixed effects estimator could, and more (Bai, 2009).

Our results show that trade cost has a rather large effect on economic development in the LLDCs. For example, we find that a one standard deviation reduction in *Harpex Cost* is associated with a 20% increase in GDP per capita on average. Applying the income elasticities of poverty from Ravallion and Chen (1997), this result also roughly translates into a 40% reduction in the poverty rate on average, and an escape of 6 in 10 persons from the US$1 poverty line.[10]

We also observe positive effects of trade cost reduction on other dimensions of economic development. Although income is a widely used indicator of development (Frankel and Romer, 1999; Acemoglu et al., 2008, 2009; Bloom et al., 2008), GDP data is often fraught with measurement error and missing observations (Deaton, 2005; Ross, 2006). To proxy for income, we use data on the amount of satellite-recorded lights per capita at night, as it is highly correlated with GDP but yet does not suffer from the same data problems (Henderson et al., 2012).[11] In doing so, we find an even stronger effect whereby a one standard deviation reduction in *Harpex Cost* is associated with a 29% increase in the nighttime lights per capita on average.[12] We also consider measures of health such as child mortality and life expectancy to capture a different aspect of development, since it is possible for a country to become wealthier but yet has worsening public health on average (Wagstaff, 2000; Gwatkin, 2004; Sim, 2006; Halder and Kabir, 2008). We find that on average, the

[10]The income elasticities of poverty estimated by Ravallion and Chen (1997) are widely accepted in the literature on growth and poverty (Collier and Dollar, 2001, 2002; Adams, 2004). See Section 4 for further details.

[11]Henderson et al. (2012) proposed the use of satellite night lights an alternative to GDP for measuring economic growth. While GDP data often contain measurement error and can be missing for developing countries, satellite night nights are observable for all countries, rich or poor.

[12]We also find that the LLDCs' urban population increases by 5.4% (holding a country's total population constant) when *Harpex Cost* falls by one standard deviation.

infant and under-5 child mortality rates will fall by 9 and 5 deaths per 1,000 and life expectancy will rise by 4 years following a one standard deviation reduction in *Harpex Cost*. These results suggest that the reduction in trade cost can generate significant improvements for the LLDCs across broad areas of development.

In addition to the above, we investigate the effect that trade cost might have on trade per capita. We find that trade per capita increases by 21% on average following a one standard deviation reduction in *Harpex Cost*. Furthermore, using our measure of trade cost as an instrument for trade, we also find that a 1% increase in trade per capita increases GDP per capita by 1% on average for the LLDCs. This estimate of trade elasticity is about twice of that for the Least Developed Countries (LDCs) (Lin and Sim, 2013), and about five times of that for the world (Feyrer, 2009a,b). Therefore, among these various groups of countries, the LLDCs have the most to gain from policies that help to promote trade.

Our paper contributes to the literature in the following ways. Firstly, our paper proposes *Harpex Cost* as measure of trade cost that is relevant to the LLDCs, which has the advantage of being simple and easy to construct. Secondly, our paper is among the first in the empirical trade and development literature to use interactive fixed effects. The interactive fixed effect, which is an important advancement in the panel data literature, has the ability to take care of a much larger class of unobserved confounders than what the standard two-way fixed effects approach can handle. Finally, in using *Harpex Cost* as an instrument for trade, our paper offers what we believe are robust estimates of the effect that trade has on development with respect to the LLDCs. This robustness comes from the use of panel interactive fixed effects instrumental variable estimation (i.e. the IV-CCE approach) and the use of different indicators to capture various aspects of development, including night lights, a recent advancement in the development literature, as well as child mortality and life expectancy.

Given that trade cost is inversely related to the ease with which countries or regions access external markets, our paper is related to the literature that studies the effect that market access has on development. Using cross-country data, Redding and Venables (2004) offered some early insights on how the geography of market access could account for the variation in per capita income across countries.[13] Exploiting the reunification of Germany as a natural experiment, Redding and Sturm (2008) showed that the loss of market access due to German division had affected the growth of cities negatively and that the effect of the loss of market access was more pronounced for small cities. Donaldson (forthcoming) explored the relationship between infrastructure improvements, market access and development using an historical event, the mass construction of railroads that took place in British India. He showed that geographically remote regions that were linked up with railroads were able to progress from autarky to trade and enjoyed higher income levels as a result. Our paper adds to this literature by considering landlocked geography as a barrier to market access and how the breaking down of that barrier (by reducing trade cost) may lead to improvement in various development outcomes.[14]

The remainder of this paper is as follows. Section 2 describes the data and the variables. Section 3 presents the main estimating equation and discusses some estimation issues. Section 4 presents our main results on the effect of trade on development for the LLDCs. Section 5 examines the role of trade as the channel. Section 6 concludes.

[13] See, also, Hanson (2005) for a similar study based on county level data in the US.

[14] However, unlike Redding and Venables (2004), we employ panel data while they used cross-sectional data. Having panel data is useful as measures of market access, such as geographical locations, could be confounded by unobserved time invariant factors such as institutions, disease environments, etc. that panel data methods could help to easily resolve.

# 2 Data and Variables

Our data spans from 2001 to 2012 for a panel of 31 LLDCs. The dataset is constructed mainly from the UNCTAD database and the World Development Indicators. The description of our key variables is provided below, while the summary statistics as well as the variable definitions and sources are documented in Tables B1 and B2, respectively, of the Appendix B.

## 2.1 Development Indicators

In this paper, we use several indicators to capture various aspects of development. First, we consider real GDP per capita, which comes from the UNCTAD database.[15] Real GDP per capita is among the most widely used measure of economic development (see, for example, Frankel and Romer, 1999; Acemoglu et al., 2008, 2009; Feyrer, 2009a,b). However, as Deaton (2005) has pointed out, GDP is also likely to be mismeasured and the quality of income data of less developed countries also tends to be questionable (Henderson et al., 2012). Moreover, the missing values of GDP may be correlated with unobservables such as institutions (Ross, 2006), and not at random.

To overcome this issue, Henderson et al. (2012) proposed another indicator of economic development – night lights as recorded by satellites. Unlike GDP, which may not be reported in a consistent manner across countries, the measurement of night lights will be consistent across the world. Moreover, because night lights for all countries can be observed by the satellite, this information will be complete. We collect night lights data from Elvidge et al. (2014).[16] The night lights are captured

[15]GDP per capita is in the 2005 US dollars. See http://unctadstat.unctad.org/wds/TableViewer/tableView.aspx?ReportId=96 Accessed 06/04/2014

[16]Elvidge et al. (2014) constructed the country night lights index based on satellite imageries provided by the National Oceanic and Atmospheric Administration (NOAA). See http://ngdc.noaa.gov/eog/dmsp/download_national_trend.html

by satellites at some specific points in time globally. When lights in one area is detected, a value from 0 to 63 is assigned according to its intensity. The country-specific nighttime lights index is then obtained by summing up the disaggregated values recorded for a country. Using the night lights index from Elvidge et al. (2014), we calculate night lights per capita for each country, which is our second indicator of economic development.

Finally, we look at infant and under-5 child mortality rates and life expectancy taken from the World Development Indicators. The mortality of infants and under-5 children is usually a problem faced by households from the lower quantile of income distribution (Wagstaff, 2000; Gwatkin, 2004; Halder and Kabir, 2008). Therefore, the infant and under-5 children mortality rates offer some insights into the living conditions of the poor (within each country) that GDP or night lights per capita may not represent well. Life expectancy, which is related to health, offers some information about the welfare of the general population. For example, if economic growth is achieved at the expense of greater pollution, the general population could be worse off when output increases. Therefore, measures such as GDP and night lights, which are correlated with output, may not be completely representative of actual living conditions.

## 2.2 Trade and *Harpex Cost*

Our trade data is taken from the UNCTAD database for the period between 2001 and 2012.[17] The raw data is measured in nominal terms at the current values and we deflate it with the US urban commodity price index at the base year of 2005.[18]

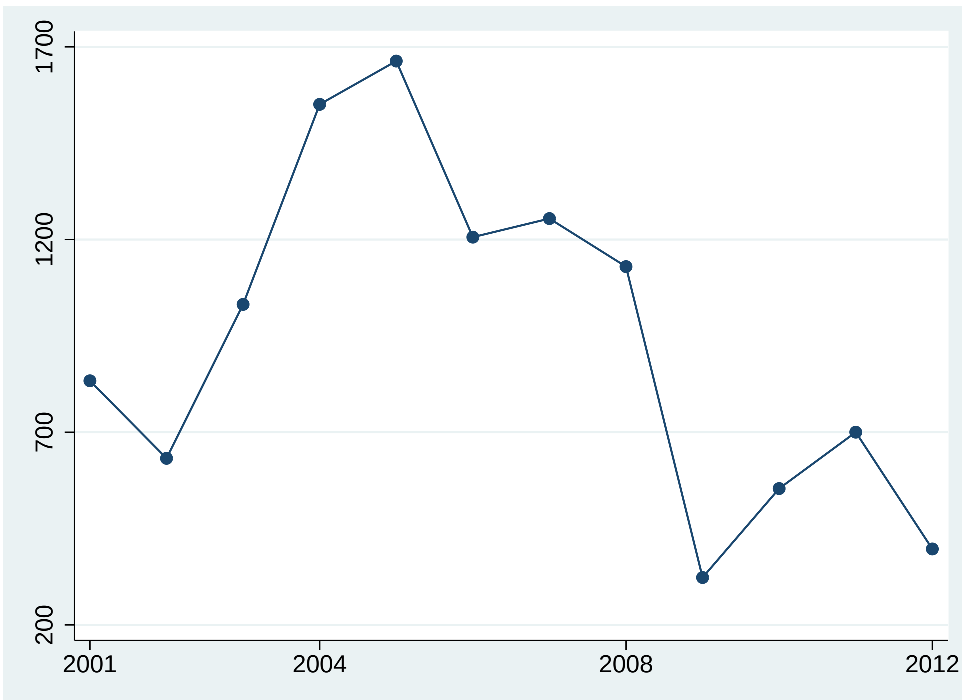
We construct our measure of trade cost for the LLDCs, called *Harpex Cost*, in

[17] `http://unctadstat.unctad.org/wds/ReportFolders/reportFolders.aspx`. Accessed 06/04/2014.

[18] `http://data.bls.gov/cgi-bin/surveymost?cu`. Accessed 06/04/2014.

the following way. First, we use information about the cost of container freight, which is captured by the Harpex index belonging to the London shipbroker Harper Petersen & Co. The Harpex index, plotted in Figure 1, is a yearly index of the weighted average of earnings for all eight classes of container ships.[19] Like the more well-known Baltic Dry Index, which is the foremost indicator of the cost of dry bulk shipping, the Harpex index is the best indicator we have on the cost of container shipping.[20]

Figure 1: The Harpex Index




To capture the idea that container shipping cost may affect each LLDC differently, we interact the log of the Harpex index with each country's share of containerizable trade over total trade, expressed by:

$$HarpexCost_{it} = \theta_i \log(Harpex_t). \tag{1}$$

[19]The yearly index is computed on the basis of a weekly index.

[20]`http://www.dallasfed.org/pages/institute/annual/2010/annual10e.cfm`

The parameter $\theta_i \equiv T^{-1} \sum_{t=1}^{T} \theta_{it}$ is the country's $i$ average (time-invariant) value of containerizable trade share over its total trade, where the value of containerizable trade is constructed by aggregating the value of containerizable products at the 4-digit SITC level following the approach of Bernhofen et al. (forthcoming). By interacting the share of containerizable trade with the log of Harpex index, Eq. (1) assumes that an LLDC with a larger share of containerizable trade would be more strongly affected by fluctuations in container shipping cost.

## 3 The Model

Our main estimating equation relates some measures of development with *Harpex Cost* of country $i$ at year $t$ as:

$$development_{it} = \beta HarpexCost_{it} + \psi' x_{it} + \lambda_i' F_t + e_{it}, \tag{2}$$

where $x_{it}$ is a set of control variables that we consider in our robustness checks and $F_t$ represents a set of unobserved common factors such as global shocks and time trends. These factors may affect each LLDC differently, which is reflected by the fact that $F_t$ is interacted with a possibly unique vector of country factor loadings, $\lambda_i$. When interacted together, the term $\lambda_i' F_t$ represents what is known as interactive fixed effects. The use of interactive fixed effects is a powerful approach for addressing the issue of unobserved heterogeneity and omitted variables, which we will discuss below. The dependent variable $development_{it}$ is represented by the following indicators: real GDP per capita, night lights per capita, the infant and under-5 child mortality rates, and life expectancy. Our parameter of interest is represented by $\beta$, which generically reflects the effect that trade cost (represented by *Harpex Cost*) might have on some development indicators.

### 3.1 Estimation Issues

To identify $\beta$, we need to ask ourselves if *Harpex Cost* plausibly exogenous. This could be violated, for instance, if individual LLDCs have influence on *Harpex Cost* to some non-trivial degree (i.e. reverse causality), or *Harpex Cost* is correlated with some unobserved variables (i.e. omitted variables) that are not fully accounted for.

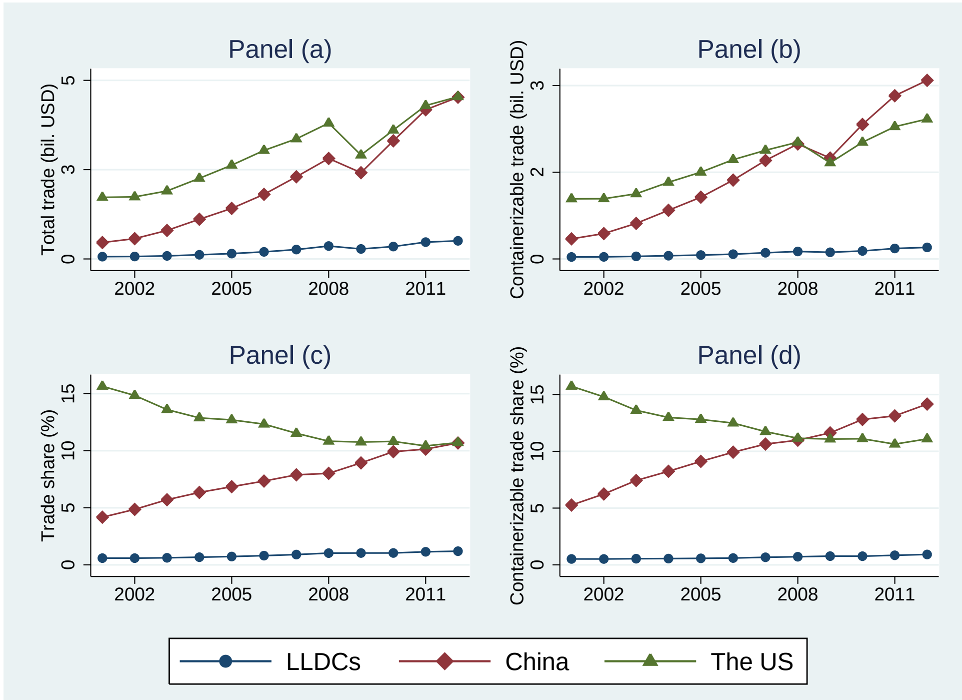
**Reverse Causality** On the issue of reverse causality, notice that the variation in *Harpex Cost* is driven mainly by the Harpex index, as the containerizable trade share used in constructing *Harpex Cost* is fixed across time. Given that the Harpex index is a summary of the global container shipping cost, it is unlikely for a small country like an LLDC to have the ability to affect the Harpex index in a significant way.

To emphasize this point, Figure 2 compares the volume and the share of total trade and containerizable trade for all the LLDCs with those of two very large countries, China and the US. For total trade, the combined amount from the LLDCs has been low (around US$0.5 billion) (see Panel (a)) and accounts for no more than 1.2% of world trade in 2012 (see Panel (c)). By contrast, for China and the US, each of their total trade is roughly ten times the combined total trade of the LLDCs. For containerizable trade, the combined amount from the LLDCs only accounts for 0.9% of the world's containerizable trade in 2012, which is far exceeded by what China or the US accounts for in the same year (11% and 14% respectively). Therefore, given that the LLDCs as a whole is rather small in terms of world trade, the reverse causal effect that an individual LLDC might have on global shipping cost is unlikely to be significant.

For another perspective on the same assertion, we compare the annual growth rate of the Harpex index with the growth rate of trade volume for selected LLDCs in Figure 3.[21] If a country has the ability to influence the Harpex index, for example,

[21]Note that the comparison in growth than in levels is chosen for exposition sake, as

Figure 2: Trade in the LLDCs, China and the US



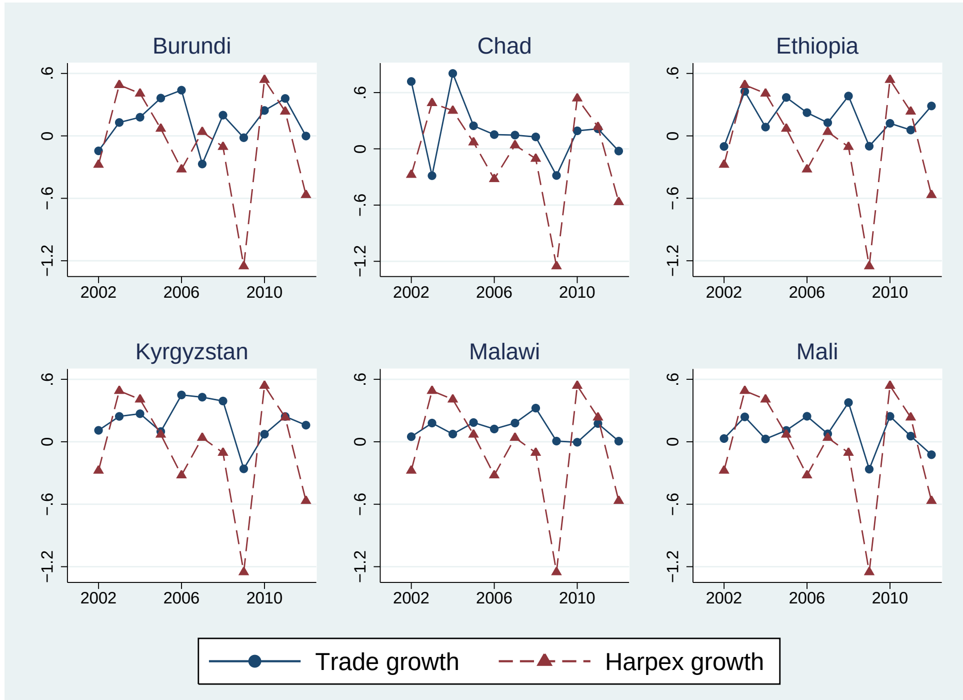

*Note*: This figure plots the volume and the share of total trade and containerizable trade for the LLDCs, China and the US. Volumes of total and containerizable trade (billion US dollars) are plotted in Panels (a) and (b), while the total trade share and containerizable trade share (%) are plotted in Panels (c) and (d). The trade volume is in the constant 2005 price. Containerizable trade data are obtained based on the list of containerizable products (Bernhofen et al., forthcoming)

if the increase in its demand for trade puts upward pressure on the container freight rates, we will then expect to see a tight positive co-movement between trade volume and the Harpex index. However, if a country takes the price of container shipping as given, a rise in the Harpex index could lead to a fall in its trade volume. In fact, because common trends such as global demand tend to drive trade and shipping cost in the same direction for all countries, any negative co-movement between the trade volume of a country and the Harpex index is good evidence that the country in question does not have significant influence on shipping cost.

With respect to the sample of LLDCs, Figure 3 offers some evidence that the

it is nicer to plot these series in growth given that in levels, trade volume is very large compared with the Harpex index.

