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

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Abstract

This paper investigates the impact of a trade policy, the African Growth and Opportunity Act (AGOA), on infant mortality and fleshes out the likely mechanisms. This paper derives a causal estimate by developing a micro panel dataset across countries and exploiting within-mother variation in survival of infants. I find that the policy reduces infant mortality by about 9% of the sample mean. I also identify channels through which the mortality reduction operates including increasing health seeking behavior, increased possession of assets, and increased maternal labor supply in non-agricultural sectors. Disaggregation reveals heterogeneity of treatment at the country and individual level.

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

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1 Introduction

Historically, trade routes have played a major role in increasing the prosperity of nations.[1] Free trade can create access to a better variety of goods, increase women labor force participation, increase incomes and often leads to improvements in infrastructure investment (Dollar and Kraay, 2001; Broda and Weinstein, 2006; Wood, 1991; Storeygard, 2013). There are few empirical studies estimating the effect of trade on development, especially child health.[2] This paper estimates the effect of being exposed to a trade policy on infant and neonatal mortality, analyzes heterogeneous effects both at the macro and micro level, and examines possible pathways in the context of sub-Saharan Africa.[3]

Empirically, it is difficult to identify causal effects, as trade policy is likely to be endogenous to other socio-economic factors that also affect development. To overcome this, identification in previous literature has come from using instrumental variables like predicting trade volumes as a ratio of GDP using geographic factors.[4] However, these approaches might have potential threats to validity as geographical trade share may be correlated with other factors that affect children's welfare like presence of strong institutions.[5] This paper uses a novel way of combining micro datasets across countries to study the effect of macroeconomic trade policy on development outcomes. The effect of trade policy on infant mortality will be gauged by studying the varying exposure between the

[1] The infrastructure created to boost trade becomes the main arteries of countries and turn cities into "engines of growth". Railroads had a great impact on the counties in American economy due to a change in that county's "market access" (Donaldson and Hornbeck, 2013).
[2] Edmonds, Pavcnik, and Topalova (2010) analyze effect of trade policy on schooling and child labor decisions in India; Topalova (2007), Porto (2004) focus on poverty and inequality in India after trade liberalization, Levine and Rothman (2006) focus on effect of trade on infant and child mortality and stunting in a cross-country cross-sectional setting.
[3] It is developed by collating household surveys across 30 sub-Saharan African countries. Details are discussed in the Data section.
[4] Levine and Rothman (2006), Frankel and Romer (1999)
[5] For example, Mauritius is surrounded by sea and has experienced an export boom in garments. But, this boom has been attributed to a sound economic strategy by the government underpinned by social and political arrangements. Mauritius also has very low infant mortality rates which would have been brought about by the safety nets provided by the government. Hence, role of institution has been playing an instrumental role in decreasing infant mortality as well as increasing trade, which may not be properly captured by an instrumental variable approach. For more details on institutions, see Rodrik (2001)

children born to same mothers but exposed to the trade policy or not in both policy-affected and non-affected countries.

Recently, sub-Saharan African countries signed a huge non-reciprocal trade agreement – the African Growth and Opportunity Act (AGOA) - which conferred on these sub-Saharan African countries largely duty-free and quota-free access to US markets. The head of the countries signing these agreements hoped the agreement would increase export volumes and spur economic growth in these economies. Frazer and Van 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 an almost 700% increase in exports to US (from $36 million in 2000 to $284 million in 2010) (Onyago and Ikiara, 2011). This agreement took effect in 2000 with 34 sub-Saharan African countries eligible for the trade benefits included in the AGOA.

Identification in this analysis is based on each country's exposure to the trade policy at different points of time. Using retrospective birth histories from Demographic and Health Survey (DHS), I develop a micro panel dataset that spans 30 sub-Saharan African countries, and about 686,000 children born to 212,000 mothers. By observing different children of the same mother conceived before and after the trade policy change between AGOA affected and non-AGOA affected countries, a within-mother variation in survival of infant is carried out rather than cross-country or within-country variation. This analysis ensures that it is able to separate the effect of trade policy from other country level confounding factors since it is able to control for country specific time trends and unobservable time invariant characteristics of mothers and countries. Moreover, since this developed dataset are collated micro-level surveys across countries, it also overcomes the problem of small samples endemic to cross-country analysis.

The results of this analysis suggest that infant mortality falls by about 0.7 to 0.8 percentage points, or about 9%-10% of the sample mean, even after controlling for country-time linear trends as well as mother's time invariant characteristics. The results are also robust to controlling for some time variant country characteristics. A large portion of this fall comes from a decrease in neonatal mortality. The drop in infant mortality is evident immediately after AGOA takes place. Dynamics of mortality reveal that there exists no effect prior to AGOA being implemented, corroborating that the decrease in infant mortality is due to AGOA. The benefits of AGOA are not equally distributed across countries and across households. The effect of AGOA on infant survival is stronger for countries that export large amounts of agricultural goods and mineral ores as compared to oil exporting countries. Results suggest that infant mortality falls more for socially disadvantaged women. Infant deaths fall more for employed women than unemployed women, hinting towards spurring employment in export sectors.

The theoretical effect of trade on household is ambiguous.[6] Trade increases employment opportunities and, especially in a developing country context, opportunities for low-skilled labor. 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).[7] By collating multiple rounds of household surveys for each country, this paper is able to identify three potential mechanisms at the household level: (a) change in household income/assets; (b) change in female employment in labor force; and (c) changing health seeking behavior of mothers.[8] Since AGOA mainly boosted exports out of the country, access to a variety of goods for consumers does not seem to be a major pathway in infant reduction. This study finds that AGOA led to a significant decline in the number of households possessing no assets, a realignment of employment of female labor from agriculture to manual labor and increased delivery care and tetanus toxoid injections to kids.

Evidence of macroeconomic trade policies on microeconomic outcomes like child health has been understudied. This paper provides new evidence of a causal effect of trade on development. AGOA has been studied mainly to look at the effectiveness of the policy in

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[6] Various routes through which trade can affect infant health, both at the macro and micro level, are discussed in Section 2.2.

[7] Kishor and Parasuraman (1998), find using NFHS Data for India in 1992-93 that mothers who are employed have a 10 percent higher IMR for their children 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).

[8] Multiple rounds of DHS datasets are available for 22 of 30 countries. See Appendix for more details.

increasing exports from these countries.[9] This study provides first estimates of the effects of AGOA on infant mortality, to the best of my knowledge. Results point towards dominance of an income effect in reducing infant mortality in this setting. Income shocks may lead to realignment of preferences with respect to health care investment in children.[10] The results are consistent with an increase and realignment of employment and increasing incomes being the driving force of the observed decrease in infant mortality. Mothers are also choosing to receive additional health care for their children after AGOA, either because of easier availability and better infrastructure or a change in investment preference in their child's health when times are better.

2 Background

2.1 African Growth and Opportunity Act (AGOA)

The African Growth and Opportunity Act (AGOA) provide for preferential treatment of exports from sub-Saharan Africa in the form of duty-free and largely quota-free access to US markets. It entails a series of incentives provided to African countries by the US opening its market for exports originating from these countries. AGOA has been part of the US international cooperation efforts for Africa since 2000. At the onset of the legislation, 34 countries were eligible for AGOA benefits.[11] AGOA was initially set to expire in 2008 but was eventually extended to 2015. Under AGOA provisions, four main sectors account for over 90% of the exports - energy-related products, textiles and apparel, transportation equipment, and minerals and metals. Figure 1 plots the total US imports and exports from sub-Saharan Africa. There is a significant increase in exports from sub-Saharan Africa to US after 2001 when the AGOA took effect. Overall, total US imports from AGOA countries have increased from $5B in 2000 to over $25B in 2005 (Paulos et al., 2010).

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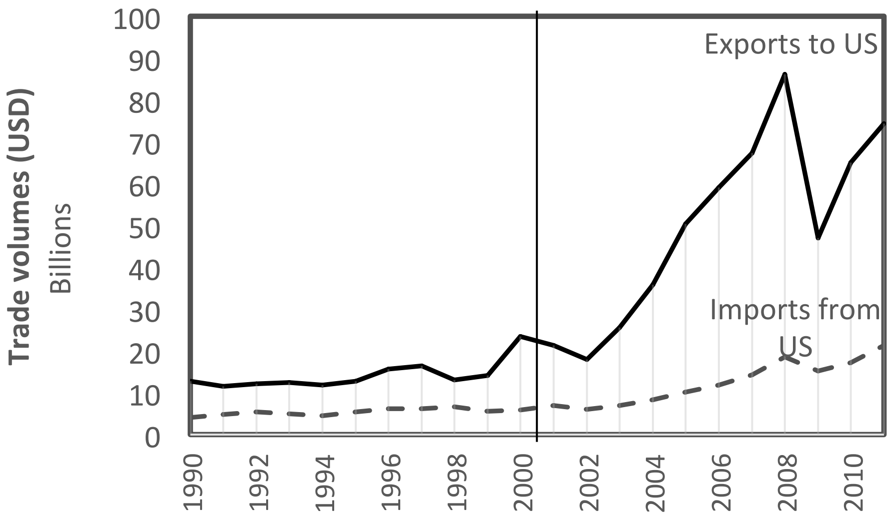
[9] Frazer and Biesebroeck (2007), Condon and Stern (2011), Collier and Venables (2007), Paulos et al. (2010)
[10] Case (2001), Paxson and Schady (2005), Bhalotra (2007)
[11] More countries were added for the benefits later and some were removed due to failures regarding political or democratic freedom. Cote D'Ivoire was removed from the list in January, 2005. Effective December 23, 2009, the President removed Guinea, Madagascar and Niger from the list of AGOA eligible countries.

Figure 1: 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.

The AGOA was implemented not only to boost exports but also improve and foster economic growth. Country eligibility for AGOA is determined by the US President, 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.[12] 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 the AGOA covers more product lines and includes additional criteria. Under initial AGOA legislation, 1800 additional items were allowed to be exported duty-free in addition to the 4,600 under GSP. These newly added lines included items such as

[12] Country eligibility is listed in Section 104 of African Growth and Opportunity Act. It states that 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".

footwear, handbags, many agricultural products, chemicals, steel etc. These constituted the non-apparel exports under AGOA and could be exported at zero import duties as soon as the countries were declared AGOA beneficiary.

AGOA also 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 take place locally. However, the lesser-developed countries were eligible for a Special Rule and could source raw materials from all over the world until 2004 while still receiving AGOA benefits.[13] AGOA also benefits these signatory countries as the exports under AGOA are not subject to a maximum volume ceiling as under GSP. However, with the ending of Multi-Fiber Agreements (MFA) in 2005, the apparel 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.[14] 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 provide evidence on heterogeneous effects of AGOA based on country's main item of export and 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 explores the heterogeneity and inherent differences between the 30 sub-Saharan African beneficiaries to capture the differences in effects on those countries.

[13] 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.

[14] 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.

2.2 Trade Linkages

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 increased job creation which in turn affects the socio-economic indicators. Trade may improve health conditions by increasing tax revenues of the government allowing it to possibly increase health expenditures.[15] 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. Trade also spurs employment in labor-intensive sectors in a developing economy. Increasing employment can benefit child health due to increasing incomes or worsen health due to increased time away from home by the mothers.

Most of studies concerning trade liberalization look at outcomes like growth rates, income inequality, productivity and wages.[16] There are many studies estimating the effects of trade policy on income growth rates, showing a positive effect (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. The studies estimating the effect of trade on income growth rates are cross country studies over many developing nations using different indicators of openness like decade-over-decade changes in the volume of trade, index of real exchange rate distortion or geographically determined amount of trade to counter the issue of endogeneity. But, this large literature on trade remains inconclusive about a clear-cut effect of trade on both growth and development. Though they provide insights into the effect of trade on macroeconomic outcomes, drawing a causal conclusion between the two is difficult.

[15] (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, Stotsky, and WoldeMariam 2006) 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.

[16] Goldberg & Pavnick (2007a), Frankel and Romer (1999), Winters, McCulloch, and McKay (2004), Hanson (2007)

Trade may also affect the individuals and households directly at the micro-level through multiple channels. International trade can affect economic outcomes by decreasing transportation costs (Clark, Dollar, and Micco, 2004; Hummels and Skiba, 2004; Storeygard, 2013). As transportation costs decrease, the price of traded goods decreases. In the scenario where trade promotes better infrastructure and better market access, it has been argued that access to transportation networks may not have large impact on the relative economic performance of those areas affected by improvements in transportation infrastructure in a developing country (Banerjee, et al., 2012). Mobility of factors and development of institutions play a critical role in realizing the gains from trade. Institutional differences are a large factor in explaining the differences in economic prosperity between nations (Acemoglu, et al., 2001).

Trade can also bring variety gains by making a bigger set of consumption bundle available for people in the country (Broda and Weinstein, 2006). Increased variety in food may also result in increased diversity of micronutrient consumption, which can be important for maternal and child health in countries where micronutrient deficiency is endemic.[17] Topalova (2010) finds evidence that Indian districts with greater exposure to trade do not have a significant gain in consumption levels. In the Indian context, Topalaova (2007) establishes that rural areas experienced slower progress in poverty reduction but with no significant impact on inequality.

Effect of trade directly 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. The country specific effects are taken care by this latter channel of estimation.

[17] (Cutler, Deaton, and Lleras-Muney 2006), (Porto 2004)

3 Data

The micro level health data for the sub-Saharan African countries comes from the Demographic and Health Surveys (DHS). DHS are nationally representative household surveys that provide data for population, health and nutrition The DHS questionnaire is (mostly) standardized across countries and rounds, and so allows for comparisons across countries. The Standard DHS Surveys have large sample sizes (about 5,000 households) and are typically conducted about every 5 years. Information regarding child health, immunizations, antenatal care, 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 child birth year.

One problem with the recall data is measurement error. 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.[18] This ensures that the siblings are not very far apart in age and hence are broadly comparable. This also reduces the recall bias. Moreover, some sub-Saharan African countries in the sample gained their independence between 1975 and 1990[19] and also experienced higher rates of civil wars, which may muddle with the effects of trade on infant mortality. Since the most recent year in the surveys have few observations, they have been merged with the previous year to prevent sharp spikes in infant

[18] The results are not dependent on the year of birth cut off. Other models with different year of birth (1994 or 1995) cutoffs gave similarly significant results. See Table 13 for results.

[19] Mozambique (1975), Cape Verde (1975), Comoros (1975), Sao Tome and Principe (1975), Angola (1975), Zimbabwe (1980), Namibia (1989)

death due to limited observations in the last year of survey.[20] Even though, Mozambique, Liberia, Ethiopia and Cote D'Ivoire were given AGOA rights, in the sample they effectively behave as not treated since the law came into effect in the last year of the survey. These are in the non-treated group, along with Zimbabwe, which is not AGOA eligible.

There are 36 DHS Surveys publically available for the sub-Saharan countries where DHS survey has been carried out at least once.[21] The surveys for Central African Republic, Comoros, Gabon, South Africa, Sudan and Togo were all carried out before AGOA was implemented in these countries. The remaining 30 surveys are included in this analysis.[22] 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. As long as at least one round of survey has been conducted in a particular country, a panel dataset of mothers for that country can be built.[23]

After dropping data for children born within twelve months of the survey, to ensure full exposure for every child in the sample and reduce measurement error, the sample includes 686,093 children born to 212,738 mothers. Infant (Neonatal) mortality rate is the number of deaths of children before reaching the age of one year (month) per 1000 live births. In this sample, it is calculated by multiplying the sample mean child deaths (in the appropriate age group) by thousand. The sample average infant mortality rate is 8.15% of live births while the sample neonatal mortality rate is 3.8% of live births. Since determinants of neonatal mortality may differ from infant mortality, an indicator for child dying before the age of 1 month is also constructed and effect of AGOA on it is studied.

In Table 1, I show 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. Infant mortality varies significantly (based on t-statistic) between AGOA and non-AGOA countries. A mother is labeled as educated if she has attended any type of school and

[20] Results are robust to not doing this.
[21] These are most recent surveys at the time of analysis. Newer DHS has been carried out in past 2-3 years.
[22] The list of DHS used and respective sample periods are listed in Table A1 in Appendix.
[23] 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.

uneducated is defined as mother did not attend any school. Since DHS does not have income data, definition of poor is based on possession of assets. 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. A mother is categorized as poor if the wealth index is marked as poor or poorer, while mothers with wealth index being middle, richer or richest are categorized as non-poor. Rural or urban are defined by the place of residence of mother during the time of interview. Infant and neonatal deaths also vary between AGOA and non-AGOA countries for women of different socio-economic status. Among the child characteristics, birth order differs between these countries and is also included in controls.[24] It is observed that these countries are similar in terms of sex composition, but the composition of mother's age at birth is different across these countries. I include controls for maternal age at birth.

Figure 2 plots the sample mean infant mortality rates by year for countries affected by AGOA by 2001, affected after 2001 and never affected by AGOA. It shows that AGOA affected countries have higher infant mortality than non-AGOA countries at the time of first implementation of AGOA in 2001. All three groups of countries exhibit a declining trend in infant mortality over the years and the difference seems to be decreasing after AGOA has been implemented. The differential trends in infant mortality will be accounted for by using country time trends in this analysis. The mean infant mortality rates for the 25 AGOA affected sub-Saharan African countries in the sample by year of birth of child, 1990 onwards is shown in Appendix Figure A2. The data shows a declining trend in infant mortality over time for all countries. A sharp fall in infant deaths in some of the countries after the year AGOA is implemented is observed, more prominently than others.

[24] Country specific birth order is also controlled for in robustness check.

Table 1: Summary Statistics – Child Variables

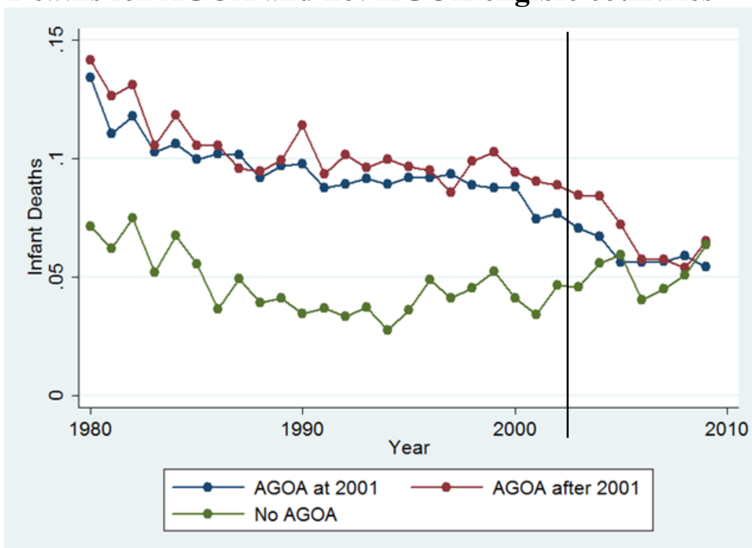
	(1)	(2)	(3)	(4)	(5)
	All	**Before AGOA**	**After AGOA**	**Non-AGOA**	**T-test**
Child Variables					
Infant Mortality	0.0815	0.089	0.065	0.089	9.57
Uneducated *N*	0.0939 *342382*	0.1016 *201754*	0.0719 *93566*	0.104 *47062*	8.34
Educated *N*	0.0691 *343693*	0.075 *174889*	0.059 *124351*	0.074 *44453*	4.26
Poor *N*	0.0902 *300418*	0.101 *161300*	0.069 *97069*	0.098 *42049*	6.42
Non-Poor *N*	0.0747 *385675*	0.081 *215353*	0.061 *120856*	0.082 *49466*	6.53
Rural *N*	0.0866 *501284*	0.096 *272892*	0.067 *163277*	0.095 *65115*	8.27
Urban *N*	0.0677 *184809*	0.071 *103761*	0.057 *54648*	0.076 *26400*	5.73
Neonatal Mortality	0.038	0.041	0.032	0.040	3.40
Female	0.492	0.492	0.493	0.492	-0.06
Multiple Births	0.035	0.034	0.037	0.033	-2.45
Birth Order	3.47	3.38	3.64	3.45	-1.96
Month of birth	6.15	6.10	6.23	6.07	-7.03
Mother's age at birth(20-29yrs)	0.50	0.499	0.483	0.49	-6.43
Mother's age at birth(30-39yrs)	0.24	0.23	0.26	0.24	-1.16
Mother's age at birth(40-49yrs)	0.02	0.015	0.045	0.027	5.88
N	686093	468168	217925	91515	

Note: Sample means of all child level variables are reported. 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 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. N refers to the number of observations in each sample. Educated implies having attended any type of school and uneducated is defined as mother did not attend any school. Poor is defined by 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. Rural and Urban are defined by the place of residence of mother during the time of interview. Female is 1 if sex of child is female. Multiple birth is a dummy variable indicating if the child is born in a multiple birth. It is 0 for a single birth and 1 for twins, triplets or quadruplets.

Since the estimation strategy includes maternal fixed effects, it is the mothers giving birth both before and after AGOA that contribute to the identification of effect of AGOA. Thus, in Table 2, I compare the characteristics of mothers having two or more births before and after

AGOA (column (3)) with mothers in the entire sample (column (1)) as well as mothers in AGOA countries (column (2)). Mothers who give birth at least twice and both before and after AGOA are less well-educated, live in rural areas, and poor.

Figure 2: Infant Deaths for AGOA and not-AGOA eligible countries



Note: This graph plots the sample infant mortality rates for countries affected by AGOA by 2001, countries affected by AGOA after 2001 and never affected by AGOA countries, by year of child birth. The countries affected by AGOA by 2001 are – Benin, Cameroon, Chad, Congo, Ethiopia, Ghana, Guinea, Kenya, Lesotho, Madagascar, Malawi, Mali, Mozambique, Namibia, Niger, Nigeria, Rwanda, Sao Tome and Principe, Senegal, Swaziland, Tanzania, and Zambia. Countries which received AGOA benefits after 2001 are – Angola, Burkina Faso, Burundi, Cote D'Ivoire, Democratic Republic of Congo, Liberia and Sierra Leone. Zimbabwe has never been an AGOA beneficiary.

Since mother fixed effects estimation derives the effect of AGOA on infant mortality using those mothers giving birth both before and after AGOA, Table 3 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. The sample mean infant and neonatal mortality rates fall for mothers giving birth both before and after AGOA, after AGOA is implemented. Column (2) shows that the mean infant mortality is higher for the mothers giving birth only after AGOA than mothers in Column (1), but it is lower than the mean infant mortality for mothers giving birth only before AGOA.

Table 2: Mother Characteristics – Full Sample and 2+ Mothers:

	(1)		(2)		(3)		(4)
	Full Sample		AGOA Countries All mothers		2+ Sample both before and after AGOA		T-test
	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.	
Mother's age at birth	25.72	6.44	25.72	6.42	26.03	6.39	-23.7
Mother's Education	0.501	0.499	0.503	0.499	0.478	0.499	24.78
Mother's wealth index	2.86	1.402	2.86	1.39	2.77	1.38	35.92
Mother's Residence (Rural)	0.73	0.444	0.73	0.442	0.77	0.422	-37.29
N	686093		594578		391425		
N (M.Educ)	686075		594560		391414		

Note: Sample means and standard deviations are reported for different samples of mothers. N refers to the number of observations in each sample. Column (1) gives the mean and standard deviation for different mother characteristics for the whole sample with AGOA affected and non-affected countries. Column (2) reports the same for all mothers in AGOA affected countries. Column (3) reports the sample mean and standard deviation for mothers with two or more children giving birth before and after AGOA. All variables are categorical variables except mother's age at birth. Column (4) provides a difference in means t-test between (2) and (3).

Table 3: Mean Infant and Neonatal Mortality for Sample of 2+ Mothers in AGOA Countries

	(1)		(2)	
	Both before and after AGOA		Only before or after AGOA	
	Mean	Std. Dev.	Mean	Std. Dev.
Infant Mortality				
Before AGOA	0.090	0.286	0.091	0.286
After AGOA	0.063	0.243	0.077	0.267
Neonatal Mortality				
Before AGOA	0.041	0.198	0.0436	0.202
After AGOA	0.029	0.168	0.0425	0.187
N	391425		165098	
Before AGOA	247784		117811	
After AGOA	143641		47287	

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

4 Empirical Strategy

To analyze the effect of trade on infant mortality, I estimate the following equation using a linear probability model[25]:

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

for child i, born to mother m in country c in year t. IMR is a dummy which takes the value 1 if child i 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 throughout time t. X_{imct} is a vector of control characteristics including sex of the child, whether or not they are born in multiple births (i.e. twins, triplets, etc.), dummies for their birth order, mother's age at birth and birth month of the child. It may also be argued that birth order trends differ between countries. As a robustness check, country specific birth orders are also controlled for. γ provides the estimate of the effect of AGOA on infant mortality. The standard errors are clustered at the country level to take into account any correlation of the error across space and time within each country.

Treatment in this paper is defined as a child's exposure to AGOA.[26] This is a dummy variable which takes the value 1 if the child is born *after* AGOA is implemented. This ensures that the child has been fully exposed to AGOA through their lifespan. For example, if AGOA was signed and passed on 1st October, 2001 for country C_1, then AGOA takes the value of 2002 for C_1. If instead, AGOA is passed on January 1, 2003 for country C_2, then AGOA takes the value 2003 in C_2. A child is then said exposed to AGOA if in C_1, they are born in 2003 or later while in C_2, they are born in 2004 or later. However, the results are not

[25] I also check for Logit estimates. They are significant. But due to easier interpretation of LPM estimates, I present those in the results. Also, LPM Model allows me to use a general form of mother fixed effects and since the estimations are deviations from the trend (after controlling for country-time control), the coefficient is likely to be small and should lie in the range of 0 to 1.

[26] There have been concerns on using trade volumes as a measure of trade policy (Rodrik, 2001). Trade volumes generally reflect the outcomes of many different things like economy's overall performance as well as productive capacity of the economy. Hence, trade volumes are not entirely controlled by the government, while trade policies are. Keeping this in mind, this study abstracts away from using trade volumes as an indicator of trade policy.

sensitive to this definition. Even if AGOA variable is defined to be the year it was announced, the results still remain highly significant.

In the next specification, an interaction between mother's birth cohort by child's birth year (β_{bt})[27] fixed effects are included:

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

This specification accounts for the possibility that women may be delaying their fertility based on improvements in survival of their kids overtime. 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. Since AGOA implementation varies by countries as well as time, fixed effects estimation can be carried out for more robust estimates.

For the estimates to be unbiased, the error cannot 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:

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

This specification also assumes that treatment selection can be based on unobserved heterogeneity at country level, but within country which mothers and children got the treatment is unrelated to the gain from the program. Another concern is that mothers affected by AGOA in AGOA affected countries do not behave differently than mothers in non-AGOA countries, if they had been AGOA affected. Thus, mothers cannot be timing their fertility in response to AGOA. I test to see later if fertility selection bias is a major concern in the data.

The main concern in studying the effect of such a policy is the difficulty of disentangling the effect of this policy from the prerequisites for being a signatory on the AGOA. 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

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

the children belong to a certain country of residence and hence controlling for mother's characteristics implies controlling for the country characteristics.

The year fixed effects (β_t) control for an aggregate time variation involving improvement of health technology and year shocks. β_{bt} controls for changing time of mother's age at birth. The mother cohort by year fixed effects controls for fertility changes overtime in that region due to improvements in health technology. The country specific trends ($\mu_c.t$), in fact, also allow country specific improvement in infant and maternal health i.e. differential states of development of the countries.

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. To capture these effects, I estimate the following equation:

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

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

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

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, employment 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:

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

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

5 Results

5.1 Event-Study Graph

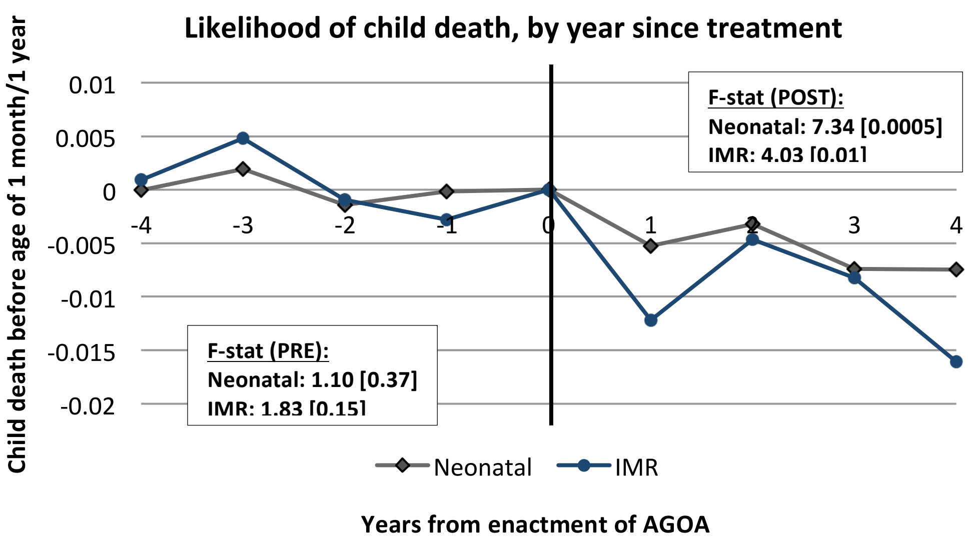
I create an event-study graph for the treated countries to show the effect of AGOA on infant and neonatal mortality. Figure 3 graphs the likelihood of child death by year, with respect to the treatment, for the treated countries. The plotted estimates depict the differential trends in infant and neonatal mortality over four years before and after the AGOA announcement (with the year of announcement being the omitted year). The estimates θ_j are derived from the following regression:

$$Death_{imct} = \alpha_c + \beta_t + \sum_{j=-4}^{4} \theta_j T_{c,t+j} + X_i'\delta + \varepsilon_{imct} \qquad (7)$$

where $T_{c,t+j}$ is 1 for j years of announcement of AGOA in country c. The specification controls for country and year fixed effects. The covariates included are mother's age at birth, mother's socio-economic characteristics, mother's education, sex of child, birth order, birth month, and whether born in multiple birth. The standard errors are clustered at the country level.

In both neonatal and infant mortality, there are no noticeable trends in the pre-treatment period. Consequently, F-test rejects the null hypothesis of joint significance of pre-treatment years. After AGOA is announced, there is a sharp fall in both infant and neonatal mortality. The child death drops are significant at the conventional levels for the 1st, 3rd and 4th years after AGOA implementation. The point estimates are presented in Appendix Table A8. The infant and neonatal mortality is below the pre-treatment level even after four years of implementation.

Figure 3: Event-Time Study



Note: These are the θj estimates plotted from estimating this equation:

$$\text{Death}_{imct} = \alpha_c + \beta_t + \sum_{j=-4}^{4} \theta_j T_{c,t+j} + X_i'\delta + \varepsilon_{imct}$$

Death takes the value of infant mortality of neonatal mortality. The sample is restricted to treated countries. The solid line at zero indicates the year of announcement of AGOA. The control variables are whether born in multiple birth, birth order, birth month, mother's age at birth, mother's education, place of residence, asset index. Both the specifications control for year and country fixed effects.

5.2 Main Results

Table 4 provides the main regression results of the effects of treatment on infant mortality Column (1) shows the results for country fixed effects, without controlling for linear country time trend. The resulting coefficient on AGOA is negative, but not statistically significant. Since there are country specific trends in infant mortality, not controlling for those trends is confounding with the effect of AGOA. Controlling for country time trends along with country fixed effects in (2) makes the coefficient statistically significant. The coefficient now indicates that AGOA reduces the probability of infant dying by 0.8 percentage points.

Controlling for maternal fixed effects in (3) decreases the coefficient to about 0.7 percentage points.[28]

Table 4: 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	-0.0071	-0.0081***	-0.0071**	-0.0079***	-0.0079***	-0.0069**	-0.0046***
	(0.0028)	(0.0028)	(0.0028)	(0.0019)	(0.0028)	(0.0027)	(0.0011)
Explanatory Variables	YES	YES	YES	YES	YES	YES	YES
Country time trend	NO	YES	YES	YES	YES	YES	YES
Country FE	YES	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: Treatment is defined as 1 for a child born after AGOA has been implemented in an AGOA affected country. The other control variables included in the specifications are sex of child, whether born in multiple birth, year of birth, mother's age at birth, birth order and birth month. Standard errors clustered at the country level are reported in brackets. Specification 2 allows for changing mother's age at birth for different year of birth of child. Hence, controls for mother's age and year of birth of child are subsumed in these specifications.
*** Significant at 1% level, ** significant at 5% level, * significant at 10% level.

Table 4, specification 2 (columns (4)-(7)) additionally controls for cohort-year fixed effects. In this specification, the changing time of mother's age at birth due to improvements in survival of babies over time in Africa is accounted. The fixed effect controls for fertility changes over the years due to improvement in health technology. Even after controlling for these with an interaction of dummies for mother's birth year (cohort) with child's year of

[28] To be robust to the possibility of small number of clusters in the sample, I also test the significance of coefficients using method outlined in Donald and Lang (2007) and Cameron and Miller (2013). Since N within each group (country) is large, the resulting t-statistic will have a T(G-2) distribution rather than standard normal, where G is the number of groups. The t-statistic is computed using the estimated coefficient and clustered standard errors and is tested using the T(G-2) distribution critical levels. The critical values for a two-tailed test using T distribution with 28 degrees of freedom are 1.70 at 10%, 2.048 at 5% and 2.763 at 1%. The coefficients still remain significant at these levels.

birth, the magnitude of the coefficient remains around 0.7 percentage points statistically significant.[29]

The absolute value of coefficient remains between 7.9 to 6.9 reductions in infant deaths per 1000 live births, as we move across specifications. Thus, the results are robust to various specifications. Mother fixed effects controls for factors like maternal ability to raise kids, genetic traits, household environment, parental education, place of residence etc. 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 4.5 deaths per 1000, which is about 12% of the sample mean. Hence, about half of the reduction in infant deaths is coming via a decrease in neonatal deaths.

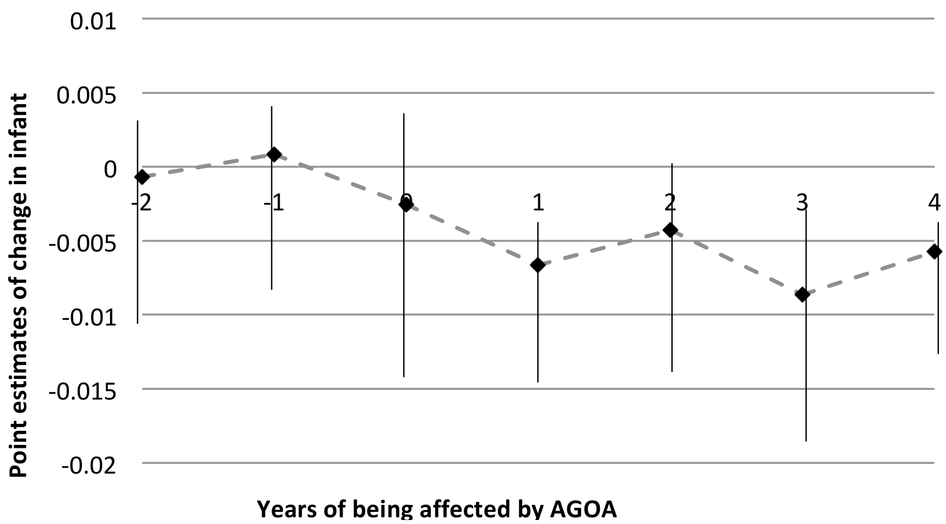
The magnitude of the estimated effect is economically significant effects as well. Exposure to AGOA reduces infant mortality by 0.7 percentage points which is 9% of the sample mean and decreases deaths before age of one month by 0.4 percentage points, which is 12% of the sample mean. For comparison, the effect of Progresa, a conditional cash transfer program in Mexico, is an 8% reduction in rural IMR (Barham, 2011). Comparing this with previous literature[30], the effect is higher in absolute magnitude using mother FE than in the cross-country setting, with trade openness contributing to a reduction of around 7 infant deaths per 1000 births.

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.[31] Figure 4 graphs the dynamics of infant mortality from 2 years before AGOA implementation to 4 years after it. It can be seen that change in infant mortality had been almost constant, not

[29] On testing sex selection at birth, I do not find differences in probability of infant dying based on gender. Results are presented in Appendix Table A7.
[30] 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.
[31] Point estimates are shown in Appendix Table A2.

significantly different from zero in the two years before AGOA was implemented. There is a significant drop in infant mortality as compared to 3 years before implementation of AGOA in year 1, year 3 and year 4 of the AGOA being implemented.

Figure 4: Dynamics of Infant Mortality



Note: The solid black line depicts the change in infant mortality compared to 3 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 least at 90% significance level. The point estimates are provided in Appendix Table A2.

5.3 Robustness to Time-variant Factors

Table 5 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. Since some benefits of AGOA were based on income threshold, especially for Apparel exports, it is imperative to control for changing GDP per capita levels for the countries since higher income countries may also display better health of children. 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 5 (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 statistical significance.

Some studies find that democracy and political regime may affect child health (Kudamatsu, 2012). Since AGOA emphasized political stability, it was the politically stable countries which acquired and retained AGOA rights.[32] It may also have served as an incentive to turn into a democratic country to acquire AGOA rights. Hence, democracy may have served as a pre-condition for getting AGOA benefits. The effect of democracy and political regime is 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. In Table 5 (2) controlling for democracy status of the country, does not change the magnitude of the coefficient much from the results in Table 4. Democracy tends to reduce infant mortality but the coefficient is not significantly different from zero at the conventional level.

Sub-Saharan African countries have increasingly received Official Developmental Assistance (ODA) from developed countries to promote economic development. It may be the case that at the same time AGOA was introduced, the trade-related or other parts of ODA also increased. ODA is intended to provide assistance in development and hence will aid in infant mortality reduction. To ensure that the actual effects of AGOA are observed, ODA is included as a control variable in Table 4 (3). 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 5 (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 in attracting trade flows as well as decreasing infant mortality. Thus, data for the average years of schooling of females 15 years

[32] For example, Cote D'Ivoire was removed as an AGOA beneficiary due to not implementing a peace plan and Eritrea was removed after failing to bring about democratic reforms.

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 5 (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.

Table 5: 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**	-0.0076***	-0.0082***	-0.0069**	-0.0067*	-0.009***	-0.0066**
	(0.0025)	(0.0026)	(0.0025)	(0.0026)	(0.0032)	(0.0025)	(0.0028)
Log GDP per capita	-0.0099* (0.0054)						-0.0175* (0.0094)
Democracy		-0.0041 (0.0029)					-0.0043 (0.0028)
ODA			0.00009 (0.0001)				-0.00003 (0.00007)
Openness				-0.00002 (0.00007)			0.00009 (0.00005)
Female Education					0.0029 (0.0053)		-0.001 (0.0048)
Commodity Price Index						0.0327*** (0.0067)	0.0311*** (0.0066)
Number of countries	30	30	29	30	21	29	21
Number of mothers	212738	209721	205420	212738	134952	206137	131959
Observation	686093	673646	655443	686093	410833	663838	394715

Note: The regressions control for 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) is taken from Democracy-Dictatorship (DD) Data by Cheibub et al (2010), (3) Net Official Development Assistance received as a % of GNI is taken from World Bank Indicators, (5) from Barro and Lee (2010), and (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.

Commodity price fluctuations have contributed to improved incomes and growth in Africa over the last decade (Deaton, 1999). Changes in international commodity prices can work through changes in consumption and government expenditure, which results in changes in national output. Since sub-Saharan Africa relies a lot on primary exports and these are subject to volatility in commodity prices, it is necessary to separate the effects of a commodity price boom from the effects of AGOA. Considering this finding, the commodity price index derived from PWT 8.0 in Table 5 (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 5 (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.[33]

5.4 Heterogeneity in Effects

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. I explore these in the following section.

Table 6 columns (1)-(4), check for heterogeneity in effects based on mother's place of residence, education, possession of assets and employment.[34] The AGOA differentially decreases infant deaths for uneducated mothers more than educated mothers.[35] 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 more than non-poor; negating the widely held notion that trade increases inequality. While interpreting these results, it should be kept in mind that data on asset variables is available at the time of survey. So, as long as mothers have not moved across wealth categories (moving within wealth categories does not pose a problem), these results are informative. AGOA seems to be affecting the more backward sections of the society,

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[33] I also check for robustness to controlling for ODA since sub-Saharan African countries were highly dependent on foreign aid and these changed with time, the coefficient still remain significant and similar in magnitude.

[34] The definitions of variables are elaborated in Data Section.

[35] The coefficients are not significantly different from each other using an F-test for educated and uneducated mothers. Though, individual coefficients point towards more reduction in infant deaths for uneducated mothers. F-statistic for difference in coefficients is significant for rural and poor mothers vis-à-vis urban and non-poor mothers.

where there is a larger scope of reducing infant mortality. This is consistent with 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.

Table 6: Heterogeneity across different types of mothers

	(1)	(2)	(3)	(4)
Dependent Variable	**Infant Mortality**	**Infant Mortality**	**Infant Mortality**	**Infant Mortality**
Educated	-0.0054* (0.0031)			
Uneducated	-0.0082*** (0.0029)			
Rural		-0.0085*** (0.0028)		
Urban		-0.0018 (0.0031)		
Poor			-0.0102*** (0.0028)	
Non-Poor			-0.0044 (0.0029)	
Employed				-0.0095*** (0.0028)
Unemployed				-0.0057 (0.0038)
F-Stat	0.83 (0.371)	5.71 (0.021)	7.82 (0.009)	2.25 (0.145)
Number of Countries	30	30	30	28
Number of mothers	212732	212738	212738	197632
Observations	686075	686093	686093	632951

Note: The control variables 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 vis-à-vis all mothers of control group. 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. Column (4) specifies the effect of infant mortality for mothers who are employed, where employment has been categorized into 9 categories – Professional and managerial, clerical, sales, Agricultural self-employed, Agricultural employee, household and domestic, services, skilled manual and unskilled manual. Unemployed is defined for a mother who is not working. Data for employment status is not available for mothers in Angola and Nigeria in the DHS survey used. F-stat and the corresponding p-values for equality of coefficients are also reported.
*** Significant at 1% level, ** significant at 5% level, * significant at 10% level.

One of the main channels through which AGOA may affect women is by affecting their employment. The women who are working should benefit more than women who have no gainful employment. The results in Table 6 column (4) show this. Moreover, among the employed, women employed in agriculture and manual labor benefits the most since many of these countries were apparel, mineral or agriculture exporting countries. This can be seen in Table 7. The infant mortality for mothers employed in the agriculture and manual labor sector, falls significantly by around 1.2 percentage points while those involved in household and services do not show a significant decline with respect to the fall in infant mortality for unemployed women.

Table 7: Heterogeneity across different employment groupings for mothers

	Treat	Agriculture	Manual Labor	Managerial Services	Household and Services
Infant Mortality	0.0063 (0.0040)	-0.0185*** (0.0035)	-0.0155*** (0.0043)	-0.0081*** (0.0026)	-0.0022 (0.0061)
F-Stat	3.16 (0.041)				
Number of Countries	28				
Number of mothers	148006				
Observations	484754				

Note: The control variables 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. All the coefficients are derived from the same regression. