Does Trade reduce Infant Mortality? Evidence from Sub-Saharan Africa[1]

Pallavi Panda

University of California, Riverside

May 9, 2014

Abstract

This study estimates the effects of a large scale trade policy on a development indicator like infant mortality, using the recent experience of African Growth and Opportunity Act (AGOA) affecting sub-Saharan Africa. The average difference in probability of death of children born to the same mother before and after AGOA in both AGOA affected and not-AGOA affected countries were estimated, using the retrospective Demographic and Health Surveys (DHS) from 30 sub-Saharan African countries. This helps in exploiting the within-mother variation, which is an improvement over the cross-country studies carried out till date. Findings suggest that infant mortality falls by about 7 to 13 infant deaths per 1000 which is as much as 9% to 16% of the sample mean. This result is robust to controlling for country specific linear trends and country level time varying indicators like GDP per-capita, average female literacy, commodity price index and political regime of the country. It was also found that uneducated women and rural women experience more decreases in infant deaths than educated and urban women. At the macro level, the effect seems to be taking place via increase in GDP per capita and increases in health expenditure per capita. Studying the heterogeneity at country level suggests that the low-income sub-Saharan African countries benefit more out of the policy change.

Keywords: Infant Mortality, Child Health, Trade Openness, sub-Saharan Africa

[1] I would like to thank Hewlett foundation/IIE for awarding the 2013-2015 Hewlett Foundation Dissertation Fellowship in Population, Reproductive Health and Economic Development for this research. This is a preliminary version and work in progress. Please do not cite without author's permission.

1 Introduction and Background

Over the years, trade has been posited as a key factor in economic development. Economists have argued that trade predicts higher income growth rates (Dollar and Kraay, 2001; Frankel and Romer, 1999). Hence, many developing countries have adopted increasingly open trade policies in the hopes of spurring growth. But, this large literature on trade by far remains inconclusive about its effects on development. In the literature, there are a few country-specific studies analyzing the effect of trade on poverty and inequality as development outcomes (Topalova, 2005; Porto, 2004).[2] There have been even fewer studies analyzing the effect of trade on child health and those exist only in a cross-country cross-sectional setting (Levine and Rothman, 2006).[3] They find that trade leads to slightly reduced infant mortality rates, child mortality rates and stunting. The problem with cross-country data analysis is that data across countries may not be comparable, may suffer from small sample size and may face difficulty in disentangling the effects of trade policy vis-à-vis simultaneous change in other policies. To alleviate this problem, this study focusses on the impact of a large-scale trade policy shift on an important social development indicator – viz., infant mortality – by building a pseudo-panel micro-dataset across countries and using this dataset for analysis.

Trade can affect the development process of a country via various direct and indirect mechanisms, both at the macro and micro level. Trade affects the overall aggregate or macro state of the economy by affecting economic growth, government health expenditures, urbanization and cultural changes which in turn affects the socio-economic indicators. Trade will improve health conditions in the country if it increases the tax revenue of the government allowing it to increase health expenditures.[4] Economic growth also results in higher household incomes, which in turn could improve health outcomes via mechanisms like improved nutrition, improved access to sanitation and health care etc. On the other hand, if trade results in increased inequality, then the incomes of the poor may be adversely affected and this in turn may worsen their health conditions.

2 Winters et al. provide an analytical framework and pathways to study the effect of trade liberalization on poverty.

[3] The development outcomes studied here are infant and under-5 child mortality, child stunting and wasting using data from World Development Indicators, WHO and UNICEF for a cross-section of 100-130 countries.

4 Adam, Bevan, and Chambas (2001) find that openness raises trade tax revenues in CFA franc countries while it has little effect in non-CFA franc countries in sub-Saharan Africa. Agbeyegbe et al (2004) find that trade liberalization is not strongly linked to aggregate tax revenue, but with one measure, is linked to higher income tax revenue in sub-Saharan Africa.

Trade may also affect the individuals and households directly at the micro-level through multiple ways. First, international trade can affect economic outcomes by decreasing transportation costs (Clark et al., 2004; Hummels and Skiba, 2004; Storeygard, 2012). As transportation costs decrease, the price differential of traded goods between two markets should go down by the amount of transport cost component of the prices of these goods. Decreased prices of goods due to trade could harm a household that is a net seller of the good, and benefit that which is a net buyer. Second, trade can also bring variety gains by access to a variety of goods in the country (Broda and Weinstein, 2006). Availability of a variety of goods increases the general welfare gain of the society. Increased variety in food may also result in increased intake of micronutrients which is beneficial for mother and child health. Third, trade increases employment opportunities and especially in a developing country context, opportunities for low-skilled labor. It is believed that trade liberalization has led to a feminization of labor force, especially in manufacturing industries like apparel and textiles. Increasing opportunities for employment of mothers may contribute towards improving health of the child, due to increasing incomes (income effect) or may even deteriorate health of child as the mother stays away from home (substitution effect).[5] So theoretically, trade may have positive impact, negative impact or no impact at a micro level. An empirical study of this kind intends to analyze the impacts and pathways through which these effects are taking place.

Sub-Saharan Africa is plagued with one of the highest infant and child mortality rates. Infant mortality rate is a socio-economic indicator which points towards well-being and/or health of the population in any country. At the same time while these countries are grappling with these developmental concerns, they are also looking for increased growth rates via increased openness. Recently, sub-Saharan African countries experienced a huge non-reciprocal trade agreement - African Growth and Opportunity Act (AGOA) - which conferred on these sub-Saharan African countries largely duty free and quota free access to US markets. This agreement intended to increase export volumes, spurring economic growth in these economies. This deal started in 2000 and has had amendments at regular intervals. There was a phase-wise allocation of AGOA rights to these countries, which permits the usage of the time variation for identification.

[5] Kishor and Parasuraman (1998), find using NFHS Data for India in 1992-93 that mothers who are employed have a 10 percent higher IMR and 36 percent higher child-mortality than mothers who are not employed. Many studies find strong relationship between increased female employment and increased exports (Wood, 1991, Standing, 1999).

Frazer and Biesebroeck (2010) found that AGOA had a large and robust impact on exports to US without decreasing the country's export to Europe. Some countries like Kenya experienced almost a 700% increase in exports to US from $36 million in 2000 to $284 million in 2010.[6] Since this trade agreement increased trade volumes and hence incomes for these countries, this study becomes extremely relevant in analyzing if there has been any substantial benefit in terms of improving health conditions in these countries, which is a major developmental concern for the countries in question.

The problem with the studies concerning liberalization in a single country or cross-country at a point in time is that trade liberalization or trade policies are generally endogenous and it is difficult to infer causality in the presence of other confounding socio-economic policies changing at the same time. For example, well governed countries would negotiate trade deals better as well as have better programs in place to improve health outcomes, which would be captured in the regression estimate from a cross country regression at a point in time. This paper exploits this huge trade agreement AGOA to exploit the relationship between trade and health outcomes in these countries which helps overcome these issues by constructing a dataset which observes the same mother overtime for these 30 sub-Saharan African countries. Specifically, in this paper, datasets across 30 sub-Saharan African countries from existing household level cross-sectional surveys (Demographic and Health Surveys, DHS) have been collated using the recall data to get a micro-dataset which runs across the sub-Saharan African countries, with the time dimension being the year of child birth given by each mother. By observing the children of the same mother before and after the trade policy change, a within-mother variation in survival of infant is carried out rather than cross-country or within-country variation; which in turn develops a causal analysis of effect of trade on health.

The paper's findings suggest that infant mortality falls by about 0.7 to 1.3 percentage points which is as much as 9%-16% of the sample mean. This operates via the mechanisms of increasing GDP per capita and increasing health expenditures per capita. The income boost brought about by trade does not only have a transient effect, but also affects development outcomes. Having a micro dataset which runs across countries also helps in identifying the heterogeneous effects based on education, place of residence and wealth. Heterogeneity at the country level based on primary commodity of export and initial income levels is also explored.

---

[6] Onyago and Ikiara (2011) in Reflections on Kenya's Experience under AGOA: Opportunities and Challenges.

2 African Growth and Opportunity Act (AGOA)

The African Growth and Opportunity Act (AGOA) has been part of the US international cooperation efforts for Africa since 2000. AGOA was initially set to expire in 2008 but was eventually extended to 2015. It entails a series of incentives provided to African countries by the US opening its market for exports originating from these countries. The legislation provides for preferential treatment of exports from Africa in the form of duty-free and largely quota-free access to US markets. Under AGOA benefits, four main sectors such as energy-related products, textiles and apparel, transportation equipment, and minerals and metals account for over 90% of exports. Figure 1(a) plots the total US imports and exports from sub-Saharan Africa. It is seen that there is a significant increase in exports from sub-Saharan Africa to US after 2001. Overall, total US imports have increased significantly from $5B in 2000 to over $25B in 2005 under AGOA (Paulos et al., 2010).

This act was implemented not only to boost exports but also improve and foster economic growth for these countries. Country eligibility for AGOA is determined by the US President (and listed in section 107 of the African Growth and Opportunity Act), and takes into account whether countries have made efforts to improve human rights, follow open market economic policies, protect worker rights and remove child labor, combat corruption, and establish rule of law among others.[7] The eligibility criteria for the Generalized System of Preferences (GSP), a US trade preference program that applies to more than 120 developing countries and AGOA substantially overlap, and countries must be GSP eligible in order to be eligible for AGOA. But, AGOA covers more product lines and includes some additional criteria than the GSP. In December 2002, 38 sub-Saharan African nations were AGOA eligible of which 27 had eligibility for textile and apparel benefits.

AGOA places heavy emphasis on Africa's emerging textile and apparel industry as the primary sector for trade benefits. While AGOA removes import duties on eligible African imports, preferential market access is granted only upon compliance with the relevant Rules of Origin. These rules prescribe the percentage value added that must take place locally in an AGOA-beneficiary country, while special provisions relating to apparel outline what processing must

---

7 Countries need to "have established, or are making continual progress toward establishing the following: market-based economies; the rule of law and political pluralism; elimination of barriers to U.S. trade and investment; protection of intellectual property; efforts to combat corruption; policies to reduce poverty, increasing availability of health care and educational opportunities; protection of human rights and worker rights; and elimination of certain child labor practices".

take place locally. However, the lesser developed countries were eligible for Special Rule and could source raw materials from all over the world till 2004 and still could get AGOA benefits.[8] Under initial AGOA legislation, beneficiary countries were given access to 1,800 tariff product lines, in addition to the 4,600 under GSP. AGOA also benefits these beneficiary countries as the exports under AGOA are not subject to a maximum volume ceiling as under GSP. Also, GSP's Most Favored Nation (MFN) status of countries expired in 2006 giving AGOA beneficiary countries an edge over all developing countries in this regard. However, with the ending of Multi-Fiber Agreements (MFA) in 2005, the exports from African countries have decreased in the face of competition from China, Bangladesh, and India.

Many studies have been conducted to study the effectiveness of AGOA in increasing exports to US. Frazer and Biesebroeck (2007), Condon and Stern (2011) and Collier and Venables (2007) find a positive and significant impact of AGOA on exports, especially apparel.[9] Thompson (2004) and Mattoo et al. (2006) show that the largest share of US imports from Africa remain to be the oil and energy sectors. These studies indicate towards a heterogeneous effect of AGOA based on country's main item of export as well as volume of exports from these countries. In line with this argument, along with looking at the effect of AGOA on the people living in these economies, this study also delves into the heterogeneity and inherent differences between the 30 sub-Saharan African beneficiaries to capture the differences in effects on those countries.

3 Brief Literature Review

The main channel through which trade is thought to affect any country, is via increase in income growth rates. There are many studies studying the effects of trade policy on income growth rates, finding a positive result (Dollar, 1992; Frankel and Romer, 1999; Dollar and Kraay, 2001). Dollar and Kraay (2001) argue that the increase in growth rates with trade leads to proportionate increases in the income of the poor and therefore poverty reduction in poor countries. They also find that there is no systematic relationship between changes in trade and changes in inequality, and hence it would not hurt the poor. These studies are cross country studies over many developing nations using different indicators of openness like decade-over-decade changes in the

---

[8] The lesser developed beneficiary countries are countries with a per capita income of less than $1,500 in 1998. By the end of 2002, 33 countries were beneficiaries of Special Rule provision.

[9] There have been few studies questioning the distribution of benefits of AGOA inside the country. Paulos et al. (2010) review the progress of a decade of AGOA and find that even though exports may be increasing, it may not be benefitting the countries internally. Kimenyi (2009) argues that only a few countries from the whole of Africa actually reap the maximum benefits.

volume of trade, index of real exchange rate distortion or geographically determined amount of trade to counter the issue of endogeneity.

Main criticisms of this literature point out the methodological problems with the empirical strategies employed in this literature like the use of indicators of openness which are poor measures of trade policies (Rodriguez and Rodrik, 2000). There are specific concerns of using cross-country growth regressions. Levine and Renelt (1992) point out that the existing cross sectional studies are not robust to small changes in the information set. The studies have not adequately controlled for other economic policies and therefore the effect of trade on growth may capture the effects of all these simultaneous policies together. At the country level, therefore there are many confounding factors which may not allow us to draw a causal inference of the impact of trade on any socio-economic outcome.

There are some country specific studies using micro-level data which directly study the effect of trade on economic development like poverty. Topalova (2005) analyzes the effect of trade liberalization on poverty, in the country-specific context of India, using micro-level data from NSS. She finds that rural areas experienced slower progress in poverty reduction but with no significant impact on inequality. Though these studies give evidence of trade affecting development, they are not generalizable to the context of other countries which may be facing completely different kind of trade conditions.

Effect of trade on child health has been under-studied. Levine and Rothman (2006) use Frankel and Romer’s approach in predicting how much a country will trade based on exogenous geographical characteristics and then use this predicted trade share to obtain a cross-sectional effect of trade on children’s health. They find that for an average country, a 15-percentage point increase in predicted trade as a share of GDP (an increase of about 1 standard deviation) corresponds to approximately 4 fewer infant deaths per 1000 births. However, they do not use a panel data set and hence are unable to capture how the change in trade affects change in infant mortality. Basically, the country specific effects are taken care by this latter channel of estimation.

Accordingly this paper adds to the literature in various ways. First, it develops a novel way of combining micro datasets across countries to study the effect of macroeconomic policy on development outcomes. This ensures that it is able to separate the effect of trade policy from other country level confounding factors. This provides a clean causal estimate even in a non-randomized setting, in the absence of a randomized control trial. Second, using this micro level dataset, this study develops infant mortality at the household level to overcome the problems of measurement error of infant mortality rates at the country level. Third, by using the trade policy shift of AGOA, it is able to provide a clean identification of trade policy instead of using other indicators of trade openness which may not be the best indicators of trade policy. Fourth, this study provides plausible pathways and accounts for heterogeneity at the country and the individual level due to the use of micro-level data across countries. Fifth, this is the only study in my knowledge to study the effect of trade (specifically AGOA) for 30 different countries in sub-Saharan Africa on health outcomes. This makes this study more generalizable for a region but at the same time is able to capture the nuances at the individual level for each country.

4 Data

The micro level health data for the sub-Saharan African countries comes from the Demographic and Health Surveys (DHS). The DHS questionnaire is standardized, which provides a perfect platform to compare datasets across countries where this survey is carried out. DHS are nationally representative household surveys that provide data for population, health and nutrition. The Standard DHS Surveys have large sample sizes and are typically conducted about every 5 years. Information regarding child health, anemia, domestic violence, maternal mortality etc. is found in the surveys, along with mother and household characteristics.

DHS collects data using three types of questionnaires – household, women's and men's questionnaires. Household questionnaire is used to collect data on household dwelling units, nutritional status, and anemia; while women's questionnaire is used to collect data from women about the characteristics, reproductive behavior, contraception, children's health etc. Women of reproductive age (15-49 years) are interviewed about the date of birth and death (if applicable) for up to 20 children they have had. This kind of retrospective survey gives an opportunity to build a panel dataset of mothers, with the time dimension being the year of child birth given by each mother. One problem that can be raised with the recall data is the measurement error problem. To be robust to measurement error and to capture the maximum effect of carrying out the siblings analysis, all children born before 1990 were dropped from the sample.[10] This ensures

[10] This is not dependent on the year of birth cut off. Other models with different year of birth (1994 or 1995) cutoffs gave significant results.

that the siblings are not very far apart in age and hence are broadly comparable. This also reduces the recall bias.

There are 36 DHS Surveys publically available for the sub-Saharan countries where DHS survey has been carried out at least once till now. But the surveys for Central African Republic, Comoros, Gabon, South Africa, Sudan and Togo have been all carried out before AGOA was implemented in these countries. Hence, the surveys for these 6 countries are not usable for this analysis. Based on the survey time requirements, the rest 30 surveys have been collated to obtain a sample of children along with their mothers.[11] A dummy variable indicating if the child has died before reaching the age of 1 year is constructed based on mother's birth history. This will be the indicator for *individual-level* infant mortality. Since measurement error is a serious concern for country level data such as infant mortality across countries (Krueger and Lindahl, 2001), the construction of this indicator from household level data overcomes this problem at a broad level. As long as at least one round of survey has been conducted in a particular country, a pseudo-panel dataset of mothers for that country can be built. The effect of trade policy on infant mortality will be gauged by studying the varying exposure between the children born to same mothers but exposed to AGOA or not. The DHS dataset provides an excellent opportunity to carry on the type of micro level analysis for a macroeconomic shock as is intended.[12]

After dropping data for children born within twelve months of the survey or born before 1990, to ensure full exposure for every child in the sample and reduce measurement error, there is a sample of 686,093 children born to 212,738 mothers. The sample average infant mortality rate is 8.15% of live births while the sample neonatal mortality rate is 3.8% of live births. In Table 1(a), we can see that average infant deaths for the whole population, as well as infant mortality based on different characteristics of mother like education, place of residence and wealth levels, significantly (based on t-statistic) decreases after AGOA is implemented. Table 1(b) compares the average number of girl births, number of multiple births and mother's age at birth between AGOA affected and non-affected countries. It is observed that these countries are similar in terms of sex composition and multiple births, but the composition of mother's age at birth is

[11] The list of DHS used and respective sample periods are listed in Table A1 in Appendix.
[12] DHS dataset has been used in this manner to study the effect of income fluctuations on infant mortality (Bhalotra, 2007, Paxson and Schady,2005) and effect of democracy on infant mortality (Kudamatsu, 2012). This paper follows that methodology.

different across these countries. In the estimation, hence, there is an additional control for mother age at birth to see the effect on the estimated coefficients.

To check if the mothers having two or more births are different from mothers in the entire sample, Table 1(c) shows the summary characteristics of children born to these different sets of mothers. It is observed that the average infant mortality and neonatal mortality are not systematically different for mothers with two or more births than from the population at large. The sample of mothers with two or more children has the same average educational attainment, wealth and age at birth. There are no systematic differences between the two samples and hence mother fixed effects will not be biasing the results. Since mother fixed effects estimation derives the effect of AGOA on infant mortality using those mothers giving birth both before and after AGOA, Table 1(d) shows the sample mean infant and neonatal mortality rates for mothers giving birth both before and after AGOA and for mothers with more than two births only before or after AGOA. It is seen that sample mean infant and neonatal mortality rates fall for both the groups after AGOA is implemented, though it falls more for the mothers giving birth both before and after AGOA. This hints towards a change in composition of mothers after AGOA has been implemented, leading us to believe the necessity of controlling for mother fixed effects.

5 Empirical Strategy

To analyze if trade has reduced infant mortality, the following linear probability model[13] is estimated:

$$IMR_{imct} = \alpha_m + \beta_t + \gamma T_{ct} + X_{imct}\delta + \mu_c.t + \varepsilon_{imct} \quad (1)$$

Here, IMR is a dummy which takes the value 1 if child i born to mother m in country c at time t dies before reaching the age of 1 year, α_m is mother fixed effect, β_t is birth-year fixed effect and $\mu_c.t$ captures the country-time specific trend. T_{ct} takes the value 1 if the specific country was under AGOA at time t. X_{imct} is a vector of control characteristics like sex of the child, whether or not they are born in multiple births (i.e. twins, triplets, etc.), dummies for their birth order and birth month. Since the children born after AGOA are necessarily older than the ones before, it is important to control for birth order to give more precise estimates. It may also be argued that

[13] I also check for Logit estimates. They are significant. But due to easier interpretation of LPM estimates, I present those in the results. Using Logit in Mother FE model would limit the possibility of obtaining marginal effect of trade on infant mortality.

birth order trends differs between countries and hence as a robustness check, country specific birth orders are also controlled for. γ provides the estimate of the effect of AGOA on infant mortality.

To account for changing time of mother's age at birth due to improvements in survival of babies overtime in Africa, an interaction between mother's birth cohort by child's birth year (β_{bt})[14] fixed effects is controlled for:

$$IMR_{imbct} = \alpha_m + \beta_{bt} + \gamma T_{ct} + X_{imbct}\delta + \mu_c.t + \varepsilon_{imbct} \quad (2)$$

γ captures the average difference in changes in probability of death of infants born to the same mother between those countries that have been affected by AGOA vis-à-vis those that are not. Hence this aligns itself to a difference-in-difference strategy with mother fixed effects. For the estimates to be unbiased, the error should not be correlated with any of the covariates and outcomes, not only contemporaneously but also in leads and lags as the same mother gives birth. Specifically:

$$E(\varepsilon_{imbct} | T_{ct}, \beta_{bt}, \alpha_m, \mu_c.t, X_{imbct}) = 0 \quad (3)$$

The main concern in studying the effect of such a policy is the difficulty to disentangle the effect of this policy vis-à-vis the prerequisites for this policy that a country has. In terms of disentangling this effect, this study does better than cross-country studies. Time-invariant heterogeneity regarding geography, history, culture, politics and attitudes etc. are taken care of by the mother fixed effects (α_m) since this is implicitly a country fixed effect – mothers of the children belong to a certain country of residence and hence controlling for mother's characteristics implies controlling for the country characteristics. There is a risk in works involving studying of trade policy change that higher ability mothers may self-select into having babies when incomes are higher and times are better (after the trade liberalization). But the formulation of this panel individual-level data rather than country level data helps tackle this endogenous selection issue as this is now taken care by the mother fixed effects.

This specification also helps in controlling for events and factors which may affect both trade openness and changes in infant mortality overtime individually but not necessarily having a relationship between the two like changes in population. Hecksher-Ohlin theory suggests that

[14] Subscript b denotes the mother's birth cohort.

country's exports are influenced by resources. Education then can be viewed as prerequisite to trade. Wood and Mayer (1998) find that human capital stock or education/skills determine the exports at macro level in Africa. There is evidence of parental education associated with decreased infant mortality.[15] Hence stock of education may affect both the placement of trade policy as well as declines in infant mortality. But, this does not create a problem in this analysis because the effect of mother's education on infant mortality is take care by using the mother fixed effects. This is the advantage of using individual level data instead of country level data.

The year fixed effects (β_t) control for an aggregate time variation involving improvement of health technology etc. β_{bt} controls for changing time of mother's age at birth due to improvements in survival of babies overtime in Africa. This controls for fertility changes overtime in that region due to improvements in health technology. The country specific trends (μ_c.t), in fact, also allow country specific improvement in technology i.e. differential states of development of the countries. Standard errors will be clustered at the country level to account for any serial correlation within the countries in the region.

But, there may be time variant heterogeneity which may affect both trade and infant mortality rates. Implementation of AGOA or how well the country does after its implementation may depend on the country's political situation, GDP per capita, average female education of the country etc. Countries with a higher GDP per capita or in a democratic regime may experience a lower IMR too (Kudamatsu, 2012). Hence these may bias the estimates. As a robustness check, at the country level there is a control for additional characteristics (Z_{ct}) like GDP per capita, political regime of the country, whether it is a democracy, degree of openness overtime, average level of female education etc. which may help control some of the time variant heterogeneity at the country level. The following equation is estimated to capture these effects:

$$IMR_{imbct}= \alpha_m + \beta_{bt} + \gamma T_{ct} + X_{imbct}\delta + \mu_c.t + \lambda Z_{ct} + \varepsilon_{imbct} \qquad (4)$$

To check for heterogeneity based on mother's level of education, place of residence and possession of assets, the mother-FE regression has been run with appropriate interactions to tease out the effects:

$$IMR_{imbct}= \alpha_m + \beta_{bt} + \gamma(T*MC)_{ct} + X_{imbct}\delta + \mu_c.t + \varepsilon_{imbct} \qquad (5)$$

[15] Established in Chou et al (2007), Desai and Alva (1998), Schultz (1993), Cochrane et al (1982) etc.

Where, MC defines the mother's characteristics. The interaction term $(T^*MC)_{ct}$ provides an estimate of treatment effect of AGOA on probability of infant death for a specific subsection of the population based on assets, education and place of residence in comparison to the reference population.

Heterogeneity at the country level is also necessary to observe given the difference in exports variety and volumes across AGOA beneficiaries. To capture these effects, I estimate the following regression:

$$IMR_{imbct} = \alpha_m + \beta_{bt} + \gamma(T^*CC)_{ct} + X_{imbct}\delta + \mu_c.t + \varepsilon_{imbct} \quad (6)$$

CC captures differences in country characteristics like whether a country is a predominant petroleum exporter, apparel exporter, low income country, possesses an apparel visa etc. The interaction term will indicate which countries are actually accruing the most benefits in reducing infant deaths via AGOA.

6 Main Results and Heterogeneity

6.1 Main Results

Figure 1(b) graphs the mean infant mortality rates for the 27 AGOA affected sub-Saharan African countries in the sample by year of birth of child, 1990 onwards. The data shows a declining trend in infant mortality over time. A sharp fall in infant deaths in some of the countries after the year AGOA is implemented is observed, more prominently than some others. There also seem to be some delayed effects overtime. Table 1(a), 1(b) and 1(c) present the summary statistics of the data, as discussed in the Data Section.

Table 2 provides the main regression results of the effects of treatment on infant mortality. Specification 1 (columns (1)-(3)) controls for linear country time trend and explanatory variables like birth order, sex of child, multiple birth and birth month. Column (1) shows the OLS results. The coefficient on AGOA is negative and statistically significant. Controlling for country fixed effects in (2) increases the absolute value of coefficient to 1.3 percentage points. Controlling for mother fixed effects in (3) increases the absolute value of the coefficient marginally but the coefficient is still significant. Table 2, specification 2 (columns (4)-(7)) additionally controls for cohort-year fixed effects. By controlling for this, the changing time of mother's age at birth due to improvements in survival of babies over time in Africa is being controlled. It is observed that controlling for these with an interaction of dummies for mother's birth year (cohort) with child's year of birth reduces the magnitude of the coefficient to around 0.7 percentage points, but it still remains significant. Therefore some of the effect that was observed in (1)-(3) may be attributed to changing mother's age at birth over time.

It is also seen that the absolute value of coefficient decreases from 7.6 to 6.95 reductions in infant deaths per 1000 live births, as we move from OLS to Mother FE. This implies that not accounting for quality of mothers in this analysis has created a bias and including fixed effects takes the coefficient to be nearer to zero but is still significantly different from zero. Healthier and more 'intelligent' women seem to be timing the birth of their babies when times are better. This time invariant mother characteristic explains a part of the fall in infant mortality, which initially was wrongly attributed to exposure to AGOA in the OLS specification. Comparing this with previous literature[16], it is found that the effect is higher in absolute magnitude using mother FE than in the cross-country setting, with trade openness contributing to a reduction by around 7 infant deaths per 1000 births. On carrying out mother fixed effects analysis of AGOA on neonatal mortality in column (7), a significant negative effect is found. Neonatal deaths reduce by 4.4 deaths per 1000, which is about 12% of the sample mean. Hence, majority of the reduction in infant deaths is coming via a decrease in neonatal deaths.

It is crucial that it is AGOA which brings about the change in infant mortality and we are not wrongly attributing the effects of some other change to AGOA. For the estimates to be unbiased, the error should not be correlated with any of the covariates and outcomes, not only contemporaneously but also in leads and lags as the same mother gives birth. To corroborate this, a regression involving lags and lead periods for AGOA has been estimated.[17] Figure 2 graphs the dynamics of infant mortality from 3 years before AGOA implementation to 4 years after it. It can be seen that infant mortality had been almost constant, not significantly different from zero in the three years before AGOA was implemented, but there is a significant drop in infant mortality as compared to 4 years before implementation of AGOA in year 1, year 3 and year 4 of AGOA being implemented. The effect decreases year 4 onwards most probably because of expiration of Multi-Fiber Agreement which decreased the exports from AGOA countries into the US and hence decreasing the effect of the agreement on the countries.

Table 3 controls for country level variables like log GDP per capita, Democratic regime, Openness, female education etc. in the mother FE specification with cohort-year FE. It can be

[16] Levine and Rothman (2006) find that for an average country, a 15-percentage point increase in predicted trade as a share of GDP results in 4 fewer infant deaths per 1000 births.
[17] Point estimates are shown in Table 7(b).

argued that all the effect that trade brings on infant mortality is due to increasing per capita income. GDP per capita data is obtained from PWT 7.0 and log of GDP per capita is used to run the regression with cohort year fixed effects in Table 3 (1). Infant mortality was observed to decrease with an increase in the GDP per capita (significant at 10% level), but even controlling for GDP per capita did not reduce the magnitude of the AGOA coefficient much nor remove significance. Hence, it can be said that little effect that trade brings on infant mortality is via increasing per capita income at the country level.

In the literature, some studies find that democracy and political regime may affect child health (Kudamatsu, 2012). The effect of democracy and political regime has been controlled for by using the democracy-dictator data from Cheibub et al. (2010) which is an updated dataset based on Przeworski et al. (2000). They define democracy as: the executive is directly elected or indirectly elected via the legislature; the legislature is directly elected; there is more than one party; and the executive power alternates between different parties under the same electoral rule. If a country satisfies these conditions, the democracy indicator takes the value 1. Regime is a categorical variable indicating parliamentary democracy; mixed (semi-presidential) democracy; presidential democracy; civilian dictatorship; military dictatorship; or royal dictatorship. In Table 3- columns (2) and (3), even controlling for both, democracy and political regime of the country, does not change the magnitude of the coefficient much from the results in Table 2. Democracy tends to reduce infant mortality but the coefficient is not significantly different from zero at the conventional level.

It may be argued that a country which already had trade routes open under GSP would have benefitted more from AGOA and hence its coefficient maybe capturing the effects of already increased trade flows. But controlling for openness from PWT 7.0 in Table 3 (4), it is observed that the coefficient is not significantly different from zero and the original coefficient on AGOA does not decrease in absolute value or significance. Countries with higher growth of human capital such as average years of education of females in a country may be benefitting more than others. Hence, data for the average years of schooling of females 15 years or older is collated from Barro and Lee (2010) and there is a control for average years of female education of the country in Table 3 (5). The number of countries for which this data is available falls to 21. It is seen that the coefficient is not significantly different from zero and also the coefficient on treatment to AGOA does not change much and stays statistically significant.

Commodity price fluctuations have contributed to improved incomes and growth in Africa over the last decade (Deaton, 1999). Considering this finding, the commodity price index derived from PWT 8.0 in Table 3 (6) is controlled for but this does not decrease the magnitude of the coefficient on AGOA much. The coefficient on commodity price index is itself significant and tends to increase infant mortality. In Table 3 (7), all the macro variables are controlled for and that also does not reduce the magnitude or significance of the variable in question. It confirms that the coefficient on AGOA is robust to controlling for some of the important country level time variant factors.

6.2 Heterogeneity

AGOA may affect the recipient countries differentially based on their composition of exports at the country level. At the individual level, heterogeneity may exist based on characteristic of the mother and the household. These differences have been explored in the following section.

Table 4 checks for heterogeneity in effects based on mother's place of residence, education and possession of assets. It is observed that AGOA has a significant effect (similar in absolute magnitude) in decreasing infant deaths of uneducated mothers. AGOA also has a significant effect in reducing infant mortality for mothers living in rural areas but not for those living in urban areas. AGOA seems to be effective in significantly reducing infant deaths for poor, negating the widely held notion that trade increases inequality. AGOA seems to be affecting the more backward sections of the society, where there is a larger scope of reducing infant mortality. This is consistent with the standard economic theory (Hecksher-Ohlin model) stating that gains of trade should flow to abundant factors, and in this developing country setting, unskilled labor (uneducated rural poor mothers) should benefit the most.

AGOA may affect the recipient countries differentially based on their predominant commodity of export. It will be interesting to see if these differences also affect individuals and the health indicators differentially. There is a check for macro level heterogeneity in Table 5. Contrary to expectations, it is seen that countries having the highest volume of exports under AGOA or with petroleum products and apparel products as major exports do not differentially benefit more than other countries. It may well then be that resource rich countries are not really blessed in terms of harnessing the long term gains that trade may bring. The ending of Multi-Fiber Agreement in 2005 does seem to have an impact. With increasing competition in exports from China and other countries after 2005, it is observed that the impact of AGOA on infant mortality is significantly more before 2005. Also, low-income countries in sub-Saharan Africa experience a significant decline in infant mortality due to AGOA vis-à-vis the middle income countries. Even at the macro level, therefore, AGOA helps in levelling the disparities.

It may be argued that the benefits and heterogeneity we see at the micro level is actually reflected in the country level heterogeneity analysis. The benefits to the poor and uneducated are consistent with low income countries and countries with apparel visa benefitting more than countries with predominantly petroleum exports. This is because countries with apparel visa and apparel exporting manufacturing units, must be employing low unskilled labor which is depicted by greater benefits accruing to that section of the society. On the other hand, countries with predominantly petroleum exports, even though are generating revenues, the benefits are not seeping into the population living in those countries as it does not generate the type of employment for women as an apparel factory or manufacturing does.

6.3 Pathways and Robustness Checks

Table 6 delves into finding the possible pathways through which the effects are taking place at the macro level. Country level macro data from World Development Indicators and Penn World Table has been used and the Country Fixed Effects regression was run controlling for time, to find that increasing GDP per capita and health expenditure per capita seem to be major routes through which these effects are taking place. Apart from income boost, it is bringing about changes in public and private health expenditures which are benefiting the individuals in those countries. The pathway findings are similar to Levine and Rothman (2006)[18]. The country level data doesn't suggest any increase in women labor force participation. It seems that increase in employment may be coming from the unorganized sector, which is not captured in this country level statistic.

In order to ensure the effects are totally attributable to the policy, a placebo test is run where a country is randomly allocated (from a uniform distribution) AGOA beneficiary status as well as the time of AGOA implementation for the country. The results are given in Table 7(a). We should expect that the coefficient for this regression should not be significant. The results in fact turn out to be insignificant in various specifications, implying that the estimate derived earlier is attributable to AGOA.

---

[18] The authors find that trade predicts higher income, higher immunization rate, and larger public health expenditures.

Table 8 shows some more robustness result. To alleviate the concern that the results may be driven by one outlier country, table 8(a) shows that the result is robust to dropping one country at a time implying that these are not driven by changes in any single outlier country. Also, since there are 30 countries and there may be country specific differences in birth order or mother's age trend, table 8(b) controls additionally for country specific birth order dummy and country specific mother's age quadratic trend. The magnitude and significance of the coefficient derived in the main specification is unchanged, implying that the result is robust to differing trends and decline among countries in birth order and mother's age.

7 Conclusion and Future Work

Trade policy has been pursued mostly keeping macroeconomic benefits in mind. But, these policies may have intended or unintended effects on microeconomic development indicators as well. Most of the studies till now either have all macroeconomic variables or all microeconomic variables in their analysis. This study bridges the gap and brings synthesis between the two literatures. With such a large policy change, which affects so many countries at one time, it is difficult to simulate this experience through a randomized control trial. Even in a non-randomized setting, this analysis derives a clean estimate of the effect of trade policy on health outcomes and behavior using the variation of implementation of AGOA. The results in this paper establish a positive relation between AGOA and health indicators, pointing towards a welfare and long term developmental gain to the society by trade and not just a short term income boost. This is a step towards establishing that macroeconomic policies, in fact, may have a positive causal effect on development outcomes like health.

Heterogeneous effects like differential benefits to different sections of the population have been found. AGOA reduces infant death significantly for the uneducated and rural mothers. This may be happening because uneducated rural mothers provide cheap labor which is employed with the job creation that comes with trade openness. In this sense, trade closes the gap between the groups. At the country level, petroleum export dominated countries do not significantly do better than others. In fact, it is the other group of countries which benefits more in terms of infant death reductions. Also, at the macro level, infant deaths are lowered mostly via two mechanisms namely increase in GDP per capita and increase in health expenditures.

It is expected that AGOA may affect the health seeking behavior of mothers. This may constitute an important pathway through which the changes in infant mortality are taking place at the household level. Since data on various micro pathways like access to toilets, piped water, tetanus toxoid injections etc. are not retrospective, data from the countries which have at least 2 rounds of DHS will be collated to construct a repeated cross section to gauge the effect of AGOA on these routes, controlling for mother characteristics. This will give an insight into what are the mechanisms through which households are successful in averting infant and neonatal deaths. Moreover, a country case study in this region will give more insights into all the mechanisms through which these gains are being realized. This work is being carried out in an associated paper.

It is important to point out here that the effects that are being captured here are short term effects that take place after a policy is implemented. The long term effects need to be studied separately. For that, we would require more data on the same cohort of children overtime. This would help analyze other attributes like IQ, educational outcomes and even labor market outcomes in the future. It is important that we develop a macro-micro synthesis and study the relationship between health and macroeconomic outcomes as this underdeveloped route will open up new channels of effective policy intervention which would help harness all the benefits that any macroeconomic policy may have on society's welfare.

References

Adam, Christopher S., Bevan, David L., Chambas, Gerard, 2001. Exchange rate regimes and revenue performance in Sub-Saharan Africa. Journal of Development Economics, Elsevier, vol. 64(1), pages 173-213, February.

Agbeyegbe, Terence D., Stotsky, Janet Gale, Woldemariam, Asegedech, 2004. Trade Liberalisation, Exchange Rates Changes and Tax revenue in Sub-Saharan Africa. IMF Working Paper, WP/04/178

Barro, Robert, Lee, Jong-Wha, 2010. A New Data Set of Educational Attainment in the World, 1950-2010. Forthcoming, Journal of Development Economics.

Besley, Timothy, Kudamatsu, Masayuki, 2006. Health and democracy. American Economic Review, 96 (2), 313-318

Bhalotra, Sonia, 2007. Fatal Fluctuations? Cyclicality in Infant Mortality in India. IZA Discussion Papers 3086, Institute for the Study of Labor (IZA)

Broda, Christian, Weinstein, David E., 2006. Globalization and the Gains from Variety. Quarterly Journal of Economics 121 (2), 541-585

Cheibub, Jose A., Gandhi, Jennifer, Vreeland, James R., 2010. Democracy and Dictatorship Revisited. Public Choice, vol. 143, no. 2-1, 67-101

Chou, Shin-Yi, Liu, Jin-Tan, Grossman, Michael, Joyce, Theodore J., 2007. Parental Education and Child Health:Evidence from a Natural Experiment in Taiwan. NBER Working Paper No. 13466, October 2007

Clark, Ximena, Dollar, David, Micco, Alejandro, 2004. Port E_ciency, Maritime Transport Costs, and Bilateral Trade. Journal of Development Economics 75 (2), 417-450

Cochrane, S. H., Leslie, J., O'Hara, D. J., 1982. Parental Education and Child Health: Intracountry Evidence. Health Policy and Education, 2(3-4): 213 - 250

Collier, Paul, Venables, Anthony J., 2007. Rethinking trade preferences: how Africa can diversify its exports. The World Economy, 30(8), 1326-1345

Condon, Niall, Stern, Matthew, 2010. The Effectiveness of African Growth and Opportunity Act (AGOA) in Increasing Trade from Least Developed Countries: A Systematic Review. London: EPPI- Centre, Social Science Research Unit, Institute of Education, University of London

Deaton, Angus, 1999. Commodity Prices and Growth in Africa. Journal of Economic Perspectives-Volume 13, Number 3, Summer 1999, 23-40

Desai, Sonalde, Alva, Soumya, 1998. Maternal Education and Child Health: Is There a Strong Causal Relationship? Demography, 35(1): 71 – 81

Dollar, David, Kraay, Aart, 2002. Growth is good for the poor. Journal of Economic Growth 7 (3): 195–225

Dollar, David, 1992. Outward-Oriented Developing Countries Really Do Grow More Rapidly: Evidence from 95 LDCs, 1976-85. Economic Development and Cultural Change, April, 523-544

Frankel, Jeffery A., Romer, David, 1999. Does trade cause growth? American Economic Review 89 (3), 379–399

Frazer, Garth, Biesebroeck, Johannes V., 2010. Trade growth under the African Growth and Opportunity Act. The Review of Economics and Statistics 92(1), 128–144

Heston, Alan, Summers, Robert, Aten, Bettina, Penn World Table Version 7.0, Center for International Comparisons of Production, Income and Prices at the University of Pennsylvania, May 2011.

Hummels, David, Skiba, Alexandre (2004). Shipping the Good Apples Out? An Empirical Con_rmation of the Alchian-Allen Conjecture. Journal of Political Economy 112 (6),1384-1402

Kishor, Sunita, Parasuraman, Sulabha, 1998. Mother's Employment and Infant and Child Mortality in India. National Family Health Survey Reports, Number 8

Kimenyi, Mwangi S., 2009. African Growth and Opportunity Act: A Case of Vanishing Benefits, Senior Fellow, Global Economy and Development, Africa Growth Initiative, Opinion piece, The Brookings Institution

Krueger, Alan, Lindahl, Mikael, 2001. Education for growth: why and for whom? Journal of Economic Literature 39 (4), 1101–1136

Kudamatsu, Masayuki, 2012. Has democratization reduced infant mortality in sub-Saharan Africa? Evidence from microdata, Journal of the European Economic Association. doi: 10.1111/j.1542-4774.2012.01092.x

Kishor, Sunita, Parasuraman, Sulabha, 1998. Mother's Employment and Infant and Child Mortality in India, National Family Health Survey Subject Reports, Number 8

Levine, David I., Rothman, Dov, 2006. Does trade affect child health? Journal of Health Economics 25 (2006) 538–554

Levine, Ross, Renelt, David, 1992. A Sensitivity Analysis of Cross-Country Growth Regressions. American Economic Review 82 (4), 942-963

Lofgren, Hans, 2000. Trade reform and the poor in Morocco: a rural – urban general equilibrium analysis of reduced protection. In: W. Shahin and G. Dibeh (Eds) Earnings Inequality, Unemployment, and Poverty in the Middle East and North Africa

Mattoo, Arvind , Roy, Devesh, Subramanian, Arvind, 2006. The Africa Growth and Opportunity Act and its Rules of Origin: Generosity Undermined, World Bank Policy Research Working Paper, No. 2908

Nicita, Alessandro, 2004. Who benefited from trade liberalization in Mexico? Measuring the Effects on Household Welfare. World Bank Policy Research Working Paper 3265

Onyago, Christopher, Ikiara, Moses, 2011. Reflections on Kenya's Experience under AGOA: Opportunities and Challenges. In "Improving AGOA: Toward a New Framework for US-Africa Commercial Engagement". African Growth Initiative at Brookings. The Brookings Institution, Washington D.C.

Paulos, Mekalia, Kimenyi, Mwangi, Karingi, Stephen, Paez, Laura, 2010. A Decade (2000-2010) of African-US Trade under the African Growth Opportunities Act (AGOA): Challenges, Opportunities and a Framework for Post-AGOA Engagement. African Economic Conference, Rwanda

Paxson, Christina, Schady, Norbert, 2005. Child Health and Economic Crisis in Peru. The World Bank Economic Review, vol. 19, no. 2, 203-223

Porto, Guido, 2004. Trade reforms, market access and poverty in Argentina. World Bank Policy Research Working Paper no. 3135. Washington, DC, World Bank

Przeworski, Adam, Alvarez, Michael E., Cheibub, Jose A., Limongi, Fernando, 2000. Democracy and Development: Political Institutions and Well-Being in the World, 1950-1990. Cambridge University Press.

Rodrik, Dani, Rodrıguez, Francisco, 2001. Trade policy and economic growth: a skeptic's guide to the cross-national evidence. In: Ben, B., Rogoff, K.S. (Eds.), Macroeconomics Annual 2000. MIT Press for NBER, Cambridge

Schultz, Paul T., 1993. Mortality Decline in the Low Income World: Causes and Consequences. Center Discussion Paper No. 681, Economic Growth Center, Yale University

Standing, Guy, 1999. Globalization through flexible labor: a theme revisited, World Development, Vol 27 No 3

Storeygard, Adam, 2012. Farther on down the Road: Transport Costs, Trade and Urban Growth in Sub-Saharan Africa. World Bank Working Paper 6444, Tufts University

Thompson, Carol B., 2004. US Trade with Africa: African Growth & Opportunity? In: Review of African Political Economy, vol. 31, no. 101, 457-474

Topalova, Petia, 2005. Trade liberalization, poverty, and inequality: Evidence from Indian districts, NBER Working Paper No. W11614, September

Winters, Alan L., McCulloch, Neil, McKay, Andrew, 2004. Trade Liberalization and Poverty: The Evidence So Far, Journal of Economic Literature, Vol. XLII (March 2004) pp. 72–115

Wood, Adrian, 1991, North-South trade and female labour in manufacturing: an asymmetry, Journal of Development Studies, Vol 27 No 2

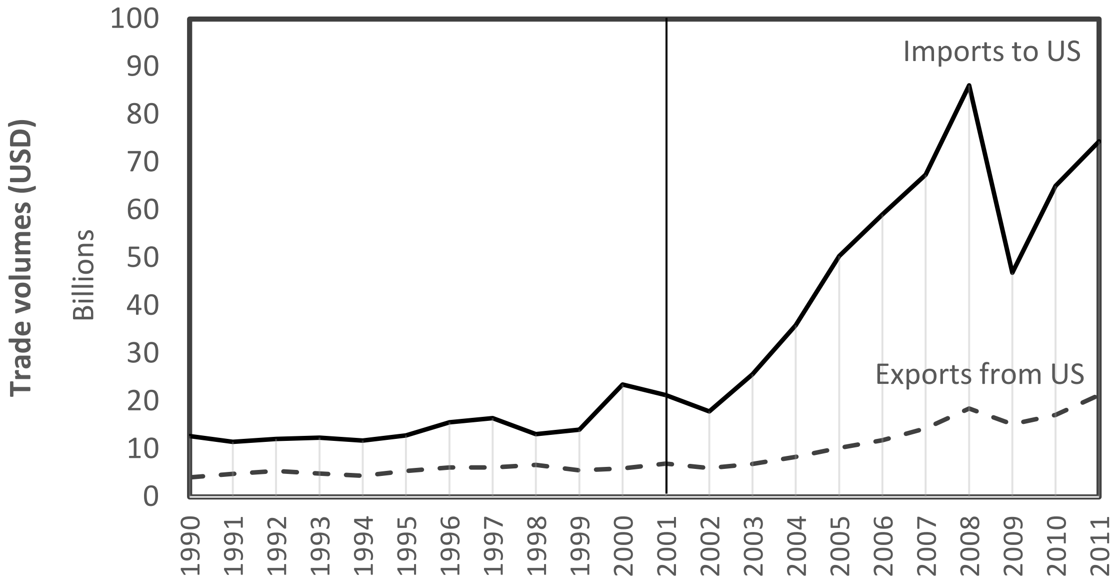
Wood, Adrian, Mayer, Jorg, 1998. Africa's Export Structure in a Comparative Perspective. United Nations Conference on Trade and Development, UNCTAD/GDS/MDPB/Misc.4

World Development Indicators, World Bank

Younger, Stephen D., 2001. Cross-Country Determinants of Declines in Infant Mortality: A Growth Regression Approach. Cornell University, Food and Nutrition Policy Program

Zakir, Mohammed, Wunnava, Phanindra V., 2010. Factors affecting infant mortality rates: evidence from cross–sectional data. Applied Economics Letters, 6:5, 271-273

Figure 1(a): Trade Volumes between US and sub-Saharan Africa



Note: This graph has been plotted using the data from International Trade Administration, U.S. Department of Commerce. It depicts the total exports and imports between US and all the sub-Saharan African countries from 1990-2011. The solid black line represents the imports into US from sub-Saharan Africa while the dotted line represents the exports from US to sub-Saharan Africa. It is observed that both exports and imports from sub-Saharan Africa increase dramatically after 2001. A more distinct increase in exports from sub-Saharan Africa to US is observed.

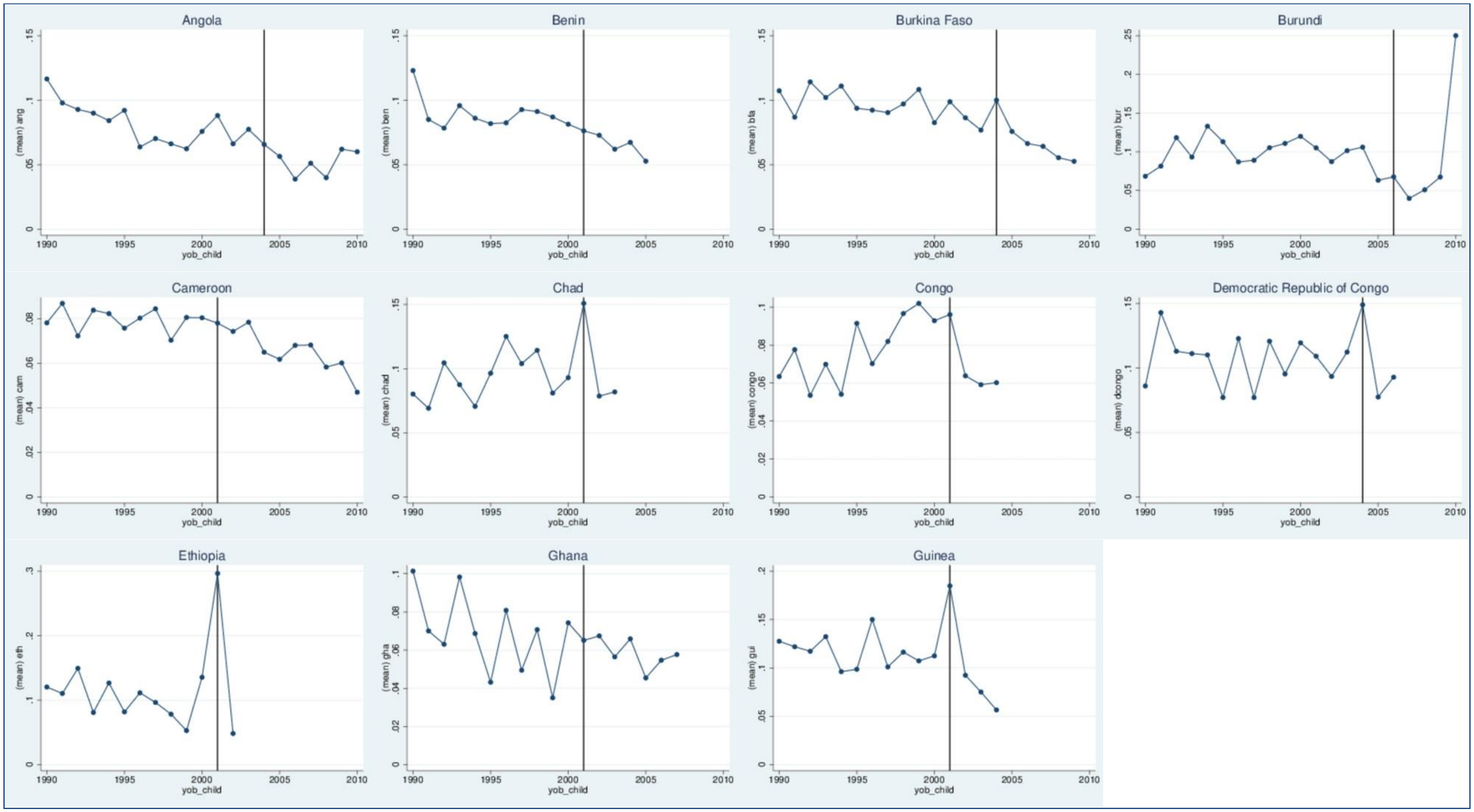


Figure 1(b): Sample mean infant mortality rates by country for AGOA affected countries overtime, 1990 onwards

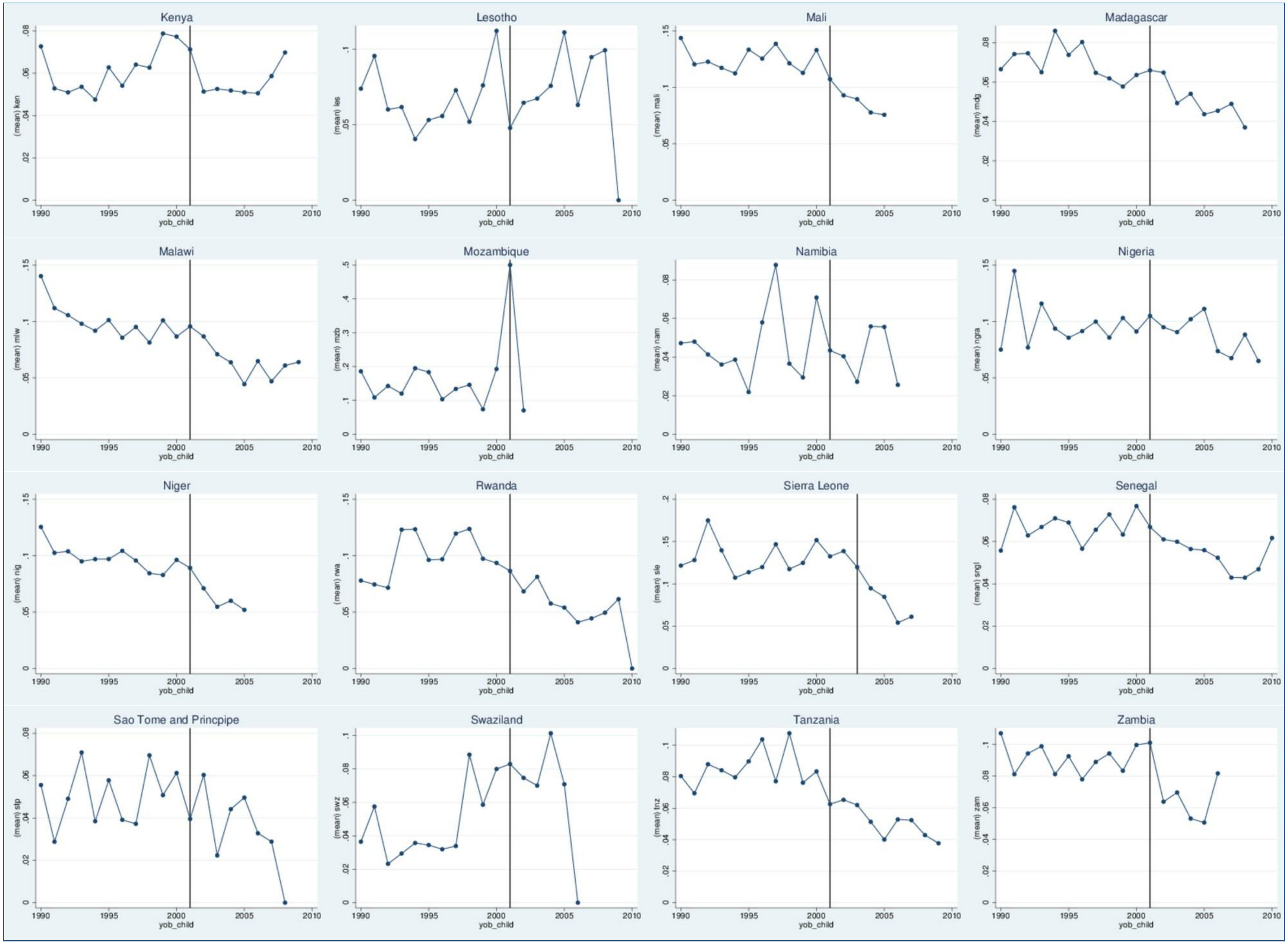
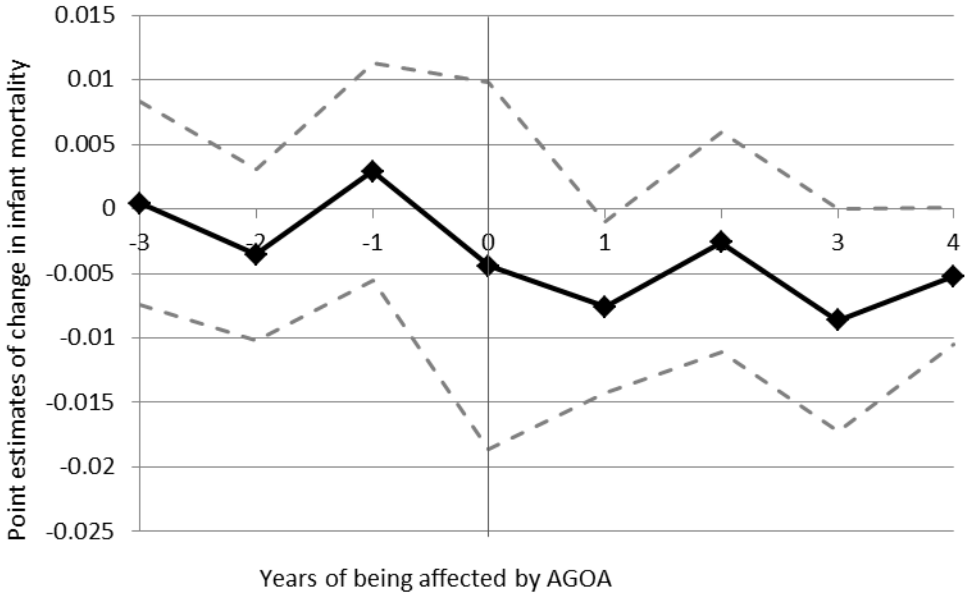


Figure 1(b): Sample mean infant mortality rates by country for AGOA affected countries overtime, 1990 onwards

Figure 2: Dynamics of infant mortality



Note: The solid black line depicts the change in infant mortality compared to 4 years before implementation of AGOA controlling for mother fixed effects, cohort-year fixed effects, country specific linear trends, sex of child, whether born in multiple birth, birth order and birth month. Year 0 is the year of implementation of AGOA, such that the countries have been at least partially affected by AGOA in that year. The dotted lines represent the 95% confidence interval with standard errors clustered at the country level. The point estimates for 1, 3 and 4 years after being affected by AGOA are significant at the conventional level.

Table 1(a): Summary Statistics – Mean Infant Mortality

	(1) All	(2)Before AGOA	(3)After AGOA	(4)t-test
Infant Mortality	0.0815	0.0912	0.0647	38.99
(All)	(686093)	(440693)	(220981)	(0.00)
Infant Mortality	0.0939	0.1031	0.0719	29.92
(Uneducated)	(342382)	(240004)	(95204)	(0.00)
Infant Mortality	0.0691	0.0769	0.0592	19.84
(Educated)	(343693)	(200679)	(125769)	(0.00)
Infant Mortality	0.0902	0.1027	0.0691	31.49
(Poor)	(300418)	(190306)	(98470)	(0.00)
Infant Mortality	0.0747	0.0824	0.0611	24.26
(Non-Poor)	(385675)	(250387)	(122511)	(0.00)
Infant Mortality	0.0866	0.0981	0.0671	38.26
(Rural)	(501284)	(319048)	(165503)	(0.00)
Infant Mortality	0.0677	0.0731	0.0575	12.60
(Urban)	(184809)	(121645)	(55478)	(0.00)

Note: Sample mean infant mortality is reported in the top row and number of observations in the bottom row for columns (1)-(3). Column (1) is for the whole sample with AGOA affected and non-affected countries. Columns (2) and (3) report the sample mean infant mortality before and after the implementation of AGOA in AGOA affected countries. Column (4) reports the t-statistic testing if the means are significantly different between columns (2) and (3). P-value is in the bottom row for column (4).

Table 1(b): Summary Statistics – Other Variables

	(1)All	(2)Before AGOA	(3)After AGOA	(4)Non-AGOA	(5)t-test
Female	0.4922	0.4916	0.4932	0.4932	0.311
	(686093)	(440693)	(220981)	(24419)	(0.755)
Multiple Births	0.0346	0.0338	0.0367	0.0326	-1.84
	(686093)	(440693)	(220981)	(24419)	(0.064)
Mother's age at	0.5001	0.5071	0.4836	0.5215	6.83
birth(20-29yrs)	(686093)	(440693)	(220981)	(24419)	(0.00)
Mother's age at	0.2408	0.2339	0.2581	0.2102	-11.94
birth(30-39yrs)	(686093)	(440693)	(220981)	(24419)	(0.00)
Mother's age at	0.0244	0.0143	0.0451	0.0187	-6.60
birth(40-49yrs)	(686093)	(440693)	(220981)	(24419)	(0.00)

Note: Sample mean is reported in the top row and number of observations in the bottom row for columns (1)-(4). Column (1) is for the whole sample with AGOA affected and non-affected countries. Columns (2) and (3) report the sample mean before and after the implementation of AGOA in AGOA affected countries. Column (4) reports the sample mean in non-AGOA countries. Column (5) gives the t-statistic testing if the means are significantly different between AGOA and non-AGOA countries. P-value is in the bottom row for column (5).

Table 1(c): Summary Statistics – Full Sample and 2+ Mothers

	Full Sample		2+ Sample	
	Mean	**Std. Dev.**	**Mean**	**Std. Dev.**
Infant Mortality	0.0815 (686093)	0.2736472	0. 0835 (639128)	0.2766692
Neonatal Mortality	0.0383 (686093)	0. 191845	0.0391 (639128)	0.193852
Mother's age at birth	25.72 (686057)	6.437027	26.02 (639095)	6.40657
Mother's schooling	0.6613 (686057)	0.7544092	0.6332 (639095)	0.7375905
Mother's wealth index	2.858 (686093)	1.401826	2.826 (639128)	1.394373

Note: Sample mean is reported in the top row and number of observations in the bottom row. Columns (1) and (2) give the mean and standard deviation for different variables for the whole sample with AGOA affected and non-affected countries. Columns (3) and (4) report the sample mean and standard deviation for mothers with two or more children. All variables are categorical variables except mother's age at birth.

Table 1(d): Summary Statistics – Infant and Neonatal Mortality for Sample of 2+ Mothers

	Both before and after AGOA		Only before or after AGOA	
	Mean	**Std. Dev.**	**Mean**	**Std. Dev.**
Infant Mortality (Before AGOA)	0.0911 (254350)	0.2876	0.0944 (169851)	0.2923
Infant Mortality (After AGOA)	0.0629 (146070)	0.2427	0.0775 (47295)	0.2673
Neonatal Mortality (Before AGOA)	0.0415 (254350)	0.1994	0.0442 (169851)	0.2054
Neonatal Mortality (After AGOA)	0.0291 (146070)	0.1679	0.0426 (47295)	0.2019

Note: Sample mean is reported in the top row and number of live birth observations for AGOA affected countries in the bottom row. Columns (1) and (2) give the sample mean and standard deviation for infant and neonatal mortality for the sample of mothers giving birth both before and after AGOA. Columns (3) and (4) report the sample mean and standard deviation for mothers with two or more children either only before AGOA or after AGOA.

Table 2: Effect of AGOA treatment on infant and neonatal mortality

	Specification 1			Specification 2			
	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**
Dependent Variable	Infant Mortality	Infant Mortality	Infant Mortality	Infant Mortality	Infant Mortality	Infant Mortality	Neonatal Mortality
Treatment	-0.0116 (0.0011)***	-0.01362 (0.0020)***	-0.01363 (0.0021)***	-0.00776 (0.0019)***	-0.00732 (0.0029)**	-0.00695 (0.0026)**	-0.004395 (0.0011)***
Explanatory Variables	YES	YES	YES	YES	YES	YES	YES
Country time trend	YES	YES	YES	YES	YES	YES	YES
Country FE	NO	YES	NO	NO	YES	NO	NO
Mother FE	NO	NO	YES	NO	NO	YES	YES
Cohort-year FE	NO	NO	NO	YES	YES	YES	YES
Number of countries	30	30	30	30	30	30	30
Number of mothers	212738	212738	212738	212738	212738	212738	212738
Observations	686093	686093	686093	686093	686093	686093	686093

Note: The explanatory variables included in the specifications are sex of child, whether born in multiple birth, birth order and birth month. Standard errors clustered at the country level are reported in brackets.
*** Significant at 1% level, ** significant at 5% level, * significant at 10% level.

Table 3: Country-level time varying variables

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Dependent Variable	Infant Mortality	Infant Mortality	Infant Mortality	Infant Mortality	Infant Mortality	Infant Mortality	Infant Mortality
Treatment	-0.0068 (0.0024)***	-0.00723 (0.0026)**	-0.00732 (0.0025)**	-0.00712 (0.0025)***	-0.0077 (0.0031)**	-0.0061 (0.0024)**	-0.0068 (0.0028)**
Log GDP per capita	-0.0101 (0.0053)*						-0.010371 (0.0081)
Democracy		-0.0035 (0.0028)					-0.003294 (0.0030)
Regime			0.0011 (0.001)				
Openness				-0.00002 (0.00007)			0.00009 (0.0001)
Female Education					0.0018 (0.0066)		-0.00021 (0.0058)
Commodity Price Index						0.02375 (0.0086)**	0.01627 (0.0104)
Number of countries	30	30	30	30	21	29	20
Number of mothers	212279	208604	208604	212279	138272	206503	129869
Observations	684139	667543	667543	684139	430184	670719	405494

Note: The explanatory variables included in the specifications are sex of child, whether born in multiple birth, birth order, birth month, mother fixed effects, country specific linear trends, mother's cohort by child birth year FE. Standard errors clustered at country level are reported in brackets. Data for (1) and (4) taken from PWT 7.0, (2) and (3) taken from Democracy-Dictatorship (DD) Data by Cheibub et al (2010, (5) Barro and Lee (2010), (6) from PWT 8.0. Number of observations and number of mothers varies depending on availability of country level control variable from different data sources.
*** Significant at 1% level, ** significant at 5% level, * significant at 10% level.

Table 4: Heterogeneity across different types of mothers

	(1)	(2)	(3)
Dependent Variable	**Infant Mortality**	**Infant Mortality**	**Infant Mortality**
Treatment effect on **Educated**	-0.0051773 (0.0031)		
Treatment effect on **uneducated**	-0.0083362 (0.0028)***		
Treatment effect on **Rural**		-0.0086262 (0.0028)***	
Treatment effect on **urban**		-0.0016895 (0.0031)	
Treatment effect on **poor**			-0.0104727 (0.0028)***
Treatment effect on **non-poor**			-0.004196 (0.0028)
Number of Countries	30	30	30
Number of mothers	212732	212738	212738
Observations	686075	686093	686093

Note: The explanatory variables included in the specifications are sex of child, whether born in multiple birth, birth order, birth month, mother fixed effects, country specific linear trends, mother's cohort by child birth year FE. Standard errors clustered at country level are reported in brackets. The treatment is interacted with the type/characteristic of mothers to get the treatment effect on those types of mothers. Column (1) includes the effect on infant mortality for educated mothers where educated implies having attended any type of school and uneducated mothers, where uneducated is defined as mother did not attend any school. Column (2) assesses this heterogeneity between women living in rural areas and urban areas at the time of interview. Column (3) has effect on infant mortality for mothers having a wealth index as defined as poor or poorer vis-à-vis with mothers who are non-poor based on the wealth index being middle, richer or richest. The wealth index is calculated using easy-to-collect data on a household's ownership of selected assets, such as televisions and bicycles; materials used for housing construction; and types of water access and sanitation facilities using principal components analysis and is reported in DHS.
*** Significant at 1% level, ** significant at 5% level, * significant at 10% level.

Table 5: Heterogeneity across different country groupings

	(1)	(2)	(3)	(4)	(5)	(6)
Dependent Variable	**Infant Mortality**	**Infant Mortality**	**Infant Mortality**	**Infant Mortality**	**Infant Mortality**	**Infant Mortality**
High volume of apparel exports countries	-0.0016569 (0.0046)					
Countries not with high volume of Apparel exports	-0.008095 (0.0028)***					
Countries having predominantly petroleum exports		0.0016571 (0.0039)				
Countries not having predominantly petroleum exports		-0.0086609 (0.0028)***				
Countries having top volume of exports via AGOA			0.00016 (0.0039)			
Countries not having top volume of exports via AGOA			-0.0089734 (0.0028)***			
Countries having apparel visa				-0.0068244 (0.0027)**		
Countries not having apparel visa				-0.0072862 (0.0045)		
All AGOA countries after MFA					-0.0016823 (0.00946)	
All AGOA countries before MFA					-0.0077183 (0.0023)***	
Low income countries						-0.009363 (0.0029)**
Middle income countries						0.000719 (0.0037)
Number of Countries	30	30	30	30	30	30
Number of mothers	212738	212738	212738	212738	212738	212738
Observations	686093	686093	686093	686093	686093	686093

Note: The explanatory variables included in the specifications are sex of child, whether born in multiple birth, birth order, birth month, mother fixed effects, country specific linear trends, mother's cohort by child birth year FE. Standard errors clustered at country level are reported in brackets. The treatment is interacted with the different country groupings to get the treatment effect on those groups of countries. Column (1) includes countries with high volume of apparel exports namely Ethiopia, Ghana, Kenya, Lesotho, Madagascar, Malawi, Swaziland and Tanzania. Column (2) has country groupings based on countries having majorly petroleum exports namely, Angola, Nigeria, Congo, Cameroon, Chad and Ghana. Column (3) includes countries which had highest share of total exports under AGOA – Nigeria, Angola, Chad, Congo, Lesotho, Kenya, Madagascar and Cameroon. Column (4) divides countries based on possession of apparel visa. These countries are Benin, Burkina Faso, Burundi, Cameroon, Chad, Ethiopia, Ghana, Kenya, Lesotho, Liberia, Malawi, Mozambique, Namibia, Nigeria, Rwanda, Senegal, Sierra Leone, Swaziland, Tanzania and Zambia. Column (5) assesses heterogeneity in effect after the expiration of Multi Fiber Agreement (MFA) in 2005 vis-à-vis before MFA expired. Column (6) divides the 30 countries based on World Bank's ranking of incomes into low and middle income countries.

*** Significant at 1% level, ** significant at 5% level, * significant at 10% level.

Table 6: Possible Macro Pathways

	(1)	(2)	(3)	(4)	(5)	(6)
Dependent Variable	Log GDP Per capita	Female LFPR	Health Expdr. per capita	Health Expdr. per capita	Inequality	Education Expenditure
Treatment	0.2623307	0.073403	13.37613	8.803252	-1.099927	-0.192887
	(0.1419)*	(1.259)	(5.5235)**	(4.5412)*	(1.7818)	(0.3516)
Log GDP per capita				51.26603 (24.333)**		
Year FE	YES	YES	YES	YES	YES	YES
Number of countries	30	29	29	29	29	26
Observations	570	551	427	427	291	360

Note: These are country fixed effects regressions controlling for year dummies. Standard errors clustered at country level are reported in brackets. Data for (1) is taken from PWT 7.0, and (2), (3), (4), (5) and (6) are taken from World Bank Indicators. Number of observations and number of countries varies depending on availability of country level data from different data sources.

*** Significant at 1% level, ** significant at 5% level, * significant at 10% level.

Table 7(a): Placebo Test

	(1)	(2)
Dependent Variable	Infant Mortality	Infant Mortality
Treatment	-0.00096 (0.0010)	-0.00101 (0.0010)
Explanatory Variables	YES	YES
Country time trend	YES	YES
Mother FE	YES	YES
Cohort-year FE	YES	NO
Mother's Age	NO	YES
Number of countries	30	30
Number of mothers	212738	212738
Observations	686093	686093

Note: The explanatory variables included in the specifications are sex of child, whether born in multiple birth, birth order, birth month. Standard errors clustered at country level are reported in brackets. These are placebo test run to test if randomly allocating fake treatment has any effect on infant mortality.

*** Significant at 1% level, ** significant at 5% level, * significant at 10% level.

Table 7(b): Point estimates for Dynamics of infant mortality

	Pre 3	Pre 2	Pre 1	Pre 0	Post1	Post2	Post3	Post 4
Infant Mortality	0.0004 (0.0038)	-0.0035 (0.0032)	0.0029 (0.0041)	-0.0044 (0.0070)	-0.0076 (0.0032)**	-0.0026 (0.0042)	-0.0087 (0.0042)**	-0.0052 (0.0025)*
Number of countries	30							
Number of mothers	212738							
Observations	686093							

Note: The explanatory variables included in the specifications are sex of child, whether born in multiple birth, birth order, birth month. Standard errors clustered at country level are reported in brackets. These are placebo test run to test if there are false effects of AGOA on infant mortality before AGOA has been implemented.

*** Significant at 1% level, ** significant at 5% level, * significant at 10% level.

Table 8(a): Robustness Check – Dropping one country at a time

Dependent Variable	**Infant Mortality**	**Infant Mortality**	**Infant Mortality**	**Infant Mortality**	**Infant Mortality**	**Infant Mortality**	**Infant Mortality**
	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**
Treatment	-0.00761 (0.0029)**	-0.00737 (0.0026)**	-0.00732 (0.0025)**	-0.00613 (0.0032)*	-0.0077 (0.0031)**	-0.00859 (0.0027)***	-0.0068 (0.0026)**
	(8)	**(9)**	**(10)**	**(11)**	**(12)**	**(13)**	**(14)**
Treatment	-0.00849 (0.0026)***	-0.00648 (0.0026)**	-0.00686 (0.0026)**	-0.00703 (0.0026)**	-0.00681 (0.0026)**	-0.00664 (0.0026)**	-0.00677 (0.0026)**
	(15)	**(16)**	**(17)**	**(18)**	**(19)**	**(20)**	**(21)**
Treatment	-0.00665 (0.0027)**	-0.00733 (0.0027)**	-0.00713 (0.0028)**	-0.00653 (0.0026)**	-0.00667 (0.0026)**	-0.00682 (0.0026)**	-0.00688 (0.0026)**
	(22)	**(23)**	**(24)**	**(25)**	**(26)**	**(27)**	**(28)**
Treatment	-0.00737 (0.0026)***	-0.00688 (0.0026)**	-0.00698 (0.0026)**	-0.00748 (0.0026)***	-0.00597 (0.0025)**	-0.00715 (0.0026)**	-0.00654 (0.0026)**
	(29)	**(30)**					
Treatment	-0.00677 (0.0026)**	-0.00616 (0.0025)**					

Note: The explanatory variables included in the specifications are sex of child, whether born in multiple birth, birth order, birth month, mother fixed effects, country specific linear trends, mother's cohort by child birth year FE. Standard errors clustered at country level are reported in brackets. In each of the separate regressions, one of the countries is dropped at a time in alphabetical order.

Table 8(b): Robustness Check – Country specific birth order and mother's age quadratic trend

	(1)	(2)
Dependent Variable	Infant Mortality	Infant Mortality
Treatment	-0.00684 (0.0025)**	-0.00676 (0.0025)**
Explanatory Variables	YES	YES
Country time trend	YES	YES
Country Specific Birth Order Dummy	YES	YES
Country specific mother's age quadratic trend	NO	YES
Mother FE	YES	YES
Cohort-year FE	YES	YES
Number of countries	30	30
Number of mothers	212738	212738
Observations	686093	686093

*** Significant at 1% level, ** significant at 5% level, * significant at 10% level.

Appendix

Figure A1: Map of AGOA eligible and not AGOA-eligible countries

Table A1: List of 30 countries in sub-Saharan Africa used in the study, categorized by AGOA Eligibility, year made AGOA eligible, DHS survey used and sample period of births

sub-Saharan Africa	AGOA Eligible	Year made AGOA Eligible	DHS used	Sample period
Angola	Y	2003	2011	1990-2010
Benin	Y	2000	2006	1990-2005
Burkina Faso	Y	2004	2010	1990-2009
Burundi	Y	2006	2010	1990-2010
Cameroon	Y	2000	2011	1990-2010
Chad	Y	2000	2004	1990-2003
Republic of the Congo	Y	2000	2005	1990-2004
Democratic Republic of the Congo	Y	2003	2007	1990-2006
Cote d'Ivoire	N	Non-AGOA	2005	1990-2004
Ethiopia	Y	2000	2011	1990-2002
Ghana	Y	2000	2008	1990-2007
Guinea		Suspended 2009	2005	1990-2004
Kenya	Y	2000	2008-09	1990-2008

Lesotho	Y	2000	2009	1990-2009
Liberia	Y	2006	2007	1990-2006
Madagascar		Suspended 2009	2008-09	1990-2008
Malawi	Y	2000	2010	1990-2009
Mali	Y	2000	2006	1990-2005
Mozambique	Y	2000	2003	1990-2002
Namibia	Y	2000	2006-07	1990-2006
Niger		Suspended 2009	2006	1990-2005
Nigeria	Y	2000	2010	1990-2009
Rwanda	Y	2000	2010	1990-2009
Sao Tome and Principe	Y	2000	2008-09	1990-2008
Senegal	Y	2000	2010-11	1990-2010
Sierra Leone	Y	2002	2008	1990-2007
Swaziland	Y	2000	2006-07	1990-2006
Tanzania	Y	2000	2010	1990-2009
Zambia	Y	2000	2007	1990-2006
Zimbabwe	N	Non-AGOA	2010-11	1990-2009

Note: Since Liberia has sample size till 2006 and AGOA was implemented in 2006 for the country, it effectively in the sample behaves as not being AGOA affected.