Figure 3: The Harpex Index Growth and Trade Growth for a Sample of LLDCs



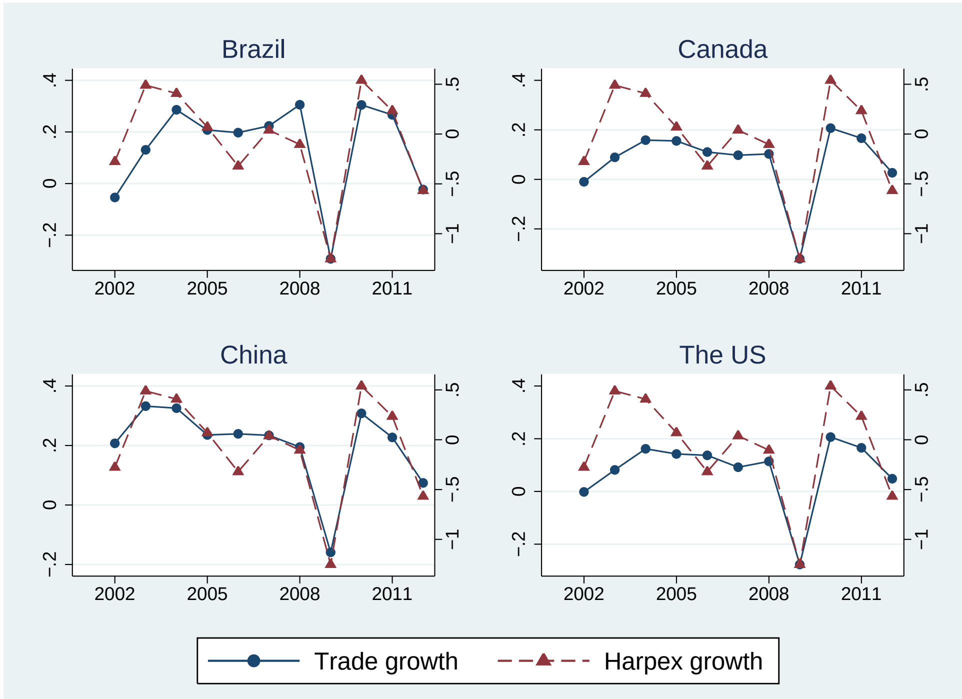

*Note*: This figure plots the growth in the Harpex index and the growth in trade for a sample of LLDCs. The growth variables are constructed as the first difference of their respective values in logs.

aforementioned negative co-movements exist. Let us take Chad as an example. When the Harpex index fell by 28% from 2001 to 2002, its trade per capita increased by 72%. Similarly, when the Harpex index fell by 32% from 2005 to 2006, its trade per capita increased by 15%. By contrast, the trade volumes of Brazil, Canada, China and the US, which are the world's largest manufacturers,[22] co-move very tightly in the same direction as the Harpex index (see Figure 4) without any negative co-movement that is observed for Chad. Therefore, unlike these large countries, it is plausible that an LLDC such as Chad has very little influence on the Harpex index.

**Omitted Variables** Although reverse causality is unlikely, *Harpex Cost* could still be endogenous if there are unobserved factors which it is correlated with. For exam-

[22]See `http://www.deloitte.com/view/en_US/us/Industries/Process-Industrial-Products/manufacturing-competitiveness/mfg-competitiveness-index/index.htm`

Figure 4: The Harpex Index Growth and Trade Growth of the LLDCs, Brazil, Canada, China and the US




*Note*: This figure plots the growth in the Harpex index and the growth in trade for the world's largest manufacturers. The growth variables are constructed as the first difference of their respective values in logs.

ple, long run factors such as historical institutions and societal fragmentation could be correlated with the country specific component in *Harpex Cost*, namely, the time-invariant containerizable trade share of each LLDC. Poor institutions and societal fragmentation may lead to political conflicts (Easterly and Levine, 1997; Besley and Reynal-Quero, 2014). Should these conflicts involve the LLDCs with their transit neighbors, the LLDCs could face increased trade cost if their opponents demand additional administration fees for traded goods that are passing through (Faye et al., 2004). Besides long run factors, global shocks (e.g. oil price shocks, aggregate demand shocks, etc.) could also be correlated with the cost of shipping. To deal with both time-invariant heterogeneity and macroeconomic shocks, it is common for the literature to employ the two-way (country and year) fixed effects estimator. However, the two-way fixed effects estimator will be inconsistent in the presence of omitted factors or shocks that have heterogeneous effects on the LLDCs, or more generally, in the presence of cross-sectional dependence.

Unobserved factors or shocks may affect countries in a heterogeneous way if different countries react to these factors or shocks differently. For example, it is likely that some countries are more affected than others by global economic downturns, depending on what drives these downturns and how integrated a country is with the rest of world. Technological improvements in containerization could significantly enhance shipping capacities and reduce shipping cost, but not all countries had been successful in adopting these technologies (Bernhofen et al., forthcoming). Oil price shocks could affect output (Rasmussen and Roitman, 2011), but how a country reacts to these shocks could depend on whether it is a net oil importer or exporter.[23]

Cross-sectional dependence may also come about if there is dependence between countries across space (i.e. spatial dependence) or within subsets of countries. For example, as climate or weather patterns are related cross-sectionally, they can generate correlation between countries across space, causing countries to be spatially dependent. Colonialism is a potential cause of cross-sectional dependence as past colonies under the same European power inherit institutions that are more similar among themselves than institutions inherited by colonies under a different European power. Finally, a country's policy or economic activity may affect other countries that are closer to it more strongly than those that are further away, and these unobserved policies may generate cross-sectional dependence structures within subsets of countries.

To address these concerns, we employ fixed effects with an interactive structure (recall $\lambda_i' F_t$ in Eq. (2)). The interactive fixed effect has the ability to take care of

[23]Rasmussen and Roitman (2011) found that oil-importing countries would experience a 0.5% reduction in growth rate following a 25% increase in oil prices. Furthermore, containerizable trade flows in these countries would fall in response to rising container freight rates due to oil price shocks. For example, UNCTAD (2009) reported that the estimated elasticity of freight rates to oil prices ranged from 0.398 to 0.403.

a large class of confounders. In particular, it subsumes the (two-way) country and year fixed effects as a special case (Pesaran, 2006; Bai, 2009; Kapetanios et al., 2011), and has the ability to absorb information related to spatial and cross-sectional dependence among countries (Chudik and Pesaran, 2013). All common factors, known or unknown, that are correlated with either $HarpexCost_{it}$ and $development_{it}$ will be "partialled out" by $\lambda_i' F_t$. To estimate a model with interactive fixed effects, we employ the Common Correlated Effects (CCE) estimator of Pesaran (2006), where the common factors are collectively represented by the unknown term, $F_t$. To control for $F_t$, the CCE approach uses the idea that the variables in the model are correlated with it (if not, $F_t$ will not be confounding). Hence, by averaging the model variables across countries, we may filter out the country-specific information in them, such that the resulting cross-sectional averages will be indexed by $t$ only and correlated with $F_t$ asymptotically. These averages can then be used to proxy for $F_t$, which therefore allows us to "control" for $F_t$ even if it is unobserved.

We will implement the CCE approach throughout this paper. There are several advantages in doing so. First, the CCE will be consistent even if the true data generating process has a two-way fixed effects structure without cross-sectional dependence.[24] However, if there are common correlated effects and cross-sectional dependence, the two-way fixed effects estimator will be inconsistent but not the CCE estimator. Second, the CCE approach is valid regardless of the time series properties of $F_t$, such as a common factor being a unit root (Kapetanios et al., 2011). This is a huge plus given that the presence of a unit root can lead to spurious empirical relationships.[25] Finally, as suggested by Pesaran (2006), we employ Newey-West robust standard errors for statistical inference.

[24]Although the CCE approach will be less efficient than the two-way fixed effects approach in this case.

[25]Chudik et al. (2011) and Chudik and Pesaran (2013) also showed that the CCE approach would be valid regardless of whether cross-sectional dependence is either weak or strong in panel data models with spatial errors.

# 4 Results

Table 1 reports our first set of estimates on the relationship between trade cost and economic development, indicated by (logs of) GDP per capita and night lights per capita. For each of these indicators, the estimated coefficient on *Harpex Cost* is negative and statistically significant at the 1% level and captures a rather strong relationship. For instance, the point estimate of $-0.220$ in Column (1) suggests that when *Harpex Cost* falls by one standard deviation, the GDP per capita of the LLDCs increases by 20% on average.[26] Similarly, the estimated coefficient of *Harpex Cost* in Column (2) implies that a one standard deviation decrease in *Harpex Cost* is accompanied a 29% increase in the LLDCs' night lights per capita on average.[27]

Table 1: Trade Cost, GDP and Night Lights

| | (1) | (2) |
|---|---|---|
| | Economic growth | |
| *Dependent Variable:* | log(GDP per capita) | log(lights per capita) |
| Harpex Cost | -0.220*** | -0.313*** |
| | (0.001) | (0.000) |
| Time trend | yes | yes |
| Interactive fixed effects | yes | yes |
| Observations | 31 | 31 |
| Countries | 372 | 372 |

*Note*: Newey and West robust standard errors are reported in the parenthesis. Statistical significance at the 10%, 5% and 1% levels are indicated by *, ** and *** respectively.

An important fact about the LLDCs is that they bear about twice the trade cost as their non-landlocked counterparts on average (Radelet and Sachs, 1998). To get a counterfactual on what the LLDCs would be like if they were not landlocked, we carry out the following back-of-the-envelop exercise. First, we derive a semi-

[26]We compute the response of GDP per capita to one standard deviation decrease in *Harpex Cost* as $0.913 \times 0.220 \times 100\% \approx 20\%$.

[27]This result is computed as $0.913 \times 0.313 \times 100\% \approx 29\%$.

elasticity of GDP per capita with respect to *Harpex Cost* based on our estimate of Eq. (2). Next, we take a 50% reduction in the sample average of *Harpex Cost* as a proxy for the average (counterfactual) trade cost faced by the LLDCs were they non-landlocked. Following which, using the estimated semi-elasticity, we compute the difference in the GDP per capita predicted by the sample average of *Harpex Cost* and by one-half of its sample average.

Holding other factors constant, we find that the LLDCs suffer from a 39% reduction in income on average for being landlocked. This result supports the literature's finding that the cost of being landlocked is very large. For example, using GDP per capita as an indicator of development, Radelet and Sachs (1998) found that the LLDCs were on average 20% less developed than they would be if they were not landlocked. UN-OHRLLS (2013) reported a similar estimate on the cost of landlocked geography by using a composite index of development based on the indicators of the Millennium Development Goals in place of GDP per capita.

When it comes to development, it is often of interest to study how a certain factor could affect the poorest or the least advantaged, and not just look at the average effect that this factor might have. For our paper, we have considered the possibility of examining the relationship between trade cost and income for the bottom 20 and 40 percent of households, but are unable to estimate this relationship as data on the latter is scant for the LLDCs.[28] To examine this issue indirectly, we use two approaches. First, we use the result of Dollar et al. (forthcoming) that the marginal effect of mean income growth on income growth of the poor is about 1, which implies that the income of the poor grows at about the same rate as mean income. If so, the income of poor households could also rise by 20% on average (like the baseline

[28]While Dollar et al. (forthcoming) used a dataset comprising of 151 countries from 1967 and 2011, this dataset only covers 25 out of 31 LLDCs. Furthermore, for these countries, the dataset contains many missing values for the period between 2001 and 2012. These missing values cause the panel dataset to be highly unbalanced and unsuitable for the implementation of the CCE approach (Chudik and Pesaran, 2013).

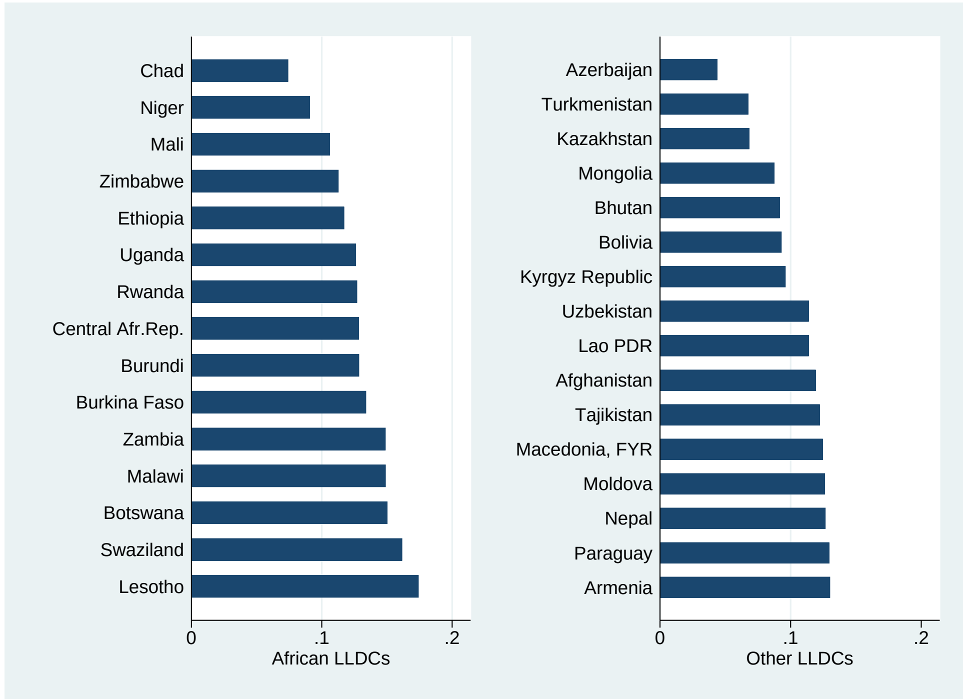
estimate) when *Harpex Cost* falls by one standard deviation. Second, we use the results of Ravallion and Chen (1997) that the income elasticity of poverty is 2 and the income elasticity of the proportion of people living below US$1 per day is 3 for developing countries, which are also supported by Collier and Dollar (2001), Collier and Dollar (2002) and Adams (2004).[29] Following these results, our finding that GDP per capita increases by 20% on average when *Harpex Cost* decreases by one standard deviation corresponds to a 40% reduction in poverty on average and the escape of 6 in 10 people who are living under US$1 per day poverty line.

An LLDC that engages more heavily in containerizable trade would have greater exposure to variations in container shipping cost. Because *Harpex Cost* has country (and also time) specific information, we may explore the effect that container shipping cost has on a single LLDC. To do so, we compute for each country, its elasticity of GDP or night lights per capita with respect to the Harpex index as $\hat{\beta}\theta_i$, where $\hat{\beta}$ (equals to -0.220 or -0.313) is the estimates on the coefficient of *Harpex Cost* (see Columns (1) and (2) of Table 1) and $\theta_i$ is fixed containerizable trade share of country $i$. To view these results, we plot the elasticities (in absolute values) corresponding to GDP and night lights per capita in Figures 5 and 6, respectively.

In Figure 5, we find that the elasticity of GDP per capita with respect to the Harpex index ranges from 0.05 to 0.15 for most LLDCs. Hence, for most LLDCs, a 10% increase in the Harpex index is associated with a 0.5% to 1.5% decline in GDP per capita. As one might expect, Figure 6 shows that the elasticity of night lights per capita with respect to the Harpex index is stronger than that with respect to GDP per capita. For 22 countries, which is more than two thirds of the LLDCs, a

[29] Ravallion and Chen (1997) used household survey panel data based on 42 countries for the period between 1981 and 1994 to estimate the income elasticities of poverty. However, Ravallion and Chen (1997) did not use a log-log model to estimate the income elasticity of poverty directly due to measurement errors and "common-survey bias". To deal with these issues, they transformed the model into difference-in-differences (DID) and regressed the rate of poverty reduction on the growth rate of income levels. They argued that under some certain conditions, the adoption of OLS in the DID framework could produce estimates of income elasticities of poverty that are similar to what the log-log model would produce.

Figure 5: The (Absolute) Elasticity of GDP per capita with respect to the Harpex Index for each LLDC

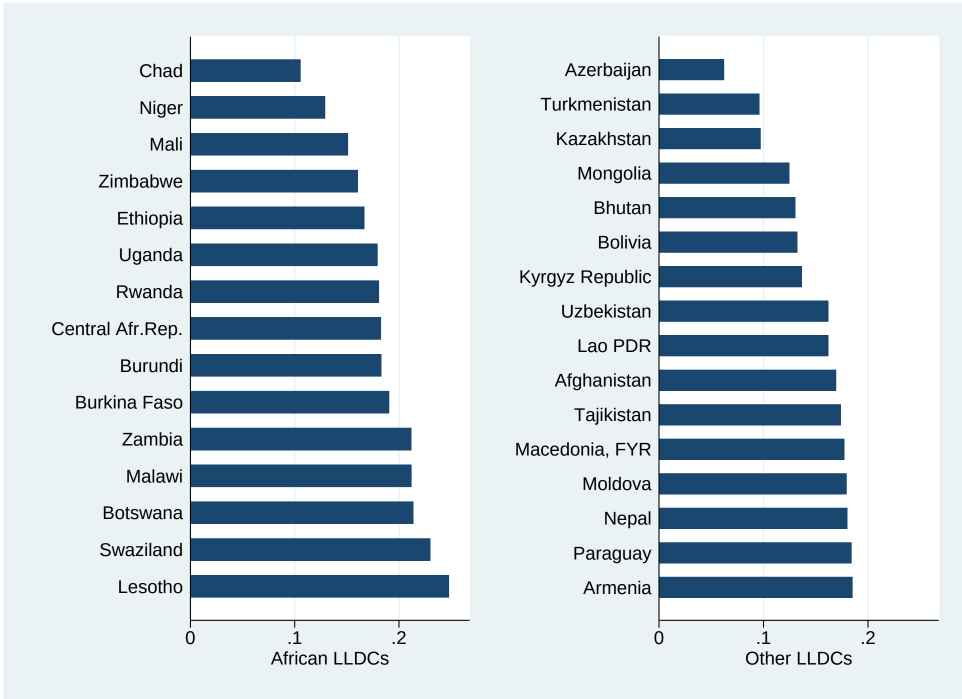



*Note*: This figure plots the absolute country-specific elasticity of GDP per capita with respect to the Harpex index. This elasticity shows the average percentage decline in GDP per capita following a one percentage increase in the Harpex index for each country.

10% decline in the Harpex index has an effect of raising the night lights per capita by at least 1.5%. The effect of the Harpex index on GDP or night lights per capita is also generally larger for African LLDCs than non-African LLDCs. For example, with respect to GDP per capita, 13 of the 15 African LLDCs have an elasticity that exceeds 0.1 while it is true only for 9 of the 16 non-African LLDCs. In other words, the African LLDCs are generally more susceptible than non-African LLDCs to large shocks in container shipping cost.

Income, as measured by GDP or night lights, may not be completely representative economic development. For example, it is possible for a country to grow rapidly but yet have people who become less healthy because of its growth policies (Sim,

Figure 6: The (Absolute) Elasticity of Night Lights per capita with respect to the Harpex Index for each LLDC




*Note*: This figure plots the absolute country-specific elasticity of night lights per capita with respect to the Harpex index. This elasticity shows the average percentage decline in night lights per capita following a one percentage increase in the Harpex index for each country.

2006). Therefore, we also explore the effect that trade cost might have on health. Here, we look at three indicators of health – the (levels) of infant mortality rate (IMR), under-5 child mortality rate (CMR), and life expectancy (LE) – and report the estimates of their response to *Harpex Cost* in Table 2.

Based on these three indicators, we find that health in general improves along with a fall in trade cost. For example, we find that a one standard deviation reduction in *Harpex Cost* increases life expectancy by 4 additional years on average. Correspondingly, we also find that the infant and child mortality rates are reduced by 9 infants and 5 children per 1,000 live births on average. Within countries, the problem of infant and child mortality is disproportionately borne by households that

Table 2: Trade Cost and Health

| | (1) | (2) Health | (3) |
|---|---|---|---|
| *Dependent Variable:* | IMR | CMR | LE |
| Harpex Cost | 9.945*** | 5.500*** | -4.554*** |
| | (0.027) | (0.012) | (0.022) |
| Time trend | yes | yes | yes |
| Interactive fixed effects | yes | yes | yes |
| Observations | 372 | 372 | 372 |
| Countries | 31 | 31 | 31 |

*Note*: Newey and West robust standard errors are reported in the parenthesis. Statistical significance at the 10%, 5% and 1% levels are indicated by *, ** and *** respectively.

are relatively more disadvantaged (Wagstaff, 2000; Gwatkin, 2004; Halder and Kabir, 2008). If infant and child mortality is a problem mainly with the poor, this result supports the earlier suggestion that a reduction in trade cost can lead to better living conditions for the disadvantaged within the LLDCs.

To conclude this section, we conduct a sensitivity analysis to check how robust our estimates are. To do so, we vary the set of control variables that are potentially relevant for development and previously omitted from the above regressions. These additional variables are inward FDI, foreign aid and a measure of institutional quality. With respect to promoting development, Nair-Reichert and Weinhold (2001) discussed the relevance of FDI, Werker et al. (2009), Rajan and Subramanian (2011) and Brückner (2013) for foreign aid, and Acemoglu et al. (2008, 2009) for institutions. We obtain data on FDI and foreign aid from the UNCTAD database. For institutions, we employ the revised Polity score (Polity-2) from the Polity IV database of Marshall and Jaggers (2009), which captures information about how democratic a country's political system. The Polity-2 score ranges from -10 to 10, where a score of 10 indicates an institution that is most democratic.[30]

[30]The revised Polity score is computed by combining a variety of sub-scores related to

Table 3: Robustness Check: Additional Country-Level Control Variables

| | (1) log(FDI) | (2) log(Foreign aid) | (3) Polity-2 | (4) all |
|---|---|---|---|---|
| *Dependent Variable:* | | log(GDP per capita) | | |
| Harpex Cost | -0.198*** | -0.199*** | -0.220*** | -0.197*** |
| | (0.000) | (0.001) | (0.001) | (0.002) |
| log(FDI) | 0.029*** | | | 0.028*** |
| | (0.001) | | | (0.001) |
| log(Foreign aid) | | -0.100*** | | -0.038*** |
| | | (0.003) | | (0.003) |
| Polity-2 | | | 0.002*** | 0.005*** |
| | | | (0.001) | (0.001) |
| Time trend | yes | yes | yes | yes |
| Interactive fixed effects | yes | yes | yes | yes |
| Observations | 372 | 372 | 360 | 360 |
| Countries | 31 | 31 | 31 | 31 |

*Note*: Newey and West robust standard errors are reported in the parenthesis. Statistical significance at the 10%, 5% and 1% levels are indicated by *, ** and *** respectively.

Table 3 reports the new estimates where Columns (1)-(3) add the log of inward FDI, the log of foreign aid, and the Polity-2 score as a control variable each at the time, while Column (4) includes these variables all at once. Inward FDI, foreign aid, and the Polity-2 score are all statistically significant at the 1% level, which suggest that these are relevant determinants of income. Despite their importance, our estimate of the effect of *Harpex Cost* on GDP per capita, which is statistically significant at the 1% level, remains close to the baseline estimate (of 0.220), whether or not we include the control variables one at a time or all at once. For the other five development indicators, we have also conducted a similar exercise of varying the set of controls to check the sensitivity of our baseline estimates of the effect of *Harpex Cost*. To save space, we have omitted these results, which essentially show that these baseline estimates are robust as well. The robustness of our baseline estimates

constraints on the chief executive, the competitiveness of political participation, and the openness and competitiveness of executive recruitment.

is perhaps not surprising here, given that the interactive fixed effect - CCE estimator is known to be an effective approach for dealing with omitted variables.

# 5 Trade Cost, Trade, and Economic Development

Trade is the channel through which trade cost affects economic development (see, for example, Frankel and Romer, 1999). Using *Harpex Cost* as an instrument for trade, we estimate the effect that trade might have on development. Getting good estimates of the effect of trade on development is an issue of significant interest in the literature as trade is widely used for advancing economic development. Here, we relate a measure of development and trade per capita as:

$$development_{it} = \alpha log(trade_{it}) + \psi' x_{it} + \lambda_i' F_t + \varepsilon_{it}, \tag{3}$$

and instrument trade with *Harpex Cost* as:

$$log(trade_{it}) = \delta HarpexCost_{it} + \Psi' x_{it} + \Lambda_i' F_t + u_{it}. \tag{4}$$

For *Harpex Cost* to be a valid instrument, it must satisfy the exclusionary restriction that it is unrelated to income except through its link to trade for which it is serving as an instrument. The idea of using trade cost as an instrument for trade is not new. For example, Frankel and Romer (1999) pioneered the approach of using bilateral trade distances to construct an instrument for trade, assuming that countries that are more remote faced higher trade cost. Similarly, Feyrer (2009b) used bilateral sea distances to construct an instrument for trade, and exploited the closing and the re-opening of the Suez between 1967 and 1975 to generate time variation in sea distances that were otherwise time invariant.

Here, we depart from Frankel and Romer (1999) and Feyrer (2009b) in our use of interactive fixed effects. Frankel and Romer (1999) employed orthodromic (great-distance) distances between capital cities to construct their instrument for trade. As such, their instrument is time invariant, which makes it incompatible with the use of fixed effects regressions to take care of unobserved heterogeneity. Feyrer (2009b) instrument has variation across time as it contains information about the closing and the re-opening of the Suez. This allows for the use of country and year fixed effects to eliminate time invariant unobservables and macroeconomic shocks with identical country effects, but not unobserved factors with a cross-sectional dependence structure.

In this paper, we use interactive fixed effects to purge as much unobserved confounding information as possible. As discussed, the interactive fixed effect is a powerful term that subsumes the two-way fixed effects as a special case. It has the ability to capture a large class of confounding variables ranging from time-persistent factors such as culture, language or institutions that could affect trade and development (Feyrer, 2009a,b), global macroeconomic shocks that could affect each LLDC heterogeneously, climate variation which has effects across space and time, unobserved country-specific policies and shocks that may have spillover effects on other countries, etc. Therefore, factors such as oil prices, global aggregate demand and business cycles that are potentially correlated with both *Harpex Cost* and development of the LLDCs, which therefore threatens the validity of *Harpex Cost* as an instrument, will be taken care of by interactive fixed effects.

To estimate Eqs. (3) and (4), we employ the CCE framework of Harding and Lamarche (2011), which extends the CCE approach of Pesaran (2006) by permitting the use of instrumental variables.[31] To assess the strength of *Harpex Cost* as

[31] In their work, Harding and Lamarche (2011) showed that under certain regularity conditions, the cross-sectional averages of all regressors in the system could be used as proxies for unobserved common factors. However, given that trade variable is endogenous, its cross-sectional average will be endogenous as well. Hence, trade and its cross-sectional average will have to be instrumented by both $HarpexCost_{it}$ and its cross-sectional average $\overline{HarpexCost}_t$.

an instrument, we consider the Cragg-Donald F-statistic and compare it against a critical value, adopted from Stock and Yogo (2005), that corresponds to the notion that 15% is the maximal rejection rate the researcher is willing to tolerate if the true rejection rate is 5%.

Table 4 reports the estimates for Eqs. (3) and (4). To measure development, we use five different variables. Columns (1)-(2) report the regressions based on economic growth (measured by the logs of GDP and night lights per capita), while Columns (3)-(5) report the regressions based on health conditions (captured by the infant and child mortality rates, and life expectancy).

In the first stage regression, we find that a one standard deviation decline in *Harpex Cost* is associated with a 21% increase in trade. Given that the *Harpex Cost* measures each LLDC's exposure to container shipping cost, it is not surprising that a rise in *Harpex Cost* is associated with a reduction in trade on average. To obtain credible instrumental variable estimates on how trade affects development, it is important that *Harpex Cost* is a strong instrument. When a weak instrument is used, the resulting instrumental variable estimator could have poor asymptotic properties, such as its failure to converge pointwise and the inaccuracy of the asymptotic distribution as an approximation of the finite sample distribution, which is non-standard. Here, we find that *Harpex Cost* is a strong instrument in the sense that its first-stage Cragg-Donald F-statistic exceeds the Stock and Yogo critical value as discussed earlier.

Using *Harpex Cost* as an instrument, we find that trade has a sizable effect on income for the LLDCs. In Column (1), we find that a 1% increase in trade is associated with a 1% increase in GDP per capita on average, which is about twice the elasticity estimated by Lin and Sim (2013) for the least developed countries (LDCs), and about five times the elasticity estimated by Feyrer (2009b) for the world. This suggests that an increase in trade has a stronger impetus for development for the

LLDCs than for the LDCs and the rest of the world.

When development is measured by night lights and health, we find that trade has a positive effect on these indicators as well. For example, Column (2) shows that a 1% increase in trade is associated with a 1.38% increase in the lights density on average, which is consistent with the idea that trade can improve income and wealth.[32] In addition, Columns (3)-(5) show that trade can have substantial positive effects on health.[33] For instance, we find that a 1% increase in trade has an average effect of reducing infant and child mortality rates by 44 and 24 deaths per 100,000 live births respectively.[34] If trade can trigger improvements in living standard (higher income levels and child health), trade may lengthen life expectancy. Our computation shows that 1% expansion in trade can increase life expectancy by 3 months on average.[35]

[32]We also find that relatively to a country's total population, a 1% increase in trade per capita will increase the urban population in the LLDCs by 0.26 percentage point on average.

[33]These results are also robust to the inclusion of additional controls such as inward FDI, foreign aid, and institutions. The robustness checks are omitted to save space and are available upon request.

[34]In Column (3), the estimated semi-elasticity of infant mortality rate with respect to trade is $-43.943$ suggests that a 1% increase in trade per capita can reduce $43.943/100 \approx 0.44$ infant deaths per 1,000 live birth or roughly 44 infant deaths per 100,000 live births on average. Similarly, the point estimate of $-24.3$ in Column (4) implies an average reduction of $24.3/100 \approx 0.24$ under-5 deaths per 1,000 live birth or roughly 24 child deaths per 100,000 live births when trade per capita increases by 1%.

[35]From Column (5), we compute the average response of life expectancy to a 1% increase in trade as $20.122/100\% \approx 0.20$ years or roughly 3 months.

Table 4: Trade Cost, Trade and Economic Development

| | (1) | (2) | (3) | (4) | (5) |
|---|---|---|---|---|---|
| | Economic growth | | Health | | |
| *Second-stage Dependent Variable:* | log(GDP per capita) | log(lights per capita) | IMR | CMR | LE |
| log(trade per capita) | 0.970*** | 1.382*** | -43.943*** | -24.300*** | 20.122*** |
| | (0.001) | (0.004) | (0.035) | (0.042) | (0.076) |
| *First-stage Dependent Variable:* | log(trade per capita) | | | | |
| Harpex Cost | -0.226*** | -0.226*** | -0.226*** | -0.226*** | -0.226*** |
| | (0.001) | (0.001) | (0.001) | (0.001) | (0.001) |
| Time trend | yes | yes | yes | yes | yes |
| Interactive fixed effects | yes | yes | yes | yes | yes |
| First-stage Cragg-Donald F-statistic | 4.585 | 4.585 | 4.585 | 4.585 | 4.585 |
| Stock and Yogo critical value (15%) | 4.58 | 4.58 | 4.58 | 4.58 | 4.58 |
| Observations | 372 | 372 | 372 | 372 | 372 |
| Countries | 31 | 31 | 31 | 31 | 31 |

*Note*: Newey and West robust standard errors are reported in the parenthesis. Statistical significance at the 10%, 5% and 1% levels are indicated by *, ** and *** respectively.

# 6 Conclusion

The economic development of low income countries is an important priority facing both policymakers and academic researchers. The LLDCs, which are among the world's poorest, face extremely high cost of development due to the lack of direct sea access.

In this paper, we explore the effect that trade cost might have on economic development for the LLDCs. To do so, we exploit information about container shipping cost based on the Harpex index, and construct a country-specific trade cost based on how much an LLDC containerizes its trade. To control for unobserved factors that may or may not affect all LLDCs uniquely, we implement interactive fixed effects regression based on the common correlated effects (CCE) estimator of Pesaran (2006).

Focusing on several measures of economic development, we find that a reduction in trade cost has a substantial positive effect on economic development in the LLDCs. A one standard deviation decrease in the *Harpex Cost* will lead to an increase in GDP and night lights per capita by 20% and 29%, on average, respectively. In addition, health conditions in the LLDCs are also improved as additional 9 infants and 5 under-5 children (per 1,000 live births) are expected to live pass their first and fifth birthday, and life expectancy is extended by 4 years. This suggests that efforts to help the LLDCs reduce the cost of trade, for example, as enunciated by the Millennium Development Goal, are likely to bring substantial economic and welfare benefits to these countries.

Our study also provides evidence on the causality of trade on living standards improvement. Although the LLDCs have low accessibility to markets due to their geographical location, they can be beneficial from a reduction in trade costs which can cause an expansion in trade. Hence, unsurprisingly our estimates suggest that a 1% increase in trade can rise income level by 1%. This elasticity of income is five times the existing estimates in the literature on the empirical effect of trade on living standards.

# References


Acemoglu, D., Johnson, S., Robinson, J., Yared, P. (2008) "Income and Democracy," *American Economic Review*, 98(3), 808–842.

——— (2009) "Reevaluating the Modernization Hypothesis," *Journal of Monetary Economics*, 56(8), 1043–1058.

Adams, R. (2004) "Economic Growth, Inequality and Poverty: Estimating the Growth Elasticity of Poverty," *World Development*, 32(12), 1989–2014.

Anderson, J., van Wincoop, E. (2004) "Trade costs," *Journal of Economic Literature*, 42(3), 691–751.

Arvis, J.-F., Carruthers, R., Smith, G., Willoughby, C. (2011) *Connecting Landlocked Developing Countries to Markets : Trade Corridors in The 21st Century*, Washington DC: The World Bank.

Bai, J. (2009) "Panel Data Models with Interactive Fixed Effects," *Econometrica*, 77, 1229–1279.

Bernhofen, D., El-Sahli, Z., Kneller, R. (forthcoming) "Estimating the Effects of the Container Revolution on World Trade," *Journal of International Economics*.

Besley, T., Reynal-Quero, M. (2014) "The Legacy of Historical Conflict: Evidence from Africa," *American Political Science Review*, 108(2), 319–336.

Bloom, D., Canning, D., Fink, G. (2008) "Urbanization and the Wealth of Nations," *Science*, 319(5864), 772–775.

Brückner, M. (2013) "On the Simultaneity Problem in the Aid and Growth Debate.," *Journal of Applied Econometrics*, 28, 126–150.

Chudik, A., Pesaran, M. (2013) "Large Panel Data Models with Cross-sectional Dependence: A Survey," in B. Baltagi ed. *The Oxford Handbook on Panel data (forthcoming)*, Oxford: Oxford University Press.

Chudik, A., Pesaran, M., Tosetti, E. (2011) "Weak and Strong Cross-Section Dependence and Estimation of Large Panels," *Econometrics Journal*, 14, C45–C90.

Collier, P., Dollar, D. (2001) "Can the World Cut Poverty in Half? How Policy Reform and Effective Aid Can Meet International Development Goals," *World Development*, 29(11), 1787–1802.

——— (2002) "Aid allocation and poverty reduction," *European Economic Review*, 46(8), 1475–1500.

Deaton, A. (2005) "Measuring Poverty in a Growing World (or Measuring Growth in a Poor World)," *Review of Economics and Statistics*, 87(1), 1–19.

Dollar, D., Kleineberg, T., Kraay, A. (forthcoming) "Growth still is good for the poor," *European Economic Review.*

Donaldson, D. (forthcoming) "Railroads of the Raj: Estimating the Impact of Transportation Infrastructre," *American Economic Review.*

Easterly, W., Levine, R. (1997) "Africa's Growth Tragedy:Policies and Ethnic Divisions," *Quarterly Journal of Economics*, 112(4), 1203–1250.

Elvidge, C., Hsu, F., Baugh, K., Ghosh, T. (2014) "Chapter 6. National Trends in Satellite-Observed Lighting: 1992-2012," in Q. Weng ed. *Global Urban Monitoring and Assessment through Earth Observation*: CRC Press.

Faye, M., McArthur, J., Sachs, J., Snow, T. (2004) "The Challenges Facing Landlocked Developing Countries," *Journal of Human Development*, 5(1), 3168.

Feyrer, J. (2009a) "Trade and Income-Exploiting Time Series in Geography," *NBER Working Paper no. 14910.*

——— (2009b) "Distance, Trade and Income-The 1967 to 1975 closing of the Suez Canal as a Natural Experiment," *NBER Working Paper no. 15557.*

Frankel, J., Romer, D. (1999) "Does Trade cause Growth," *American Economic Review*, 89(3), 379–399.

Gwatkin, D. (2004) "Are Free Government Services the Best Way to Reach the Poor?", Washington, DC: World Bank.

Halder, A., Kabir, M. (2008) "Child Mortality Inequalities and Linkage with Sanitation Facilities in Bangladesh," *Journal of Health Population and Nutrition*, 26, 64–73.

Hanson, G. (1996) "Localization Economies, Vertical Organization and Trade," *American Economic Review*, 86(5), 1266–1278.

——— (2005) "Market Potential, Increasing Returns and Geographic Concentration," *Journal of International Economics*, 67, 1–24.

Harding, M., Lamarche, C. (2011) "Least Squares Estimation of a Panel Data Model with Multifactor Error Structure and Endogenous Covariates," *Economics Letters*, 111, 197–199.

Harris, C. (1954) "The Market as a Factor in the Localization of Industry in the United States," *Annals of the Association of American Geographers*, 44(4), 315–348.

Henderson, J., Storeygard, A., Weil, D. (2012) "Measuring Economic Growth from Outer Space," *American Economic Review*, 102(2), 994–1028.

Kapetanios, G., Pesaran, M., Yamagata, T. (2011) "Panels with Non-stationary Multifactor Error Structures," *Journal of Econometrics*, 160, 326–348.

Limao, N., Venables, A. (2001) "Infrastructure, Geographical Disadvantage, Transport Costs, and Trade," *The World Bank Economic Review*, 15(3), 451–479.

Lin, F., Sim, N. (2013) "Trade, Income and the Baltic Dry Index," *European Economic Review*, 59, 1–18.

Marshall, M., Jaggers, K. (2009) *Polity IV project: Dataset users' manual*, Center for global policy, George Mason University.

Nair-Reichert, U., Weinhold, D. (2001) "Causality Tests for Cross-country Panels: a New Look at FDI and Economic Growth in Developing Countries," *Oxford Bulletin of Economics and Statistics*, 63(2), 153–171.

Pesaran, M. (2006) "Estimation and Inference in Large Heterogeneous Panels with a Multifactor Error Structure," *Econometrica*, 74(4), 967–1012.

Radelet, S., Sachs, J. (1998) "Shipping costs, Manufactured Exports, and Economic Growth," Mimeographed document, Harvard Institute for International Development, Harvard University.

Rajan, R., Subramanian, A. (2011) "Aid, Dutch disease, and manufacturing growth," *Journal of Development Economics*, 94(1), 106–118.

Rasmussen, T., Roitman, A. (2011) "Oil Shocks in a Global Perspective: Are they Really that Bad?", IMF Working Paper.

Ravallion, M., Chen, S. (1997) "What Can New Survey Data Tell Us about Recent Changes in Distribution and Poverty?" *World Bank Economic Review*, 11(2), 357–382.

Redding, S., Sturm, D. (2008) "The Costs of Remoteness: Evidence from German Division and Reunification," *American Economic Review*, 98(5), 1766–1797.

Redding, S., Venables, A. (2004) "Economic Geography and International Inequality," *Journal of International Economics*, 62, 53–82.

Ross, M. (2006) "Is Democracy Good for the Poor?" *American Journal of Political Science*, 50(4), 860–874.

Sim, N. (2006) "Environmental Keynesian macroeconomics: Some further discussion," *Ecological Economics*, 59(4), 401–405.

Stock, J., Yogo, M. (2005) "Testing for Weak Instruments in Linear IV Regression," in D. Andrews, J. Stock eds. *Identification and Inference for Econometric Models: Essays in Honor of Thomas and Rothenberg*, Cambridge: Cambridge University Press.

UN-OHRLLS (2013) "The Development Economics of Landlockedness: Understanding the Development Costs of Being landlocked."

UNCTAD (2009) "Oil Prices and Maritime Freight Rates: An Empirical Investigation."

United Nations (2014) "Programme of Action for Landlocked Developing Countries for the Decade 2014-2024," Second United Nations Conference on Landlocked Developing Countries, Vienna.

Wagstaff, A. (2000) "Child Mortality Inequalities and Linkage with Sanitation Facilities in Bangladesh," *Bulletin of the World Health Organization*, 78(1), 19–29.

Werker, E., Ahmed, F., Cohen, C. (2009) "How is Foreign Aid Spent? Evidence from a Natural Experiment," *American Economic Journal: Macroeconomics*, 1(2), 225–244.

World Bank (2013) "Improving Trade and Transport for Landlocked Developing Countries."

World Bank-United Nations (2014) "Improving Trade and Transport for Landlocked Developing Countries."

# Appendix B

Table B1: Summary Statistics

| Variable | Obs | Mean | Std. Dev. | Min | Max |
|---|---|---|---|---|---|
| CMR (per 1,000) | 372 | 85.16 | 48.49 | 7.400 | 217.4 |
| containerizable trade share (0-1) | 372 | 0.525 | 0.146 | 0.115 | 0.930 |
| Harpex Cost | 372 | 3.534 | 0.913 | 1.147 | 5.871 |
| IMR (per 1,000) | 372 | 56.71 | 25.63 | 6.500 | 113.1 |
| LE | 372 | 59.26 | 9.257 | 42.51 | 75.03 |
| log(FDI) | 372 | 22.90 | 2.254 | 15.21 | 28.40 |
| log(Foreign aid) | 372 | 3.796 | 0.848 | 1.317 | 6.013 |
| log(GDP per capita) | 372 | 6.573 | 0.952 | 4.918 | 8.757 |
| log(Harpex) | 372 | 6.731 | 0.503 | 5.778 | 7.416 |
| log(lights per capita) | 372 | -5.212 | 1.460 | -8.326 | -2.889 |
| log(trade per capita) | 372 | -0.719 | 1.392 | -3.877 | 2.287 |
| Polity-2 | 360 | 1.022 | 6.292 | -10 | 10 |

Table B2: List of Variables, Definitions and Sources

| Variable | Description | Source |
|---|---|---|
| CMR | Mortality rate, under-5 (per 1,000 live births) | WDI |
| CPI | The US urban consumer price index | US Bureau of Labor Statistics |
| FDI | Nominal FDI stock (millionUS Dollars at current prices) | UNCTAD |
| Foreign aid | Nominal ODA (million US Dollars at current prices) | UNCTAD |
| GDP per capita | Real GDP per capita (US dollars in 2005 price) | UNCTAD |
| Harpex | Harpex index | Harper Petersen & Co |
| IMR | Mortality rate, infant (per 1,000 live births) | WDI |
| LE | Life expectancy at birth, total (years) | WDI |
| Night lights | Lights index | Elvidge et al. (2014) |
| Polity-2 | Polity2 score, -10 to 10 | Polity IV data |
| Population | Total population (thousand) | UNCTAD |
| Trade | Nominal trade (million US dollars at current prices) | UNCTAD |

# Chapter 4

# Exports and Urbanization: Evidence from Sub-Saharan African Countries

by

Ngoc T.A. Pham

*School of Economics, University of Adelaide*

# Statement of Authorship

| | |
|---|---|
| Title of Paper | **Exports and Urbanization: Evidence from Sub-Saharan African Countries** |
| Publication Status | ☐ Published ☐ Accepted for Publication ☐ Submitted for Publication ☑ Unpublished and Unsubmitted w ork w ritten in manuscript style |
| Publication Details | This paper is written in Publication Style for submission to a journal. |

## Principal Author

| | | | |
|---|---|---|---|
| Name of Principal Author (Candidate) | Ngoc T.A. Pham | | |
| Contribution to the Paper | This paper is written by a sole author (the Candidate) | | |
| Overall percentage (%) | 100% | | |
| Certification: | This paper reports on original research I conducted during the period of my Higher Degree by Research candidature and is not subject to any obligations or contractual agreements with a third party that would constrain its inclusion in this thesis. I am the sole author of this paper. | | |
| Signature | | Date | 2016. 1.15 |

## Abstract

This paper explores the effect that exports might have on urbanization in Sub-Saharan African countries (SSAs) between 1985 and 2012. We use a recent advancement in panel data estimation, the correlated common effects (CCE) estimator, which employs interactive fixed effects to handle a large class of omitted and potentially confounding variables and cross-sectional dependence. We also use a known instrumental variable for exports relevant to the SSAs to address the possibility of reverse causality, where the instrument is related to the Baltic Dry Index (BDI), a measure that summarizes the shipment cost of primary goods which the SSAs mainly export. We find that the doubling of exports per capita, on average, is associated with a 7.876 percentage point increase in the urbanization rate, a 4 percentage point increase in the size of primate cities, and an 8% decline in income levels of these cities. We also find that an increase in exports can lead to improvements in urban infrastructure (i.e. water accessibility and sanitation facilities), but at a cost of increasing urban-rural inequality in accessing clean water and sanitation facilities. To explain how exports can affect the urbanization rate, we investigate the effect that exports may have on shaping a country's production in agriculture, manufacturing and services. We find that the size of the services sector responds significantly to an expansion in exports, this subsequent increase in turn is associated with higher rates of urbanization in the SSAs.

**Key Words**: Urbanization · Urban Development · International Trade · Structural Transformation · Cross-section Dependence · Panel Data · Common Correlated Effects
**JEL Codes**: O18 · F15 · C23 · R11

# 1 Introduction

Improving living standards is a key priority faced by both policymakers and researchers. This is important to 48 Sub-Saharan African countries (SSAs) which are classified as less developed and home to 13% of the world's population (i.e. 961.5 million).[1] The dramatic urbanization process may reflect improvements in living standards in the SSAs because urbanization is characterized as one feature of economic development (Kuznets, 1973).[2] In fact, the SSAs have the highest growth rate of urbanization in the world.[3] As recent as 2014, at least 37% of the population in the SSAs is living in urban areas, whereas the figure was below 10% in 1950. If urbanization captures one aspect of development, finding factors contributory to determining this process may help the SSAs to achieve their development goals and enhance living conditions.

As early as Robertson (1940), trade-related activities were characterized as an "engine of growth" by which a country can achieve its goals of development and improving living standards. Since the SSAs export at low levels, accounting for 2% of the world's exports, if it is the case that exports can promote a country's development (an insight from Frankel and Romer, 1999), then expanding exports may also contribute to the SSAs' high rates of urbanization. To explore this possibility, in this paper, we investigate the extent to which an expansion in exports may affect the urbanization rate in 48 SSAs during the 1985-2012 period.

However, examining the correlation between exports and urbanization does not provide evidence on the causal effect of exports on urbanization because exports and urbanization can be confounded by unobserved factors that may generate cross-

[1] 33 out of 48 SSAs are listed as least developed countries.

[2] Kuznets (1973) noticed that economic development was a multidimensional concept in which a country's development could be characterized by the high growth rate of income per capita, changes in economic structure and urbanization.

[3] According to United Nations (2014), the SSAs' growth rate of urbanization is 50% higher than the average growth rate of the world.

sectional dependence or spatial dependence across space. For example, climate change (i.e. low rainfall) can affect agricultural production, reduce exports and influence decisions on urban migration significantly (Brückner and Ciccone, 2011; Brückner, 2012; Henderson et al., 2014).[4] Since climate or weather patterns are cross-sectionally related, they can generate dependence among countries across space. Furthermore, measurement error and reverse causality can threaten the estimated effect that exports might have on urbanization. For instance, data on the urbanization rate may contain measurement error that is related to export activities. Decisions on the urban-rural devision are based on a population distribution that can be driven by the concentration of economic activities like exports. If countries do not often update their urban definition, their data on the urban population and urbanization may contain measurement error and are incomparable. Thus, the relationship between exports and urbanization will be estimated inconsistently (Wooldridge, 2012). Reverse causal effect is another issue as countries can implement urban-related policies to accommodate exports (World Bank, 2009),[5] the causal relationship thus can run from urbanization to exports.

To address confounding factors, we use a recent advancement in panel data estimation, the correlated common effects (CCE) estimator, which employs interactive fixed effects to handle a large class of omitted and potentially confounding variables and cross-sectional dependence. This interactive fixed effects framework also subsumes the country and time fixed effects structure as a special case (Pesaran, 2006; Bai, 2009).[6] To estimate the effect of exports in the interactive fixed effects structure, we adopt a novel econometric technique, the CCE estimator of Pesaran (2006). The

[4] Brückner and Ciccone (2011) showed that GDP per capita in the SSAs responded strongly to low rainfall because these countries mainly produce agricultural products which are weather dependent. Thus, negative weather shocks may shift people to cities and increase the urbanization rate (Brückner, 2012; Henderson et al., 2014).

[5] World Bank (2009) reported that the SSAs export at low levels due to their low urban population density.

[6] The two-way or country and year fixed effects panel data model is widely used in empirical literature on economic development (Brückner, 2012; Henderson et al., 2013).

CCE enables us to find proxies for unobserved common factors so that the coefficient of interest can be estimated consistently. To address the possibility of endogeneity, we employ an instrumental variable approach from Harding and Lamarche (2011) which extends the CCE of Pesaran (2006). To construct an instrumental variable for exports, we interact between the Baltic Dry Index (BDI), an international shipping rate for dry bulk cargoes, and the country-specific fixed exports share of primary commodities. The construction of this indicator is based on an insight from Lin and Sim (2013, 2015) who argued that less developed countries mainly exported primary commodities, and thus, responded highly to bulk shipping rates. The fixed share reflects the relative intensity of bulk shipping utilization in each SSA, as such, the share will amplify the response of exports due to fluctuations in the bulk shipping rates in the market. Crucially, our instrument contains both country- and year-specific information that will not be "cleaned out" by proxies of unobserved common factors in the interactive fixed effects framework, and therefore can be employed in panel data regressions.

Our main results show that the doubling of exports per capita can raise the urbanization rate in the SSAs by 7.876 percentage points on average. Our regression results are robust to the inclusion of several control variables that are key determinants of urbanization such as income (Moomaw and Shatter, 1996; Davis and Henderson, 2003; Henderson et al., 2013)[7] and "urban bias" policies relating to political regimes (Ades and Glaeser, 1995; Junius, 1999; Davis and Henderson, 2003; Henderson et al., 2013).[8]

[7]Using cross-country in panel data, Moomaw and Shatter (1996) found that GDP per capita was positively associated with urbanization. However, this finding was potentially inconsistent as the pooled OLS estimate cannot handle omitted variable bias (i.e. historical institutions) and endogeneity (i.e. the simultaneous determination of urbanization and income levels). Davis and Henderson (2003) employed panel data and lagged variables to address omitted variable bias and endogeneity. They showed that an increase in GDP per capita could cause the urbanization to raise across countries, including the SSAs. Similarly, Henderson et al. (2013) found that the SSAs were urbanizing as a result of accumulating human capital.

[8]Ades and Glaeser (1995) found that the size of cities in autocratic countries was 50%

We also find that exports can affect the growth of primate cities and promote urban development. The doubling of exports per capita, on average, can increase the population of primate cities (holding urban population constant) by 4 percentage points, but can reduce income levels in these cities. To investigate the effect of exports on income levels of primate cities, we use data on the amount of associated satellite-recorded nighttime lights per capita which is correlated with income but yet is available at subnational level (Henderson et al., 2012).[9] This is because data on GDP of primate cities is scant in less developed countries (i.e. the SSAs). In doing so, we find that the night lights per capita of primate cities will, on average, decline by 29% as exports per capita double. Using the lights-income growth elasticity of 0.284 from Henderson et al. (2012), this result also roughly translates into a 8% decrease in primate cities' true income. Our results further show that exports can improve urban development in terms of infrastructure. Following the doubling in exports per capita, the proportion of urban residents that can access improved clean water and sanitation facilities, on average, will increase by about 7 and 5 percentage points respectively, whereas the urban-rural gap in water access and sanitation facilities will expand by roughly 10 and 6 percentage points. These estimates suggest urban residents are likely beneficial from exports more than their rural counterparts.

We then explore if exports relate to changes in production activities or structural transformation which can generate urban-rural migration within countries. We find that an expansion in exports per capita can reduce agricultural production but raise

larger than their counterpart in democratic countries. They argued that incumbents in non-democratic countries were likely to allocate more resources for urban areas to persuade voters and to enforce their political power. However, Junius (1999) offered evidence that the effect of political factor was moderate on raising the density of urban population. Davis and Henderson (2003) even showed that democratic governments tend to provide resources to develop hinterlands and that consequently urbanization would decline.

[9]Based on insight that the night lights reflect economic activities at night, Henderson et al. (2012) proposed the use of the satellite lights index an alternative of GDP in measuring economic growth. Henderson et al. (2012) found that the night lights could be a better proxy for growth in cities/countries whose income data quality is poor (i.e. the SSAs). Supporting the findings of Henderson et al. (2012), Storeygard (forthcoming) showed that cities' lights could be used in place of cities' GDP in the SSAs.

total output of the manufacturing and services sectors. The subsequent changes in each sector are then linked to the urbanization rate. Evidently, higher exports can expand the size of services sector which in turn relates to the urbanization process in the SSAs.

Our paper is related primarily to three areas within the literature on urbanization. The first is the debate on whether economic growth can affect urbanization. Davis and Henderson (2003), among others, showed that income per capita could increase urbanization substantially in that a 1% increase in GDP per capita could raise the urbanization rate by 19% on average. However, Fay and Opal (2000), Brückner (2012) and Jedwab and Vollrath (forthcoming) found no evidence on the impact of growth on urbanization in the SSAs.[10] Our paper contributes to this body of work, showing that exports can affect decisions on urban-rural migration regardless a given level of real income measured by GDP per capita or night lights per capita.

The second set of related literature concerns whether structural transformation can drive urbanization. As early as Williamson (1965), it was predicted that an economy would transform from rural-based agriculture to urban-based manufacturing when its sectoral productivity increased as a result of economic growth. Laborers are pushed to the manufacturing sector (Gollin et al., 2002), pulled out of the agricultural sector (Michaels et al., 2012) or are shifted to the services sector (Jedwad, 2013; Gollin et al., forthcoming). We contribute to this literature by offering further evidence that exports increase the size of the services sector, which can drive urbanization.[11]

[10]Brückner (2012) found that once he controlled for the size of agricultural sector, urbanization in the SSAs did not respond to the growth in GDP per capita. In their review, Jedwab and Vollrath (forthcoming) argued that urbanization could occur because of an increase of urban utility (i.e. better human capital or eduction in cities).

[11]Our paper is closest to Gollin et al. (forthcoming) in that exports were found to relate to urbanization in the SSAs. However, Gollin et al. (forthcoming) were interested in the correlation between natural resource exports and urbanization, whereas we focus on the causal effect that exports might have on urbanization. Moreover, Gollin et al. (forthcoming) mainly based on OLS cross-sectional estimates that might be affected by unobserved factors which might generate cross-sectional dependent (i.e. historical institutions, colonialism) or

From the broad literature of urbanization, our paper contributes to the new economic geographical literature that focuses on whether trade and transport costs can shape economic activities within countries. For example, Ades and Glaeser (1995) and Krugman (1996) showed that trade and people were more concentrated in cities as transport costs from and to cities were cheaper than the costs from and to hinterlands. Storeygard (forthcoming) found that negative shocks to transport costs caused by oil prices could increase the size of cities near trade hubs. Our estimates suggest that an increase in shipping costs for exports (i.e. the BDI-based instrument) can deter urbanization through a reduction in exports. We also find that exports can expand the size of primate cities (i.e. primacy), but put upward pressure on income levels of these cities.

Finally, our paper offers further evidence on the "impact of international trade on standards of living" (Frankel and Romer, 1999) by looking at a different aspect of development: urbanization. In their landmark paper, Frankel and Romer (1999) showed that an expansion in trade could improve economic development by increasing GDP per capita. This causal relationship has been supported by numerous papers (Feyrer, 2009a,b; Lin and Sim, 2013).[12] Our paper finds that an increase in exports can lead the urbanization rate to raise. In addition, we show that exports can relate to urban development which is linked to the research on whether urbanization can put upward pressure on urban infrastructure (i.e. clean water accessibility, sanitation facilities) (Patel and Burke, 2009; Ramin, 2009; Glaeser, 2014).[13]

---

spatial correlated (i.e. climate change). We address these issues by adopting the interactive fixed effects framework with the CCE approach.

[12]Feyrer (2009b), for example, employed the closing and re-opening of the Suez Canal to generate shocks to shipping costs and found that a 1% increase in trade could raise income levels by 0.2% on average. Considering a shipping cost for primary goods based on the BDI, Lin and Sim (2013) found that the trade elasticity of income was 0.5.

[13]Urban dwellers' heath may suffer due to a lack of clean water (Patel and Burke, 2009) and sanitation facilities (Ramin, 2009) if the growth of the urban population exceeded improvements in urban infrastructure. At worst an overcrowding urban population could put upward pressure on urban living conditions such as higher poverty and poorer infrastructure (i.e. a lack of clean water or air pollution) (Glaeser, 2014).

The remainder of this paper is as follows. In Section 2, we describe our main variables of interest and the construction of our BDI-based shipping cost for exports. Section 3 presents the econometric strategy – the CCE – and relevant identification issues. Empirical results are discussed in Sections 4, 5 and 6. Section 7 concludes the paper.

# 2 Data and Variables

Our data for 48 SSAs spans from 1985 to 2012. The dataset is constructed mainly from the United Nations Conference on Trade and Development (UNCTAD), NBER-UN, the United Nations (UN), the World Development Indicators, and the International Labour Organization. The main variables of interest are explained below, while their summary statistics, variable definitions and sources are provided in Tables C1 and C2, respectively, of the Appendix C.

## 2.1 Data on Exports

The exports data is constructed from (i) NBER-UN database between 1970 and 1994, and (ii) UNCTAD database between 1995 and 2012.[14] As these data are expressed in nominal terms, we deflate them by the US urban commodity price index at the price of 2005 US dollars.[15]

[14]The NBER-UN trade data spans from 1962 to 2000 (Feenstra et al., 2005), while the UNCTAD data starts from 1995. We compare these 2 datasets for the overlapping period (i.e. 1995-2000) and find that the difference is insignificant. See http://unctadstat.unctad.org/wds/ReportFolders/reportFolders.aspx

[15]See http://data.bls.gov/cgi-bin/surveymost?cu

## 2.2 Data on Urbanization

For urbanization, we use the urbanization rate defined as the proportion of urban population to total population. This series is available from the UN database. As a caveat, urban population may not be measured consistently across countries and years. According to United Nations (2014), urban areas in each country could be designated by different features such as population size (e.g. from 200 to 50,000 inhabitants), population density, and economic characteristics (e.g. manufacturing and service sectors). These features within countries might change over years, which in turn introduces the complexity of an urban versus rural devision. To reduce the inconsistencies, the UN has revised the data, but issues of measurement error and incomparable data may still exist.[16,17] Nevertheless, if measurement error is not correlated with exports, our results will be consistent (Wooldridge, 2012). This assumption is likely violated as people may decide to migrate to cities where export earnings are spent (Gollin et al., forthcoming),[18] or because climate change, which is cross-sectional dependent, can drive people out of rural areas (Henderson et al., 2014).

[16]The UN derives the urban population data from national censuses which are collected on the basis of population registers.

[17]For example, some rural areas might have population density that is higher than the cutoff point for urban areas after years. However, countries may or may not revise their urban-rural division immediately, so their censuses may be misrepresentative and not be comparable. Even despite the revision, the UN estimates may still contain measurement error and incomparable. This is because the actual urban population data could not fully observed and the UN is uninformed about the change in urban versus rural division across countries and years.

[18]According to Gollin et al. (forthcoming), export revenues might mainly be spent on urban goods. This will influence people's decision about migrating from rural to urban areas to fulfill their requirements.

## 2.3 Data on Urban Development

For urban development, we consider several variables in terms of primate cities and urban infrastructure. We first look at the growth of primate cities captured by the relative size of population and income levels. For the relative size of the population of primate cities, we use primacy from the World Development Indicators which is the proportion of urban inhabitants that live in the largest city. Although primate cities may be established on the basis of their convenient location for trade and economic activities (Ades and Glaeser, 1995; Moomaw and Shatter, 1996; Junius, 1999; Storeygard, forthcoming), the economic growth of primate cities is not always guaranteed (Glaeser et al., 2008; Ramin, 2009).[19] To test this possibility, we consider income levels of primate cities. However, GDP of primate cities is scant for the SSAs, and the GDP data quality is questionable (Henderson et al., 2012) as 45% databases in the SSAs are rated "poor" by World Bank (2002). To overcome this issue, we use the satellite-recorded night lights data associated with primate cities to measure real income as suggested in recent development literature (Henderson et al., 2012; Storeygard, forthcoming). It is argued that the quality of the night lights data is better than that of GDP in the SSAs because of technological developments,[20] and it can be collected at a disaggregated level, such as cities or regions, with high quality.[21] We obtain the total night lights data of primate cities between 1992 and 2008 from Henderson et al. (2012) and compute the associated night lights per capita.

Finally, we look at urban infrastructure captured by water accessibility and san-

[19]Glaeser et al. (2008) found that urban poverty was associated with urban concentration because the poor were likely to move to city centers to reduce their transport expense. Consistent with this finding, Ramin (2009) raised a concern about the link between urbanization and urban poverty in the SSAs.

[20]During a certain period every night satellites take photos of nighttime lights for all countries in the world. When light is detected, an index from 0 to 63 is assigned to that location. As such, the intensity of lights is almost fully observed.

[21]Even the night lights data contains measurement error, this problem is mainly because of technical development issues that are uncorrelated with economic factors (i.e. institutions). On the other hand, measurement error of the GDP data may not be that random (Ross, 2006).

itation facilities in urban areas. It has been argued that the dramatic urbanization process in the SSAs puts upward pressure on urban infrastructure resulting in low levels of clean water usage and sanitation facilities (Ramin, 2009; Patel and Burke, 2009).[22] Without taking into account the effect of exports on urban infrastructure, we may miss an important part of urban development related to urbanization. We derive the proportion of urban residents to total population that can access clean water and sanitation facilities from related information of the World Development Indicators.[23]

## 2.4 Data on Sectoral Production

To measure a country's production activities, we consider the performances of 3 main sectors: agricultural, manufacturing and services. To measure the performance of each sector, we compute data on total production, employment and productivity. For the first measure, we compute the sectoral total production based on the contributions of each sector to total GDP (i.e. value added or the percentage of net output in each sector to total GDP) from the World Development Indicators.[24] The second measure is sectoral employment obtained from the International Labour Organization over the 1991-2012 period.[25] The final indicator is sectoral productivity defined as the total net output divided by the number of sectoral workers from 1991 to 2012.

[22]Ramin (2009) and Patel and Burke (2009) noticed that urban infrastructure did not grow at the same rate as urban population. Although urbanization is expected to bring a better quality of life to its residents (Young, 2013), insufficient infrastructure has left a large proportion of urban population to live poor conditions.

[23]We also attempt to examine if exports can reduce urban poverty. However, urban poverty data is not collected frequently in the SSAs. The large number of missing values in this series prevents us from using the CCE structure that requires large and reasonably balanced panel data (Chudik and Pesaran, 2013).

[24]The real GDP per capita data is obtained from the UNCTAD database, measured at the rate of 2005 US dollars.

[25]Global Employment Trends 2014.

There may be some concern over data quality which may affect our estimates. It is undeniable that the statistical systems in the SSAs are weak (World Bank, 2002), so the data of value-added and employment by sector may be highly interpolated. The interpolation can be a main source of variation in our variables and it could affect our estimation results. To address this issue we control for both time trends and unobserved common factors in our econometric framework.

## 2.5 A Measure of Export Cost

In this paper, we follow Lin and Sim (2013, 2015) to construct an instrument for exports that extracts information of shipping costs from the global index – the Baltic Dry Index (BDI) – whose time series data is plotted in Figure 1. The BDI was first introduced by the Baltic Exchange in 1985 and soon became a general indicator of international shipping rates for dry bulk cargoes.[26] This index reflects freight costs of shipping raw commodities such as grain, coal, iron ore, copper and other primary materials. As the SSAs mainly export raw materials and agricultural commodities (Nicita and Rollo, 2013; World Bank, 2015), it makes the SSAs dependent on dry bulk carriers and the BDI becomes a relevant indicator of export costs faced by the SSAs.

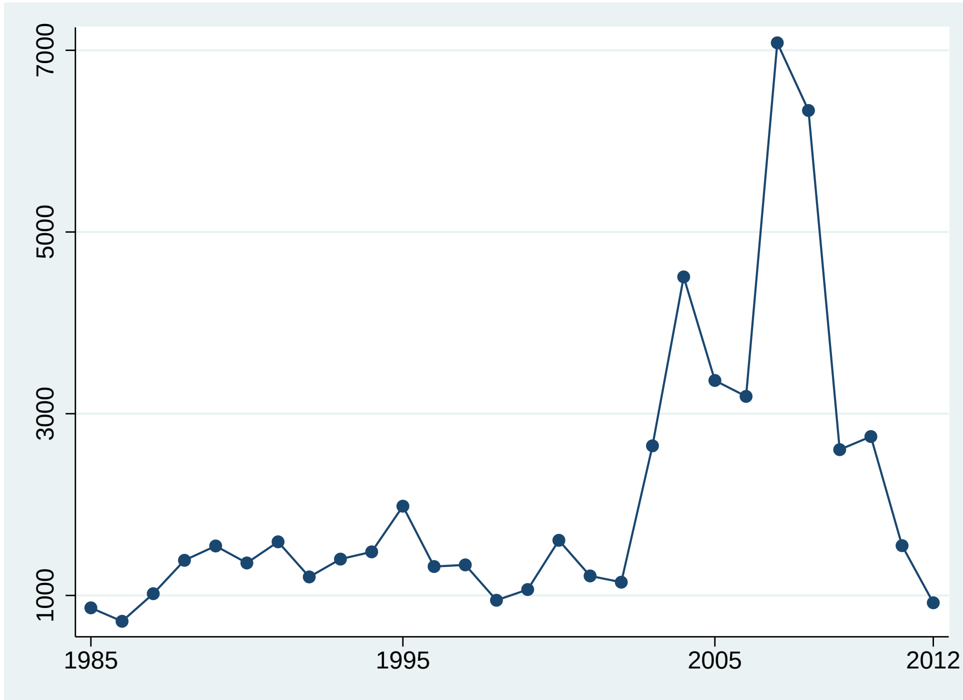
To construct an instrument for each SSA's exports using the BDI (called "BDI Cost" hereinafter), we follow Lin and Sim (2013, 2015) and specify:

$$Cost_{it} = \theta_i log(BDI_t), \quad (1)$$

where $\theta_i \equiv T^{-1} \sum_{t=1}^{T} \theta_{it}$ is the average (time-invariant) share of primary good exports to country $i$'s total export earnings over 1970-2012. To compute country $i$'s exports of primary commodities, we collect export data of SITC subclasses

[26] http://www.dallasfed.org/pages/institute/annual/2010/annual10e.cfm

Figure 1: The Baltic Dry Index




0+1+2+4+32+67+68 which contain a wide-range of primary commodities but exclude crude oil. Crude oil is excluded because it requires “wet” carriers (i.e. oil tankers), whereas the BDI relates to “dry” carriers. The primary products share of each country is then fixed by averaging across years. This share contains country-specific information of the relative intensity of bulk shipping utilization. By interacting $\theta_i$ with the BDI which contains year specificity, *BDI Cost* contains both country- and year- specific effects and therefore can be used in panel data models without being “clean out”. Intuitively, Eq. (1) captures the idea that the costs of bulk shipping would matter more for countries where primary commodities exports are important.

# 3 Methodology

Our main estimating equation relates urbanization and exports per capita of country $i$ at year $t$ as follows:

$$urbanization_{it} = \beta log(exports_{it}) + \psi' x_{it} + \gamma' d_t + \lambda_i' F_t + \varepsilon_{it}, \quad (2)$$

where $\beta$ summarizes how exports per capita affect urbanization or the semi-elasticity of urbanization with respect to exports, $x_{it}$ is a set of control variables that we consider in our robustness checks, $d_t$ is a vector of observed common factors which is either deterministic (i.e. intercepts) or unit root stochastic (i.e. time trends), and $F_t$ represents a set of unobserved common factors such as technological development or global shocks.[27] These common factors may affect each SSA differently as $F_t$ is interacted with a possibly unique vector of country factor loadings, $\lambda_i$.

## 3.1 Estimation Issues

Estimating $\beta$ consistently is a challenge because exports per capita can be correlated with omitted variables or cross-sectional dependence may present in the data. Exports can be also endogenous as the urbanization data may contain measurement error related to exports-related activities, and the causal relationship may run from urbanization to exports.

### 3.1.1 Omitted Variables and Cross-sectional Dependence

Omitted variables bias is the first issue in our $\beta$ estimate. One example would be oil price shocks raising transportation costs that could influence decisions on reallo-

[27] For a baseline analysis, we only consider the constant term (intercepts) and country time trends for $d_t$.

cating economic activities (i.e. exports). As such, export-related activities would be more concentrated in cities near trade hubs where shipping costs are cheaper, and so is the population (Ades and Glaeser, 1995).[28] Furthermore, other determinants of urbanization such as foreign investment, foreign aid and government spending that are correlated with exports may be contained in $\varepsilon_{it}$ (Ades and Glaeser, 1995; Moomaw and Shatter, 1996; Fay and Opal, 2000; Davis and Henderson, 2003). These economic resources can be distributed toward cities, and urban residents are likely to benefit from these "urban bias" policies. As a result, people will to move to cities.

Secondly, the effect of exports on urbanization can be confounded by cross-sectional dependence between countries. Weather patterns, for instance, that are cross-sectionally dependent are difficult to control for. Countries which are heavily dependent on agricultural production such as the SSAs are highly affected by weather patterns or climate change (Fay and Opal, 2000; Brückner and Ciccone, 2011; Brückner, 2012; Henderson et al., 2014), and thus, exports and the population distribution could be cross-sectionally dependent owing to the spatial nature of weather systems.[29]

In order to capture unobserved confounders, we use the interactive fixed effects structure, i.e. $\lambda_i' F_t$, in Eq. (2). This framework is quite general because it subsumes the country and year fixed effects structure as a special case (Pesaran, 2006; Bai, 2009; Kapetanios et al., 2011), and absorbs information related to spatial and cross-sectional dependence among countries. Because common shocks may have heterogeneous effects on each country and countries may be cross-sectionally dependent, the standard two-way (country and year) fixed effects model cannot take into account

[28]In line with Ades and Glaeser (1995), Glaeser et al. (2008) found that Americans were probably moving to cities to reduce their transportation expenses. Focusing on the SSA cities, Storeygard (forthcoming) showed that the size of cities increased when transportation costs were hit by negative oil price shocks.

[29]For instance, Brückner and Ciccone (2011) found that shocks in climate change (i.e. drought) could cause agricultural production to decline in the SSAs. To seek alternative income sources, farmers will move to cities (Henderson et al., 2014). Similar findings are discussed in Fay and Opal (2000) and Brückner (2012).

of such confounding effects, and may therefore produce inconsistent estimates.[30] To address this issue, we employ the approach of Pesaran (2006) known as the common correlated effects estimator (CCE), which uses proxies to control for the common factors, $F_t$. The idea is that all variables (both dependent and independent variables) in the model are correlated with $F_t$. Thus, by averaging these variables across countries to filter out all country-specific information, the remaining cross-sectional averages can be correlated to $F_t$ asymptotically. This allows us to "control" for $F_t$ even though $F_t$ is unobservable.

We will implement the CCE approach throughout this paper given its advantages. First, the CCE will be consistent even if the true data generating process has a two-way fixed effects structure without cross-sectional dependence.[31] Second, the CCE approach is valid regardless of the time series properties of $F_t$, such as a common factor being a unit root (Kapetanios et al., 2011). This is a huge plus given that the presence of a unit root can lead to spurious empirical relationships.[32] Following a suggestion from Pesaran (2006), we use Newey-West robust standard errors for statistical inference.[33]

### 3.1.2 Measurement Error and Reverse Causality

Although the use of interactive fixed effects is a powerful way of dealing with omitted variables and cross-sectional dependence, it is not a panacea to endogeniety caused by measurement error and reverse causality. As discussed in Section 2, our variables of interest may contain measurement error because of the inconsistency in

[30]See Bai (2009), Chudik et al. (2011) and Chudik and Pesaran (2013) among others.

[31]Although in this case, the CCE will be less efficient than the two-way fixed effects estimator.

[32]Chudik et al. (2011) and Chudik and Pesaran (2013) showed that the CCE was valid regardless of cross-sectional dependence was either weak or strong in panel data models with spatial errors.

[33]There could be serial correlation in the error term as because current urbanization rates could be informative in predicting future urbanization.

urban data and the poor statistical systems in the SSAs. This type of measurement errors is likely correlated with exports, so our estimations can be inconsistent. Furthermore, there may be reverse causality running from urbanization to exports that can cause the CCE estimate of Eq. (2) to be susceptible to self-selection bias or reverse-causality problem. For example, countries that implement export-led growth policies may impose some policies to encourage more people to live in cities to accommodate exports sufficiently.[34]

To deal with endogeneity, this paper adopts an instrumental variable approach in which *BDI Cost* is used to instrument exports per capita. The exports-and-cost equation is given by:

$$log(exports_{it}) = \delta Cost_{it} + \Psi' x_{it} + \Gamma' d_t + \Lambda_i' F_t + \upsilon_{it}. \tag{3}$$

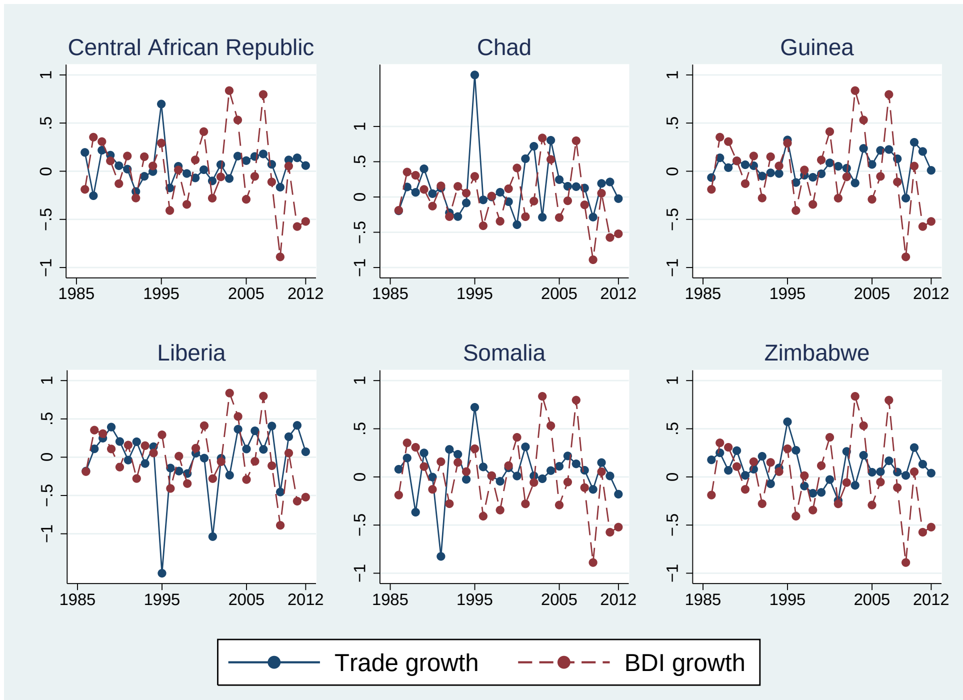
For *BDI Cost* to be a valid instrument, it must be plausibly exogenous and satisfy the exclusionary restriction. The exogeneity condition can be violated if an individual SSA has an influence on *BDI Cost* to some extent. From the perspective of the SSAs, the variation in the BDI – the main source of the variation in *BDI Cost* – can be taken as exogenous because the SSA is unlikely to have the ability to influence the cost of bulk shipping.[35] If an SSA has an ability to influence the BDI, we would expect that an increase in its trade would exert upward pressure on bulk shipping rates. However, in Figure 2 which presents the co-movement between the growth of the BDI and the growth of trade in some SSAs, the negative relationship of these two series could be clearly observed. Between 2002 and 2007 in which the volatility of the BDI was significant (e.g. the BDI went up by 131% from 2002 to

[34]World Bank (2009) noticed that although the SSAs were highly dependent primary exports, they export at low levels which could be due to the low density of the urban population or the shortage of an urban labor force.

[35]Given that *BDI Cost* is an interaction between the fixed share of primary commodities exports and the log of the BDI, the variation in this shipping cost is driven mainly by the BDI.

2003), the trade per capita of Chad and Liberia, for instance, fell by 25% and 21% respectively.

Figure 2: The BDI Growth and Trade Growth of a Sample of SSAs




*Note*: This figure plots the growth in the BDI and the growth in trade of some SSA. The left vertical axis measures the growth in the BDI and the right vertical axis measures the growth in trade per capita. The growth variables are constructed as the first difference of their respective values in logs.

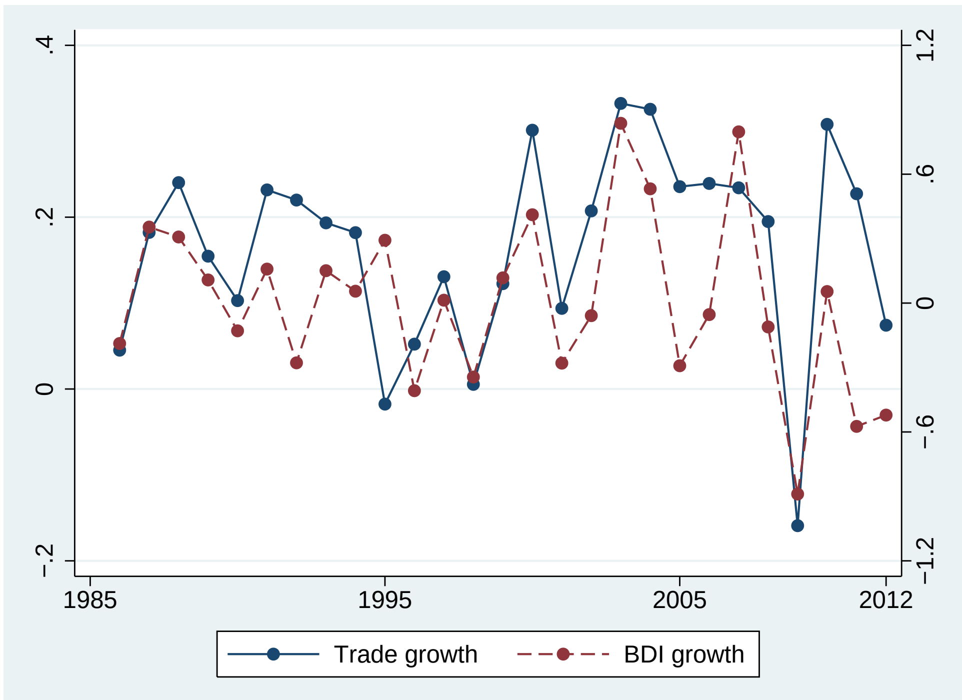
The variation in the BDI, on the other hand, is likely driven by large emerging economies such as China.[36] Since 2002, China has become the world's leading importer of iron ore and coal which are two important bulk commodities, thereby driving up the demand for bulk carriers and in turn influencing the BDI.[37] As one might expect, instead of the negative co-movement which is shown in Figure 2, we can see in Figure 3 that the fluctuation of the BDI closely follows changes in trade

[36]Jim Buckley, the CEO of the Baltic Exchange, remarked that "To put it in extremely simplistic terms, China is importing huge amounts of raw materials and exporting manufactured goods, and that's drawing ships into the Pacific." See `http://www.stockengineering.com/pictures/090104%20-%20BDI.pdf`.

[37]By 2015, China imported well over half the world's ship-borne iron ore and a quarter of its coal. See `http://www.economist.com/blogs/economist-explains/2015/03/economist-explains-7`

from China during 1985-2012. Because the BDI is a measure of shipping costs (and thus should be negatively associated with trade), the *positive* co-movement between the two could be symptomatic of the endogenous response of the BDI to the demand for trade by China.[38]

Figure 3: The BDI Growth and Trade Growth of China




*Note*: This figure plots the growth in the BDI and the growth in trade of China. The left vertical axis measures the growth in the BDI and the right vertical axis measures the growth in trade per capita. The growth variables are constructed as the first difference of their respective values in logs.

Some may argue that the SSAs' crude oil exports could be related to oil price shocks raising dry cargo freight rates or the BDI. By 2012, the SSA region ranks sixth in the world's fuel producers and its production accounts for 7% of the world's fuel output.[39] Whilst crude oil requires "wet" carriers, it can feedback on the BDI as bunker fuel oil is an input of dry shipping services (Kilian, 2009). However, as discussed by Frankel (2012), the influence of the SSAs on the world oil market was

[38]This tight positive relationship was also reported for other large primary goods producers such as Australia, Brazil, India and Russia in Lin and Sim (2013).

[39]See `http://www.eia.gov/pressroom/presentations/howard_08012013.pdf`

negligible, and their economies were classified as small, open economies.[40] Therefore, the BDI can be seen as plausibly exogenous to the SSAs.

For the exclusionary restriction, *BDI Cost* must be unrelated to the urbanization rate except through its link to exports for which it is serving as an instrument. The use of shipping cost as an instrument for trade-related activities (i.e. exports) has been around since Frankel and Romer (1999). In their groundbreaking paper, Frankel and Romer (1999) proposed to use shipping cost proxied by country-pairwise geographical distances as an instrument for trade-related activities by assuming that a country that was far away from its partner had to pay extra shipping cost for goods. Similarly, Feyrer (2009b) constructed an instrument for trade based on bilateral sea distances and exploited the closing and re-opening of the Suez Canal to generate time variation in sea distances that were otherwise time invariant. Departing from Feyrer (2009b), Lin and Sim (2013, 2015) constructed a country- and time-specific shipping cost for low income countries by extracting information of bulk dry shipping rates from the BDI.

We adopt the instrumental variable CCE framework (IV-CCE) of Harding and Lamarche (2011), which extends Pesaran (2006)'s CCE to a panel instrumental variable regression model with cross-sectional dependence. As urbanization could reverse affect exports, using the cross-sectional average of urbanization to control for unobserved $F_t$ can also lead to an endogenity issue. Borrowing the insight from Harding and Lamarche (2011), we use $Cost_{it}$ and its cross sectional average $\overline{Cost_t}$ to instrument $log(exports_{it})$ and its cross-sectional average $\overline{log(exports_t)}$.[41] To detect if *BDI*

[40]Frankel (2012) argued that developing countries that were resource-abundant were likely to expand their exports of crude oil. Even though these countries were net exporters of basis commodities like oil, they were still reasonably considered as price-takers for both export and import goods.

[41]Harding and Lamarche (2011) showed that under some regularity conditions, the cross-sectional averages of all variables in the system including instruments could be used as proxies for unobserved common factors similar to the Pesaran (2006) framework. However, as the main variables of interest are endogenous, so are their cross-sectional averages. Thus, these endogenous regressors have to be instrumented by the excluded instrumental variables and their cross-sectional average in the first-stage estimations.

*Cost* is a weak instrument, we report the Cragg-Donald F-statistic and evaluate it against a critical value, adopted from Stock and Yogo (2005), according to which 10% is the maximal rejection rate the researcher is willing to tolerate if the true rejection rate is 5%.

# 4 Results

## 4.1 Standard Estimates and the CCE Approach

While standard OLS regressions are bias and inconsistent, starting with OLS estimates can nevertheless provide useful insight into the magnitude of bias as well as the possible existence of threats to identification. Table 1 compares several standard estimates from the pool OLS to the two-way fixed effects model (Columns (1)-(4)) with that from the interactive fixed effects (i.e. CCE) model (Column (5)). The pool OLS estimate indicates a positive and significant correlation between exports per capita and urbanization (Column (1)). This positive relationship reduces when common trends in economic activities (i.e. general time trends) across all countries are added (Column (2)). However, the statistical significance disappears once country and year fixed effects are controlled for (Columns (3) and (4) respectively). If exports have a causal effect on urbanization, this exercise suggests that controlling for unobserved heterogeneity that affect each country all years uniquely (i.e. country fixed effects) or all countries each year identically (i.e. year fixed effects) is not sufficient to uncover the true effect of exports on urbanization.

We then report the CCE estimate (Pesaran, 2006) in Column (5). The 4.781 estimate indicates that as exports per capita increase by 1 log point (approximately doubled), urbanization increases by 4.781 percentage points on average. This result is statistically significant at 1% and its magnitude is far larger than the 0.265 estimate

Table 1: Exports and Urbanization - Standard Fixed Effects and CCE approaches

| | (1) | (2) | (3) | (4) | (5) |
|---|---|---|---|---|---|
| | | OLS and fixed effects | | | CCE |
| *Dependent variable:* | | | urbanization | | |
| log(exports) | 4.781*** | 4.714*** | 0.275 | 0.265 | 4.781*** |
| | (1.125) | (1.237) | (0.493) | (0.527) | (0.009) |
| Time trend | no | yes | yes | yes | yes |
| Country FE | no | no | yes | yes | n/a |
| Year FE | no | no | no | yes | n/a |
| Interactive FE | no | no | no | no | yes |
| Observations | 1274 | 1274 | 1274 | 1274 | 1274 |
| Countries | 48 | 48 | 48 | 48 | 48 |

*Note*: Columns (1)-(4) report the standard OLS and fixed effects estimates, while Column (5) presents the CCE result. Standard errors are reported in the parenthesis. Columns (1)-(4) report clustered robust standard errors, while Column (5) uses Newey and West robust standard error. Statistical significance at the 10%, 5% and 1% levels are indicated by *, ** and *** respectively.

of the two-way fixed effect model (Column (4)). While the CCE estimate coincides with the pool-OLS result in Column (1), the CCE produces smaller standard errors. It suggests that the unobserved factors influencing both exports and urbanization could be time heterogeneous and following a complicated structure (i.e. $\lambda_i' F_t$) rather than just a two-way fixed effects framework.

## 4.2 Baseline Results - the IV-CCE Approach

The CCE estimate reported in Table 1 Column (5) does not provide evidence of a causal relationship between exports and urbanization. To deal with endogeneity, we implement the IV-CCE method of Harding and Lamarche (2011) that uses *BDI Cost* to instrument exports per capita. Baseline results of Eq. (2) and (3) are reported in Table 2 Column (1).

Our first-stage estimate shows that exports and *BDI Cost* are negatively related, which is consistent with the literature on trade suggesting that shipping costs and

Table 2: BDI Cost, Exports and Urbanization

| | (1) IV-CCE | (2) Reduced form |
|---|---|---|
| *Dependent Variable:* | urbanization | |
| log(exports) | 7.876*** | |
| | (0.046) | |
| BDI Cost | | -3.138*** |
| | | (0.004) |
| *First-stage Dependent Variable:* | log(exports) | |
| BDI Cost | -0.398*** | |
| | (0.002) | |
| Time trend | yes | yes |
| Interactive FE | yes | yes |
| First-stage Cragg-Donald F-statistic | 38.588 | |
| Stock and Yogo critical value (10%) | 7.03 | |
| Observations | 1274 | 1274 |
| Countries | 48 | 48 |

*Note*: Newey and West robust standard errors are reported in the parenthesis. Statistical significance at the 10%, 5% and 1% levels are indicated by *, ** and *** respectively.

exports are negatively related (see Frankel and Romer, 1999; Feyrer, 2009a,b; Lin and Sim, 2013, 2015; Storeygard, forthcoming, among others). A one standard deviation increase in *BDI Cost*, on average, is associated with a 70% decline in exports per capita. The effect of our IV is negatively and statistically significant at 1%, and the Cragg-Donald F-statistic well exceeds the Stock and Yogo critical value. Thus, *BDI Cost* can be a strong instrument for exports in the SSAs.[42]

The coefficient of interest, 7.876 on $log(exports_{it})$, is statistically significant at

[42]The Cragg-Donald F-statistic, 38.588, is merely five times the 10% Stock and Yogo critical value (i.e. 7.03). The rule of thumb, 10, for accessing the strength of an IV is inapplicable in our IV-CCE. Unlike the standard instrumental variable approach, the IV-CCE framework has both $log(exports_{it})$ and its cross-sectional average $\overline{log(exports_t)}$ as endogenous variables. Thus, *BDI Cost* and its cross-sectional average are used to instrument for the two endogenous variables. The Stock and Yogo critical value then has to be adjusted accordingly.

1%. It implies that the doubling of exports per capita will, on average, lead to a 7.876 percentage point increase in urbanization. The IV-CCE coefficient is roughly twice that of the OLS-CCE estimate (see Column (5) in Table 1). Thus, ignoring reverse causality may underestimate the true effect of exports on urbanization. This finding supports the observation of Glaeser (2014) and Gollin et al. (forthcoming) that trade activities and urbanization were related. As discussed in Glaeser (2014), trade openness enabled developing countries to import food to fulfill domestic demand, rural-agricultural workers were released to urban-manufacturing sector, and thus, the urbanization rate increased. Like Glaeser (2014), our result shows that higher exports can cause urbanization to increase. Our finding is close to the work of Gollin et al. (forthcoming) in that the urban-rural migration decision was affected by earnings from natural resource exports. Although we do not directly examine the effect of natural resource exports on urbanization, our finding partially supports Gollin et al. (forthcoming) because the component of exports causing urbanization in our baseline model also includes exports of natural resources.[43]

To seek evidence on the core research interest of the new economic geography literature that transport costs are able to determine city locations and the growth of cities (Krugman, 1996), we estimate the reduced form equation given by:

$$urbanization_{it} = \beta Cost_{it} + \psi' x_{it} + \gamma' d_t + \lambda_i' F_t + \varepsilon_{it}, \tag{4}$$

where the estimation result is reported in Column (2) of Table 2. The coefficient of *BDI Cost*, -3.138, implies that a one standard deviation increase in *BDI Cost* can lower the urbanization rate by 5.532 percentage points on average. This decline could be due to a drop in exporting raw materials and natural resources when the shipping cost becomes expensive. This is compatible with the findings of Gollin et al. (forthcoming) who showed that an expansion in natural resource exports could drive

[43] *BDI Cost* captures the costs of shipping of both primary commodities and natural resources.

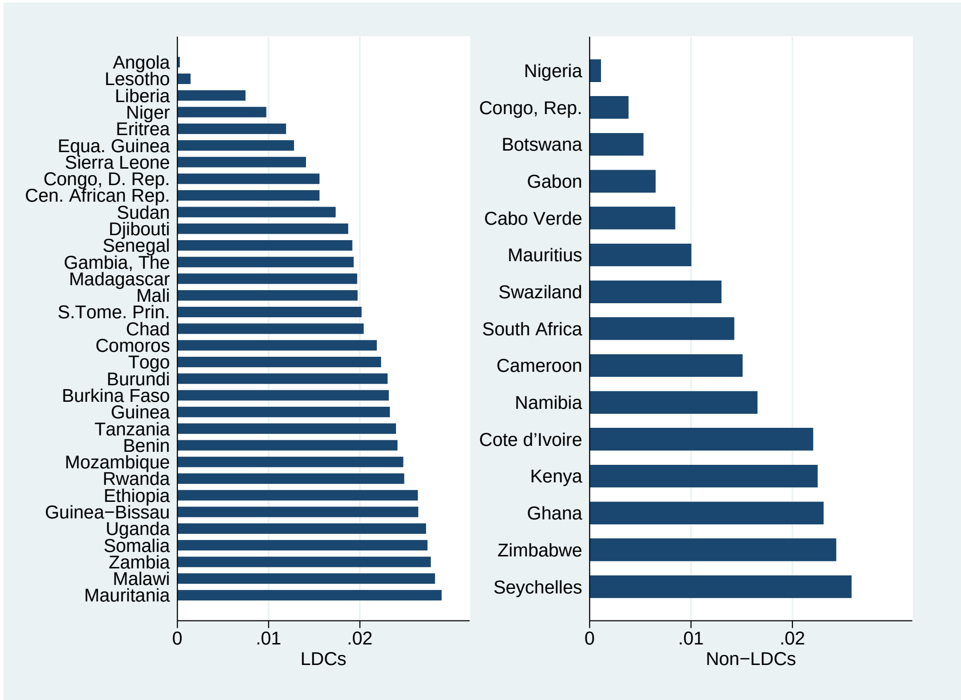
the urbanization process in the SSAs. However, our result differs from Ades and Glaeser (1995) and Storeygard (forthcoming) who found that high transport cost for trade could incentivize people to move to cities at subnational level. [44]

The effect of the BDI on urbanization could be heterogeneous across the SSAs. As indicated in Eq. (1), an SSA that relies heavily on exports of primary commodities would be more vulnerable to fluctuations in the bulk shipping costs, as is urbanization. To elaborate on this idea, we estimate the country-specific semi-elasticity of urbanization with respect to the BDI which is given by $\hat{\alpha}\theta_i$ where $\hat{\alpha}$ (equals to -3.138) is the estimated coefficient of *BDI Cost* (see Column (2) of Table 2), and $\theta_i$ is the fixed primary exports share of country $i$.

Figure 4 plots the absolute values of the average response of the urbanization rate following a 1% decline in the BDI for each SSA. As Figure 4 shows, the average absolute BDI semi-elasticity of urbanization is heterogeneous across countries. For most countries, this semi-elasticity ranges from 0.005 to 0.025, implying that the urbanization rate increases by 0.5-2.5 percentage points following a reduction of the BDI by 1 log point. Only Angola, Botswana, Republic Congo, Lesotho and Nigeria have semi-elasticity below 0.005. The insignificant response of urbanization to the cheaper BDI in these countries could be because Angola, Republic Congo and Nigeria are oil exporters and Botswana and Lesotho are diamond exporters. Their main exports are less closely related to the BDI as crude oil requires "wet" carriers and diamonds are air transported. It is also observed that the effect of the BDI on urbanization within the least developed countries (LDCs) generally fell more strongly than that within the non-LDCs. Of the 33 LDCs, 32 (or about 97% of LDCs) have

[44]Ades and Glaeser (1995) found that trade activities could shift people from rural to urban areas when the shipping costs to markets were high as a result of a low quality of infrastructure. Storeygard (forthcoming) exploited oil price shocks and the road density, and found that higher transport costs could shift people close to trade hubs. We are unable to examine the implications of infrastructure or oil price shocks on urbanization in the SSAs like Ades and Glaeser (1995) and Storeygard (forthcoming) because data of the density of roads is not well collected and missing values are highly present in the SSAs' data.

Figure 4: The (Absolute) BDI Semi-Elasticity of Urbanization for each SSA




*Note*: This figure plots the absolute semi-elasticity of urbanization with respect to the BDI. This semi-elasticity shows the average percentage point decline in the urbanization rate following a one percentage increase in the BDI for each SSA.

a semi-elasticity that ranges from 0.01, while this is only true for the 10 non-LDCs (or about 67% of non-LDCs).

## 4.3 Robustness checks

Although the interactive fixed effects and instrumental variable approaches in Eqs. (2) and (3) take care of a wide range of confounding effects and reverse causality, there could still be remaining unobserved country-year variables driving the relationship between exports and urbanization. To get a sense of whether *BDI Cost* is plausibly exogenous, and therefore the instrumented variable is reasonably uncorrelated with the error term in Eq. (2), it would be useful to evaluate how sensitive our baseline estimate might be when these determinants are drawn from the error term into the regression model.

As an initial robustness check, we include income levels as a control variable to examine the effect of exports on urbanization for a given level of income. The close relationship between income and urbanization has been observed in the literature (Kuznets, 1973; Davis and Henderson, 2003; Michaels et al., 2012; Henderson et al., 2013).[45] However, this relationship is questionable as Fay and Opal (2000) found that the SSAs were highly urbanizing during a period of economic downturn.[46] Moomaw and Shatter (1996) even reported the negative impact of income on the rate of urbanization, although this effect was statistically insignificant after controlling for country-specific effects.

We consider contemporaneous and lagged indicators of income levels.[47] Apart from (the log of) real GDP per capita which is a common measure of income levels, we consider (the log of) night lights per capita which has been recently used in the development literature (Henderson et al., 2012; Storeygard, forthcoming) as the second measure.[48] We obtain the GDP data from the UNCTAD database and the night lights data from Elvidge et al. (2014).[49]

Table 3 presents evidence that income levels are not a main source in driving the urbanization rate. Regardless of GDP or night lights per capita, the effect of exports on urbanization remains positive for a given level of income. The inclusion of income levels even strengthens this causal relationship because the coefficient of

[45]Kuznets (1973), for example, observed that a country that experienced high rates of growth in income would be urbanizing. He argued that people would move to cities to enjoy higher living standards once their income levels were higher. Davis and Henderson (2003), Michaels et al. (2012) and Henderson et al. (2013) then showed that the rate of urbanization could be determined by income.

[46]Brückner (2012) also found that the growth of GDP was statistically insignificant in affecting urbanization in the SSAs.

[47]The lag variable is considered because one may argue that income levels last year can determine the urban-rural migration this year

[48]While the time span of the lights index is shorter than that of the GDP per capita data, the data quality of the former for the SSAs is better than the latter (Henderson et al., 2012; Storeygard, forthcoming).

[49]We compute the night lights per capita on the basis of the total lights intensity taken from Elvidge et al. (2014).

$log(exports_{it})$ ranges from 8.408 to 10.158, whereas the baseline estimate is 7.876 (see Column (1) in Table 2). On the other hand, the coefficient of *BDI Cost* drops by half, while its statistical significance remains unchanged. Perhaps the cost of shipping is also correlated with income (captured by either GDP or night lights per capita) through the trade channel as suggested in the literature (for example, Frankel and Romer, 1999). The negative coefficient of income indicators in the second-stage estimates suggests that the higher rate of urbanization caused by an expansion of exports per capita can slow down when income increases. It could be that an increase in income levels can improve living standards in both urban and rural areas. In spite of the rural-urban migration caused by exports benefits, few people may be held back once rural living conditions do improve.[50,51]

[50]Krugman (1996) noticed that the urban-rural migration would slow down and stop once the urban-rural welfare gap was filled.

[51]We also find that higher GDP or night lights per capita can statistically reduce the infrastructure gap (i.e. clean water accessibility and sanitation facilities) between urban and rural areas in the SSAs (see Tables C3 and C4 Columns (1) and (2) of the Appendix C).

Table 3: Robustness Check 1: Control for Income levels

| | (1) log(GDP per capita$_{it}$) | (2) log(GDP per capita$_{it-1}$) | (3) log(lights per capita$_{it}$) | (4) log(lights per capita$_{it-1}$) |
|---|---|---|---|---|
| *Second-stage Dependent Variable:* | urbanization | | | |
| log(exports) | 10.158*** | 10.004*** | 8.507*** | 8.408*** |
| | (0.214) | (0.217) | (0.136) | (0.140) |
| Control | -3.909*** | -3.632*** | -1.635*** | -1.500*** |
| | (0.271) | (0.277) | (0.168) | (0.172) |
| *First-stage Dependent Variable:* | log(exports) | | | |
| BDI Cost | -0.118*** | -0.115*** | -0.194*** | -0.192*** |
| | (0.002) | (0.002) | (0.001) | (0.002) |
| Control | 1.204*** | 1.212*** | 0.892*** | 0.882*** |
| | (0.002) | (0.002) | (0.003) | (0.003) |
| Time trend | yes | yes | yes | yes |
| Interactive FE | yes | yes | yes | yes |
| First-stage Cragg-Donald F-statistic | 11.049 | 14.873 | 29.871 | 39.373 |
| Stock and Yogo critical value (10%) | 7.03 | 7.03 | 7.03 | 7.03 |
| Observations | 1274 | 1274 | 987 | 946 |
| Countries | 48 | 48 | 48 | 48 |

*Note*: Newey and West robust standard errors are reported in the parenthesis. Statistical significance at the 10%, 5% and 1% levels are indicated by *, ** and *** respectively.

As the second robustness check, we control for different economic factors associated with "urban bias" which is relevant to urbanization. For example, to promote urbanization, developing countries may distribute foreign direct investment (FDI), foreign aid, and government spending favoring urban areas so that people are attracted to cities (Ades and Glaeser, 1995; Junius, 1999; Davis and Henderson, 2003). The occurrence of "urban bias" is also associated with institutional regimes, namely, democracy and autocracy (Ades and Glaeser, 1995; Fay and Opal, 2000; Henderson et al., 2013).[52]

We obtain the data on "urban bias" from several sources. Inward FDI and foreign aid variables are obtained from the UNCTAD database. For government spending, we compute the log of government spending per capita based on the proportion of public spending to GDP from the World Development Indicators.[53] For institutions, we use revised Polity score (Polity-2) from the Polity IV database of Marshall and Jaggers (2009).[54]

Table 4 reports the results when these control variables are added separately. All control variables are statistically significant at the 1% level, which suggests the relevance of these determinants in urbanization. Despite their importance, our estimate of the effect of exports per capita on the urbanization rate ranges from 7.757 to 9.879 which includes the baseline result of 7.876. Our results show that higher inward FDI and government spending can reduce the rate of urbanization, while better foreign

[52]Ades and Glaeser (1995) found that nondemocratic governments were likely to increase government spending and allocate higher foreign investment and foreign aid in cities to increase support from urban residents and to reduce political instability. However, the urbanization process may not respond to this disproportional distribution (Fay and Opal, 2000). Henderson et al. (2013) found no evidence that better institutions could increase the urbanization rate.

[53]All measures are deflated using the US urban commodity price index.

[54]The Polity-2 score captures the degree of democratization and quality of institutions over time. The score ranges from -10 to 10, where a score of 10 indicates the highest level of democracy for an institution. This indicator is widely used to examine the relationship between institutions or political regimes and economic development (Brückner and Ciccone, 2011).

assistance (foreign aid) and institutions (Polity-2) are found to foster urbanization. A(n) (unexpectedly) negative impact of FDI on urbanization may come from the fact that FDI flows mainly to extractive sectors (i.e. natural resources) in the SSAs (Chen et al., 2015). An expansion in inward FDI driving the natural resources extraction in rural areas can explain the slowing down of urbanization.[55]

Thus, given that the estimated effect of exports instrumented by *BDI Cost* appears to be robust in these two robustness checks, we have some evidence that *BDI Cost* is plausibly exogenous and that any omitted variable bias, if it exists, is unlikely to be large.

[55] We also find that the urban-rural gap in accessing clean water and sanitation facilities reduces following an increase in FDI (see Columns (3) in Tables C3 and C4 of the Appendix C). Similar patterns can be observed when government spending is in place of FDI (see Columns (6) in Tables C3 and C4 of the Appendix C). This would imply rural residences also benefit from higher expenditure levels of government. The positive effect of foreign aid and institutions on urbanization may be achieved through improvements in urban infrastructure (see Columns (4)-(5) in Tables C3 and C4 of the Appendix C). Better institutional quality or higher Polity-2 score is found to reduce the difference between rural and urban residences that can access clean water. Conversely, the urban-rural gap in sanitation facilities widens as Polity-2 score increases.

Table 4: Robustness Check 2: Control for Urban bias

| | (1)<br>log(FDI) | (2)<br>log(Foreign aid) | (3)<br>Polity-2 | (4)<br>log(gov.spending) |
|---|---|---|---|---|
| *Second-stage Dependent Variable:* | urbanization | | | |
| log(exports) | 8.650*** | 8.758*** | 7.757*** | 9.879*** |
| | (0.116) | (0.041) | (0.038) | (0.267) |
| Control | -0.475*** | 4.593*** | 0.061*** | -3.112*** |
| | (0.047) | (0.016) | (0.008) | (0.296) |
| *First-stage Dependent Variable:* | log(exports) | | | |
| BDI Cost | -0.182*** | -0.410*** | -0.429*** | -0.104*** |
| | (0.002) | (0.003) | (0.003) | (0.002) |
| Control | 0.374*** | 0.211*** | 0.019*** | 0.984*** |
| | (0.003) | (0.006) | (0.002) | (0.007) |
| Time trend | yes | yes | yes | yes |
| Interactive FE | yes | yes | yes | yes |
| First-stage Cragg-Donald F-statistic | 11.648 | 115.192 | 36.960 | 19.187 |
| Stock and Yogo critical value (10%) | 7.03 | 7.03 | 7.03 | 7.03 |
| Observations | 1158 | 1264 | 1227 | 1115 |
| Countries | 48 | 48 | 46 | 45 |

*Note*: Newey and West robust standard errors are reported in the parenthesis. Statistical significance at the 10%, 5% and 1% levels are indicated by *, ** and *** respectively.

# 5 Do Exports promote Urban Development?

The results so far have shown the causal effect of exports on shaping the urbanization rate but have yet explored whether exports *(i)* influence the growth of primate cities, or *(ii)* matter for urban development. As noticed by Williamson (1965), the spread of economic activities within urban areas were unequal. If the population concentration is related to economic activities, primate cities associated with the highest population density will have their own growth rates (Ades and Glaeser, 1995; Krugman, 1996; Moomaw and Shatter, 1996; Junius, 1999; Davis and Henderson, 2003).[56] To elaborate on this possibility, we first investigate the effect of exports on the growth of primate cities. To answer this question, we focus on population and income aspects.

Table 5 reports the estimates corresponding to our first question of interest. In Column (1), we observe that the doubling of exports per capita, on average, is associated with a 4 percentage point increase in primacy. In other words, holding a country's population constant, the population size of the primate city will increase by roughly 4 percentage point on average if exports per capita increase 100%. By contrast, we find evidence that an expansion in exports is likely to cause a reduction in night lights per capita which is a proxy of real income per capita in primate cities. As discuss in Section 2.3, data on income and other aspects of development in the SSAs' primate cities are scant. To measure income levels of primate cities, we have to use satellite night lights index of (Henderson et al., 2012) as a proxy.[57]

[56]Ades and Glaeser (1995), for example, found that trade might foster the density of economic activities in primate cities, and thus, increase primacy. Explaining the unbalance growth of cities, Krugman (1996) argued that some cities could grow faster than others due to their convenient locations for trade (i.e. close to either domestic and oversea trade hubs).

[57]To the best of our knowledge, satellite night lights index is a disaggregate data source which is almost free of measurement errors due to technological advancements. Satellite night lights index is available globally. Therefore, researchers are able to measure real income for cities where data on GDP is unavailable (Henderson et al., 2012; Storeygard, forthcoming).

Column (2) shows that per capita night lights in primate cities declines by 29%, on average, as exports per capita double.[58] Applying the elasticity of income growth with respect to the growth of lights $\epsilon_{GDP,lights} = 0.284$ from Henderson et al. (2012), this translates into roughly an 8% decrease in primate cities' true income. Perhaps, the growth rate of the associated population is higher than that of the rate of total production in primate cities.[59] Therefore, for primate cities when exports expands, the population size is predicted to increase despite a decline in real income levels on average.

Table 5: Exports and the Growth of Primate Cities

| | (1) | (2) |
|---|---|---|
| *Second-stage Dependent Variable:* | primacy | log(lights per capita) |
| log(exports) | 4.106*** | -0.290*** |
| | (0.074) | (0.016) |
| *First-stage Dependent Variable:* | log(exports) | |
| BDI Cost | -0.415*** | -0.371*** |
| | (0.003) | (0.005) |
| Time trend | yes | yes |
| Interactive FE | yes | yes |
| First-stage Cragg-Donald F-statistic | 45.841 | 78.422 |
| Stock and Yogo critical value (10%) | 7.03 | 7.03 |
| Observations | 1072 | 623 |
| Countries | 39 | 37 |

*Note*: Newey and West robust standard errors are reported in the parenthesis. Statistical significance at the 10%, 5% and 1% levels are indicated by *, ** and *** respectively.

We next investigate whether exports matter for urban development. The dra-

[58]The unavailability of data on electricity consumption as well as public expenditure in primate cities restrict us from processing further investigations. Therefore, we are unable to provide some conjectures on the relationship between exports and night lights in primate cities.

[59]Our results differ from those of Storeygard (forthcoming) who found that both population and economic growth in primate cities increased once trade activities were shifted toward these cities. However, Storeygard (forthcoming) considered coastal primate cities only, whereas we take into account all primate cities in the SSAs.

matic urbanization process in developing countries has recently put upward pressure on urban living conditions such as the accessibility of clean water and sanitation facilities (Patel and Burke, 2009; Ramin, 2009; Glaeser, 2014). To measure urban development, we use the proportion of urban population that can access clean water and sanitation facilities.[60] If exports earnings are spent disproportionately on cities, urban residents may gain from exports. As such, urban-rural inequality is likely increasing (Young, 2013), and the urban-rural gap will persist. To follow up this idea, we consider the effect of exports on the urban-rural gap in infrastructure, the difference between the proportion of urban and rural populations that can access improved water source and sanitation facilities.[61]

Table 6 summarizes the results of two related sets of outcome variables corresponding to urban development. From Columns (1) and (2), we observe, on average, relative to total population, that the doubling of exports per capita can raise urban residents' access to improved clean water and sanitation facilities by about 7 and 5 percentage points, respectively. However, Columns (3) and (4) show that exports increase the urban-rural infrastructural gap as the proportion of urban residents who can access clean water and sanitation facilities is roughly 10 and 6 percentage points, respectively, higher than that of rural residents on average.

In sum, these findings suggest that exports can shape the growth of primate cities and affect urban development. Although income growth in primate cities drops after an expansion in exports, urban residents can enjoy improvements in urban infrastructure (i.e. clean water, sanitation facilities), but at a cost of increased inequality between urban and rural areas in terms of access to clean water and sanitation facilities.[62]

[60] We also wish to consider urban poverty. However, data on urban poverty headcount ratio from the World Development Indicators contains many missing values, as does the data from the UN on the share of the urban population living in slums.

[61] All these variables are derived from related indicators from the World Development Indicators.

[62] We also find that an expansion of exports per capita may reduce the proportion of

rural residents able to access clean water and sanitation facilities. This could be because export earnings are redistributed in such a way that they skew toward cities.

Table 6: Exports, Urban Infrastructure and the Urban-Rural Infrastructure Gap

| | (1) | (2) | (3) | (4) |
|---|---|---|---|---|
| | urban infrastructure | | urban-rural infrastructure gap | |
| *Second-stage Dependent Variable:* | water accessibility | sanitation facilities | improved water source | improved sanitation facilities |
| log(exports) | 7.269*** | 4.966*** | 9.564*** | 6.057*** |
| | (0.017) | (0.017) | (0.124) | (0.087) |
| *First-stage Dependent Variable:* | *log(exports)* | | | |
| BDI Cost | -0.380*** | -0.374*** | -0.373*** | -0.375*** |
| | (0.003) | (0.003) | (0.003) | (0.003) |
| Time trend | yes | yes | yes | yes |
| Interactive FE | yes | yes | yes | yes |
| First-stage Cragg-Donald F-statistic | 109.946 | 29.772 | 17.927 | 71.393 |
| Stock and Yogo critical value (10%) | 7.03 | 7.03 | 7.03 | 7.03 |
| Observations | 1041 | 1028 | 1034 | 1028 |
| Countries | 48 | 48 | 48 | 48 |

*Note*: Newey and West robust standard errors are reported in the parenthesis. Statistical significance at the 10%, 5% and 1% levels are indicated by *, ** and *** respectively.

# 6 Do Exports affect Economic Structure?

We have explored whether exports can affect the urbanization process, however, how exports can determine the urbanization rate has yet analyzed. Changes in the population distribution can stem from changes in production activities or economic structure that are related to the growth of all sectors: agricultural, manufacturing and services.[63] As Gollin et al. (2002) noted, high agricultural productivity could require fewer agricultural workers, and so some of them could be "pushed" toward the manufacturing sector. By contrast, Michaels et al. (2012), Henderson et al. (2013) and Gollin et al. (forthcoming) argued that laborers could be "pulled" out of the agricultural sector if the wage rates in the manufacturing sector increased. While most countries have found to follow either "labor push" or "labor pull", recently Gollin et al. (forthcoming) have argued that the SSAs are urbanizing because of their exports of natural resources.

We first explore whether each sector in general does respond to exports. Table 7 shows the regression results of sectoral total production on exports per capita. The table reveals that an expansion in exports (instrumented by *BDI Cost*) is related to a decline in agricultural production, but associated with an increase in manufacturing and services total production. The significant coefficient on $log(exports_{it})$ across all three estimates suggests the sectoral-production elasticities with respect to exports per capita are -0.152, 0.638 and 0.227 for the agricultural, manufacturing and services sectors respectively. Evidently, economic structure transformation may occur in the SSAs.

In order to conclude that the possible structural transformation in the SSAs occurs as a result of "labor push" or "labor pull", we examine whether exports can influence employment or productivity in each sector. Table 8 presents the response

[63]For simplicity, some authors combine the services sector to the manufacturing sector (Michaels et al., 2012).

Table 7: Exports and Sectoral total Production

| | (1) | (2) | (3) |
|---|---|---|---|
| *Second-stage Dependent Variable:* | log(sectoral total production) | | |
| | agriculture | manufacturing | services |
| log(exports) | -0.152** | 0.638*** | 0.227*** |
| | (0.073) | (0.075) | (0.060) |
| *First-stage Dependent Variable:* | log(exports) | | |
| BDI Cost | -0.392*** | -0.387*** | -0.387*** |
| | (0.023) | (0.023) | (0.023) |
| Time trend | yes | yes | yes |
| Interactive FE | yes | yes | yes |
| First-stage Cragg-Donald F-statistic | 136.598 | 136.489 | 100.838 |
| Stock and Yogo critical value (10%) | 7.03 | 7.03 | 7.03 |
| Observations | 1167 | 1162 | 1171 |
| Countries | 47 | 46 | 47 |

*Note*: Robust standard errors are reported in the parenthesis. Statistical significance at the 10%, 5% and 1% levels are indicated by *, ** and *** respectively.

of sectoral employment to exports, a weak impact of exports on sectoral employment is observed. Agricultural and services employment is likely to decrease as exports per capita increase, while manufacturing employment responds to the variation of exports in a statistically insignificant way. However, *BDI Cost* seems not to be a strong instrument.[64] Thus, we are unable to proceed the investigation on employment further. Sectoral productivity, on the other hand, empirically increases following an expansion in exports. Table 9 reports the estimated effect of exports on sectoral productivity. Following a 1% increase in exports per capita, productivity of the agricultural, manufacturing and services sectors will increase, on average, by 0.456%, 0.633% and 0.29% respectively. These estimates are statistically significant at 1% and *BDI Cost* is a strong IV. They imply that higher productivity associated

[64]However, we find evidence that exports affect employment composition in each sector, the share of female employment in agriculture declines and the share of female workers the other two sectors, especially in services, increases. The change in the sectoral employment composition is found to relate to urbanization. See Tables C5 and C6 of the Appendix C.

with exports may be the root of better production in all three sectors in the SSAs.

Table 8: Exports and Sectoral Employment

| | (1) | (2) | (3) |
|---|---|---|---|
| *Second-stage Dependent Variable:* | log(sectoral employment) | | |
| | agriculture | manufacturing | services |
| log(exports) | -0.727*** | -0.096 | -0.153** |
| | (0.071) | (0.067) | (0.068) |
| *First-stage Dependent Variable:* | log(exports) | | |
| BDI Cost | -0.422*** | -0.422*** | -0.422*** |
| | (0.024) | (0.024) | (0.024) |
| Time trend | yes | yes | yes |
| Interactive FE | yes | yes | yes |
| First-stage Cragg-Donald F-statistic | 2.150 | 11.424 | 6.656 |
| Stock and Yogo critical value (10%) | 7.03 | 7.03 | 7.03 |
| Observations | 966 | 966 | 966 |
| Countries | 45 | 45 | 45 |

*Note*: Robust standard errors are reported in the parenthesis. Statistical significance at the 10%, 5% and 1% levels are indicated by *, ** and *** respectively.

To connect changes in sectoral performance to the urbanization process, we investigate if sectoral activities and urbanization are related. To do so, we first obtain what we hope is plausibly exogenous variation in sectoral activities (i.e. production and productivity) by estimating a reduced form relationship between sectoral activities and *BDI Cost*. We then use this variation to estimate the effect that it might have on urbanization. As can be seen from Table 10, the first stage regressions imply a one standard deviation decrease in *BDI Cost*, on average, is associated with a 10% decrease in agricultural total production. Manufacturing and services total output are expected to increase by roughly 43% and 15%, respectively, for a one standard deviation reduction in *BDI Cost*. However, these implications may be imprecise because *BDI Cost* is not sufficiently strong. It may indicate that *BDI Cost* is not well linked to sectoral total production to influence urbanization. Thus, we are unable

Table 9: Exports and Sectoral Productivity

| | (1) | (2) | (3) |
|---|---|---|---|
| *Second-stage Dependent Variable:* | log(sectoral productivity) | | |
| | agriculture | manufacturing | services |
| log(exports) | 0.456*** | 0.633*** | 0.290*** |
| | (0.031) | (0.035) | (0.035) |
| *First-stage Dependent Variable:* | log(exports) | | |
| BDI Cost | -0.419*** | -0.413*** | -0.412*** |
| | (0.025) | (0.024) | (0.024) |
| Time trend | yes | yes | yes |
| Interactive FE | yes | yes | yes |
| First-stage Cragg-Donald F-statistic | 139.116 | 12.826 | 10.404 |
| Stock and Yogo critical value (10%) | 7.03 | 7.03 | 7.03 |
| Observations | 886 | 891 | 899 |
| Countries | 43 | 42 | 43 |

*Note*: Robust standard errors are reported in the parenthesis. Statistical significance at the 10%, 5% and 1% levels are indicated by *, ** and *** respectively.

to process our analysis further on the relationship between sectoral total production and the urbanization rate.

With regard to the relationship between sectoral productivity and the urbanization rate, Table 11 offers evidence that higher productivity in the agricultural and services sectors can be associated with an increase in urbanization. The first-stage regression in the manufacturing sector is problematic, however, because its F-statistic is small. The second-stage estimates in Columns (1) and (3) show that the doubling of the productivity of the agricultural and services sectors can increase, on average, the urbanization rate by roughly 18 and 28 percentage points respectively. This suggests that the urbanization rate tends to highly respond to productivity changes in the services sector relative to the changes in the agricultural sector.

In sum, we have shown that *(i)* exports can affect the performance of each sector

Table 10: Sectoral total Production and Urbanization

| | (1) | (2) | (3) |
|---|---|---|---|
| *Second-stage Dependent Variable:* | | urbanization | |
| log(sectoral total production) | -54.336** | 13.435*** | 37.050*** |
| | (25.507) | (2.032) | (11.332) |
| *First-stage Dependent Variable:* | | log(sectoral total production) | |
| | agriculture | manufacturing | services |
| BDI Cost | 0.060** | -0.246*** | -0.087*** |
| | (0.029) | (0.029) | (0.024) |
| Time trend | yes | yes | yes |
| Interactive FE | yes | yes | yes |
| First-stage Cragg-Donald F-statistic | 3.051 | 0.365 | 0.224 |
| Stock and Yogo critical value (10%) | 7.03 | 7.03 | 7.03 |
| Observations | 1167 | 1162 | 1171 |
| Countries | 47 | 46 | 47 |

*Note*: Robust standard errors are reported in the parenthesis. Statistical significance at the 10%, 5% and 1% levels are indicated by *, ** and *** respectively.

(i.e. total production and productivity), and *(ii)* that the contribution of each sector to a country's total output (or economic structure) in response to exports may change. We then link sectoral total production and productivity to urbanization. The chain of exports, sectoral production and urbanization is likely to be found in the services sector. Given evidence that *(i)* the component of exports that can positively affect sectoral total output and productivity is related to raw materials and primary goods, and *(ii)* that services respond strongly to an export expansion, we may reasonably infer that the SSAs' urbanization could be related to the export earnings of primary commodities through an increase in the size of the services sector.

Table 11: Sectoral Productivity and Urbanization

| | (1) | (2) | (3) |
|---|---|---|---|
| *Second-stage Dependent Variable:* | | urbanization | |
| log(sectoral productivity) | 17.586*** | 13.054*** | 28.469*** |
| | (1.249) | (1.116) | (3.843) |
| *First-stage Dependent Variable:* | | log(sectoral productivity) | |
| | agriculture | manufacturing | services |
| BDI Cost | -0.191*** | -0.262*** | -0.120*** |
| | (0.016) | (0.020) | (0.017) |
| Time trend | yes | yes | yes |
| Interactive FE | yes | yes | yes |
| First-stage Cragg-Donald F-statistic | 64.775 | 3.994 | 13.013 |
| Stock and Yogo critical value (10%) | 7.03 | 7.03 | 7.03 |
| Observations | 886 | 891 | 899 |
| Countries | 43 | 42 | 43 |

*Note*: Robust standard errors are reported in the parenthesis. Statistical significance at the 10%, 5% and 1% levels are indicated by *, ** and *** respectively.

# 7 Conclusion

Finding determinants of the urbanization rate is important for the SSAs that remain less developed because the increasing urbanization rate, one feature of economic development (Kuznets, 1973), may reflect improvements in living standards. As exports contribute to shaping a country's development, an expansion in exports may explain the dramatic urbanization process in the SSAs.

We adopt an advancement in panel data – the CCE estimate (Pesaran, 2006) – to control for a wide range of confounding factors and to deal with cross-sectional dependence. We exploit a variation of *BDI Cost* related to bulk dry shipping costs to instrument exports per capita in order to deal with reverse causality and measurement error. We find that the rate of urbanization will, on average, increase by 7.876 percentage points following the doubling of exports per capita. The size of primate cities is expected to rise by 4 percentage points (i.e. primacy), while the associated income levels decline by roughly 8%, on average, as exports double. Furthermore, urban residents benefit from export earnings in that the proportion of the urban population that can access better clean water sources and sanitation facilities increases by 7 and 5 percentage points respectively. However, there is evidence that urban-rural inequality increases as the urban-rural gap in infrastructure expands.

Our paper also attempts to explore how exports can influence the urbanization rate. We investigate if exports are able to influence the structure of an economy by shaping sectoral production. In doing so, we find evidence for the role played by the services sector in the urbanization process in the SSAs. However, our evidence on the relationship between the agricultural and manufacturing sectors and the urbanization rate in the SSAs is inconclusive.

# References


Ades, A., Glaeser, E. (1995) "Trade and Circuses: Explaining Urban Giants," *Quarterly Journal of Economics*, 110(1), 195227.

Bai, J. (2009) "Panel Data Models with Interactive Fixed Effects," *Econometrica*, 77, 1229–1279.

Brückner, M. (2012) "Economic Growth, size of Agricultural sector, and Urbanization in Africa," *Journal of Urban Economics*, 71, 26–36.

Brückner, M., Ciccone, A. (2011) "Rainfall and the Democratic Window of Opportunity," *Econometrica*, 79, 923947.

Chen, G., Geiger, M., Fu, M. (2015) "Manufacturing FDI in Sub-Saharan Africa: Trends, Determinants, and Impact."

Chudik, A., Pesaran, M. (2013) "Large Panel Data Models with Cross-sectional Dependence: A Survey," in B. Baltagi ed. *The Oxford Handbook on Panel data (forthcoming)*, Oxford: Oxford University Press.

Chudik, A., Pesaran, M., Tosetti, E. (2011) "Weak and Strong Cross-Section Dependence and Estimation of Large Panels," *Econometrics Journal*, 14, C45–C90.

Davis, J., Henderson, V. (2003) "Evidence on the Political Economy of the Urbanization process," *Journal of Urban Economics*, 53(1), 98–125.

Elvidge, C., Hsu, F., Baugh, K., Ghosh, T. (2014) "Chapter 6. National Trends in Satellite-Observed Lighting: 1992-2012," in Q. Weng ed. *Global Urban Monitoring and Assessment through Earth Observation*: CRC Press.

Fay, M., Opal, C. (2000) "Urbanization without Growth : a Not-so-Uncommon Phenomenon," World Bank Policy Research Working Paper 2412.

Feenstra, R., Lipsey, R., Deng, H., Ma, A., Mo, H. (2005) "World Trade Flows, 1962-2000," NBER Working Paper No. 11040.

Feyrer, J. (2009a) "Trade and Income-Exploiting Time Series in Geography," *NBER Working Paper no. 14910*.

——— (2009b) "Distance, Trade and Income-The 1967 to 1975 closing of the Suez Canal as a Natural Experiment," *NBER Working Paper no. 15557*.

Frankel, J. (2012) "The Natural Resource Curse: A Survey," in B. Shaffer, T. Ziyadov eds. *Beyond the Resource Curse*: U.Penn. Press.

Frankel, J., Romer, D. (1999) "Does Trade cause Growth," *American Economic Review*, 89(3), 379–399.

Glaeser, E. (2014) "A World of Cities: the Causes and Consequences of Urbanization in Poorer Countries," *Journal of the European Economic Association*, 12(5), 1154–1199.

Glaeser, E., Kahn, M., Rappaport, J. (2008) "Why do the Poor Live in Cities? The Role of Public Transportation," *Journal of Urban Economics*, 63(1), 1–24.

Gollin, D., Jedwab, R., Vollrath, D. (forthcoming) "Urbanization with and without Industrilaization," *Journal of Economic Growth*.

Gollin, D., Parente, S., Rogerson, R. (2002) "The Role of Agriculture in Development," *American Economic Review*, 92(2), 160164.

Harding, M., Lamarche, C. (2011) "Least Squares Estimation of a Panel Data Model with Multifactor Error Structure and Endogenous Covariates," *Economics Letters*, 111, 197–199.

Henderson, J., Roberts, M., Storeygard, A. (2013) "Is Urbanization in Sub-Saharan Africa different?" *Policy Research working paper*, WPS 6481.

Henderson, J., Storeygard, A., Deichmann, U. (2014) "Is Climate Change Driving Urbanization in Africa?".

Henderson, J., Storeygard, A., Weil, D. (2012) "Measuring Economic Growth from Outer Space," *American Economic Review*, 102(2), 994–1028.

Jedwab, R., Vollrath, D. (forthcoming) "Urbanization without Growth in Historical Perspective," *Explorations in Economic History.*

Jedwad, R. (2013) "Urbanization without Structural Transformation: Evidence from Consumption Cities in Africa."

Junius, K. (1999) "Primacy and Economic Development: Bell Shaped or Parallel Growth of Cities?" *Journal of Economic Development*, 24(1), 122.

Kapetanios, G., Pesaran, M., Yamagata, T. (2011) "Panels with Non-stationary Multifactor Error Structures," *Journal of Econometrics*, 160, 326–348.

Kilian, L. (2009) "Not All Oil Price Shocks Are Alike: Disentangling Demand and Supply Shocks in the Crude Oil Market.," *American Economic Review*, 99(3), 1053–1069.

Krugman, P. (1996) "Urban Concentration: The Role of Increasing Returns and Transport Costs," *International Regional Science Review*, 19, 5–30.

Kuznets, S. (1973) "Modern Economic Growth: Findings and Reflections," *The American Economic Review*, 63(3), 247–258.

Lin, F., Sim, N. (2013) "Trade, Income and the Baltic Dry Index," *European Economic Review*, 59, 1–18.

——— (2015) "Exports, HIV incidence and the Baltic Dry Index: Further evidence from sub-Saharan Africa," *Economics Letters*, 126, 35–39.

Marshall, M., Jaggers, K. (2009) *Polity IV project: Dataset users' manual*, Center for global policy, George Mason University.

Michaels, G., Rauch, F., Redding, S. (2012) "Urbanization and Structural Transformation," *The Quarterly Journal of Economics*, 127, 535586.

Moomaw, R., Shatter, A. (1996) "Urbanization and Economic Development: A Bias toward Large Cities?" *Journal of Urban Economics*, 40, 1337.

Nicita, A., Rollo, V. (2013) "Tariff Preferences as a Determinant for Exports from sub-Saharan Africa," *Policy Issues in International Trade and Commodities*, Study Series No. 60.

Patel, R., Burke, T. (2009) "Urbanization - An Emerging Humanitarian Disaster," *New England Journal of Medicine*, 361, 741–743, doi: 10.1056/NEJMp0810878.

Pesaran, M. (2006) "Estimation and Inference in Large Heterogeneous Panels with a Multifactor Error Structure," *Econometrica*, 74(4), 967–1012.

Ramin, B. (2009) "Slums, climate change and human health in sub-Saharan Africa," *Bulletin of the World Health Organization*, 87, 886–886.

Robertson, D. (1940) *Essays in Monetary Theory*, London: P.S. King and Son.

Ross, M. (2006) "Is Democracy Good for the Poor?" *American Journal of Political Science*, 50(4), 860–874.

Stock, J., Yogo, M. (2005) "Testing for Weak Instruments in Linear IV Regression," in D. Andrews, J. Stock eds. *Identification and Inference for Econometric Models: Essays in Honor of Thomas and Rothenberg*, Cambridge: Cambridge University Press.

Storeygard, A. (forthcoming) "Farther on Down the Road: Transport Costs, Trade and Urban Growth in Sub-Saharan Africa," *Review of Economic Studies*.

United Nations (2014) "World Urbanization Prospects: The 2014 Revision."

Williamson, J. (1965) "Regional Inequality and the Process of National Development: A Description of the Patterns," *Economic Development and Cultural Change*, 13(4), 1–84.

Wooldridge, J. (2012) *Introductory Econometrics: A Modern Approach*: Cengage Learning.

World Bank (2002) "Buiding Statistical Capacity to Monitor Development Progress."

——— (2009) "World Development Report 2009: Reshaping Economic Geography."

——— (2015) "Africas Pulse: An Analysis of Issues Shaping Africas Economic Future."

Young, A. (2013) "Inequality, the Urban-Rural Gap, and Migration," *Quarterly Journal of Economics*, 128, 1727–1785.

# Appendix C

Table C1: Summary Statistics

| Variable | Obs | Mean | Std. Dev. | Min | Max |
|---|---|---|---|---|---|
| BDI Cost | 1,274 | 4.563 | 1.763 | 0.306 | 8.007 |
| export share of primary products (0-100) | 1,274 | 58.17 | 29.98 | 0.162 | 99.86 |
| female share of sectoral employment, agriculture (0-100) | 990 | 61.25 | 21.18 | 3.800 | 96.70 |
| female share of sectoral employment, manufacturing (0-100) | 990 | 7.171 | 7.474 | 0.300 | 49.30 |
| female share of sectoral employment, services (0-100) | 990 | 31.57 | 17.00 | 2.700 | 82.60 |
| log(BDI) | 1,274 | 7.463 | 0.584 | 6.573 | 8.865 |
| log(exports) | 1,274 | 2.089 | 1.740 | -2.068 | 7.839 |
| log(FDI), inflow | 1,206 | 1.817 | 2.770 | -14.82 | 8.376 |
| log(Foreign aid) | 1,327 | 3.644 | 0.976 | -1.573 | 6.617 |
| log(GDP per capita) (log(GDP)) | 1,337 | 6.514 | 1.066 | 4.394 | 9.753 |
| log(government spending) (log(gov. spending)) | 1,158 | 4.479 | 1.189 | 1.832 | 7.703 |
| log(lights per capita) (log(lights)) | 1,008 | -5.894 | 1.214 | -10.18 | -3.130 |
| log(lights per capita), primate cities | 629 | -4.513 | 0.810 | -7.251 | -2.496 |
| log(sectoral employment), agriculture | 990 | 14.11 | 1.589 | 10.64 | 17.25 |
| log(sectoral employment), manufacturing | 990 | 12.18 | 1.319 | 8.863 | 15.60 |
| log(sectoral employment), services | 990 | 13.39 | 1.315 | 10.32 | 16.95 |
| log(sectoral income), agriculture | 1,220 | 20.55 | 1.484 | 16.32 | 24.71 |
| log(sectoral income), manufacturing | 1,215 | 20.61 | 1.644 | 15.09 | 25.27 |
| log(sectoral income), services | 1,224 | 21.28 | 1.400 | 15.88 | 26.11 |
| log(sectoral productivity), agriculture | 909 | 6.606 | 0.995 | 4.447 | 9.368 |
| log(sectoral productivity), manufacturing | 914 | 8.532 | 1.086 | 5.161 | 11.84 |
| log(sectoral productivity), services | 922 | 7.973 | 0.883 | 3.835 | 10.32 |
| Polity-2 | 1,274 | -0.454 | 5.856 | -10 | 10 |
| primacy (0-100) | 1,092 | 41.32 | 14.55 | 14.53 | 100 |
| urban sanitation facilities (0-100) | 1,053 | 16.76 | 13.18 | 1.625 | 56.36 |
| urban water accessibility (0-100) | 1,070 | 30.21 | 15.75 | 4.860 | 83.64 |
| urbanization (0-100) | 1,344 | 34.71 | 15.75 | 5.100 | 86.40 |
| urban-rural gap, sanitation facilities (0-100) | 1,053 | 2.674 | 14.90 | -38.34 | 51.41 |
| urban-rural gap, water accessibility (0-100) | 1,063 | -3.597 | 23.35 | -56.84 | 75.07 |

Table C2: List of Variables, Definitions and Sources

| Variable | Definition | Source |
|---|---|---|
| BDI | General indicator of shipment rates for dry bulk cargoes | The Baltic Exchange |
| CPI | The US urban consumer price index | US Bureau of Labor Statistics |
| employment | Global Employment Trends 2014 | ILO |
| FDI | Foreign direct investment (million US dollars) | UNCTAD |
| Foreign aid | Nominal ODA (million US Dollars at current prices) | UNCTAD |
| GDP | Real GDP per capita (US dollars in 2005 price) | UNCTAD |
| government spending | General government final consumption expenditure (% of GDP) | WDI |
| nighttime lights in primate cities | Nighttime lights density in primate cities | Henderson et al. (2012) |
| nighttime lights within countries | Nighttime lights density within countries | Elvidge et al. (2014) |
| Polity-2 | Ranging from -10 to +10, higher value, more democratic | Polity IV data |
| population | Total population (thousand) | WDI |
| primacy | Population in the largest city (% of urban population) | WDI |
| rural sanitation facilities | Improved sanitation facilities, rural (% of rural population with access) | WDI |
| rural water accessibility | Improved water source, rural (% of rural population with access) | WDI |
| trade (1970-1994) | Million US dollars trade levels (Nominal) | UN-BER |
| trade (1995-2012) | Million US dollars trade levels (Nominal) | UNCTAD |
| urban sanitation facilities | Improved sanitation facilities, urban (% of urban population with access) | WDI |
| urban water accessibility | Improved water source, urban (% of urban population with access) | WDI |
| urbanization | Urban population (% of total population) | UN |
| value-added agriculture | Agriculture, value added (% of GDP) | WDI |
| value-added manufacturing | Manufacturing, value added (% of GDP) | WDI |
| value-added services | Services, value added (% of GDP) | WDI |

Table C3: Economic factors and Urban-rural Infrastructure Gap in Water Accessibility

| | (1)<br>log(GDP) | (2)<br>log(lights) | (3)<br>log(FDI) | (4)<br>log(Foreign aid) | (5)<br>Polity-2 | (6)<br>log(gov. spending) |
|---|---|---|---|---|---|---|
| *Second-stage Dependent Variable:* | urban-rural gap in water accessibility | | | | | |
| log(exports) | 18.975*** | 13.119*** | 10.474*** | 9.917*** | 9.293*** | 23.366*** |
| | (0.717) | (0.299) | (0.303) | (0.130) | (0.114) | (0.781) |
| Control | -15.748*** | -6.230*** | -0.873*** | 2.250*** | -0.273*** | -18.511*** |
| | (0.909) | (0.372) | (0.136) | (0.069) | (0.026) | (0.856) |
| *First-stage Dependent Variable:* | log(exports) | | | | | |
| BDI cost | -0.102*** | -0.186*** | -0.164*** | -0.380*** | -0.405*** | -0.111*** |
| | (0.002) | (0.001) | (0.002) | (0.003) | (0.003) | (0.002) |
| Control | 1.215*** | 0.896*** | 0.411*** | 0.132*** | 0.018*** | 0.962*** |
| | (0.002) | (0.003) | (0.004) | (0.007) | (0.002) | (0.009) |
| Time trend | yes | yes | yes | yes | yes | yes |
| Interactive FE | yes | yes | yes | yes | yes | yes |
| First-stage Cragg-Donald F-statistic | 22.914 | 45.721 | 9.616 | 17.195 | 74.212 | 17.695 |
| Stock and Yogo critical value (10%) | 7.03 | 7.03 | 7.03 | 7.03 | 7.03 | 7.03 |
| Observations | 1034 | 962 | 968 | 1029 | 992 | 912 |
| Countries | 48 | 48 | 48 | 48 | 46 | 45 |

*Note*: Newey and West robust standard errors are reported in the parenthesis. Statistical significance at the 10%, 5% and 1% levels are indicated by *, ** and *** respectively.

Table C4: Economic factors and Urban-rural Infrastructure gap in Sanitation Facilities

| | (1) log(GDP) | (2) log(lights) | (3) log(FDI) | (4) log(Foreign aid) | (5) Polity-2 | (6) log(gov. spending) |
|---|---|---|---|---|---|---|
| *Second-stage Dependent Variable:* | urban-rural gap in sanitation facilities | | | | | |
| log(exports) | 14.629*** | 8.761*** | 8.559*** | 6.722*** | 5.555*** | 9.762*** |
| | (0.546) | (0.199) | (0.230) | (0.086) | (0.069) | (0.487) |
| Control | -14.343*** | -4.763*** | -2.002*** | 3.445*** | 0.168*** | -5.684*** |
| | (0.690) | (0.247) | (0.100) | (0.044) | (0.016) | (0.535) |
| *First-stage Dependent Variable:* | log(exports) | | | | | |
| BDI cost | -0.102*** | -0.187*** | -0.166*** | -0.380*** | -0.407*** | -0.112*** |
| | (0.002) | (0.001) | (0.002) | (0.003) | (0.003) | (0.002) |
| Control | 1.217*** | 0.896*** | 0.411*** | 0.131*** | 0.017*** | 0.963*** |
| | (0.002) | (0.002) | (0.004) | (0.007) | (0.002) | (0.008) |
| Time trend | yes | yes | yes | yes | yes | yes |
| Interactive FE | yes | yes | yes | yes | yes | yes |
| First-stage Cragg-Donald F-statistic | 22.772 | 11.127 | 26.760 | 11.865 | 99.597 | 17.765 |
| Stock and Yogo critical value (10%) | 7.03 | 7.03 | 7.03 | 7.03 | 7.03 | 7.03 |
| Observations | 1028 | 960 | 962 | 1023 | 986 | 906 |
| Countries | 48 | 48 | 48 | 48 | 46 | 45 |

*Note*:Newey and West robust standard errors are reported in the parenthesis. Statistical significance at the 10%, 5% and 1% levels are indicated by *, ** and *** respectively.

Table C5: Exports and Sectoral Female Employment Share

| | (1) | (2) | (3) |
|---|---|---|---|
| *Second-stage Dependent Variable:* | share of female employment | | |
| | agriculture | manufacturing | services |
| log(exports) | -14.599*** | 3.568*** | 11.032*** |
| | (0.737) | (0.294) | (0.592) |
| *First-stage Dependent Variable:* | log(exports) | | |
| BDI cost | -0.422*** | -0.422*** | -0.422*** |
| | (0.024) | (0.024) | (0.024) |
| Time trend | yes | yes | yes |
| Interactive FE | yes | yes | yes |
| First-stage Cragg-Donald F-statistic | 57.876 | 23.649 | 126.973 |
| Stock and Yogo critical value (10%) | 7.03 | 7.03 | 7.03 |
| Observations | 966 | 966 | 966 |
| Countries | 45 | 45 | 45 |

*Note*: Robust standard errors are reported in the parenthesis. Statistical significance at the 10%, 5% and 1% levels are indicated by *, ** and *** respectively.

Table C6: Sectoral Female Employment Share and Urbanization

| | (1) | (2) | (3) |
|---|---|---|---|
| *Second-stage Dependent Variable:* | urbanization | | |
| Share of female employment | -0.509*** | 2.083*** | 0.674*** |
| | (0.040) | (0.240) | (0.050) |
| *First-stage Dependent Variable:* | share of female employment | | |
| | agriculture | manufacturing | services |
| BDI cost | 6.166*** | -1.507*** | -4.660*** |
| | (0.271) | (0.113) | (0.230) |
| Time trend | yes | yes | yes |
| Interactive FE | yes | yes | yes |
| First-stage Cragg-Donald F-statistic | 195.067 | 20.268 | 168.234 |
| Stock and Yogo critical value (10%) | 7.03 | 7.03 | 7.03 |
| Observations | 966 | 966 | 966 |
| Countries | 45 | 45 | 45 |

*Note*: Robust standard errors are reported in the parenthesis. Statistical significance at the 10%, 5% and 1% levels are indicated by *, ** and *** respectively.

# Chapter 5

# Concluding Remarks

Does trade promote living standards? This has been an important topic for both policymakers and academic researchers. The LDCs, the LLDCs and the SSAs which are classified as less developed do trade at low levels. If trade does cause growth, and thus, improves living conditions, increasing trade can help these countries to achieve their development goals.

In Chapter 2 we find that trade has no impact on the child mortality rate in 48 LDCs. However, strikingly, in autocrat LDCs, our evidence suggests that the average number of under-5 children who are expected to die would increase in response to an expansion in trade. This positive relationship is found to be associated with environmental issues.

In Chapter 3, we find that a reduction in trade cost has a substantial positive effect on economic development in 31 LLDCs. A one standard deviation decrease in container shipping cost, on average, is associated with a 20% increase in GDP per capita, a 29% increase in satellite night lights per capita, a 4 year increase in life expectancy, and a reduction of 9 infant and 5 under-5 deaths per 1,000 on average. Our results also show that a 1% increase in trade is associated with a 1% increase in GDP per capita  roughly five times the existing estimates in the literature  which suggests that trade has a large positive impact on income for the LLDCs.

In Chapter 4, we find that exports contribute to determining the urbanization rate in 48 SSAs. The doubling exports per capita, on average, leads to a 7.876 percentage point increase in the urbanization rate. Our estimates also suggest that exports can promote urban development (i.e. better water accessibility and sanitation facilities), expand the size of primate cities, and reduce income levels of these cities. However, the SSAs might bear a cost as the rural-urban gap in water access and sanitation facilities. We find evidence that higher exports per capita can increase the size of the services sector, which is in turn associated with higher rates of urbanization in the SSAs.

In conclusion, our findings suggest that less developed countries may not always gain from trade. Although a cheaper shipping cost for trade and an expansion in trade are found to improve average living standards in the LLDCs, higher trade may increase child mortality rate in autocrat LDCs and widen the rural-urban gap in the SSAs on average. Therefore, the effect of trade on economic development in less developed countries can be complex and heterogeneous.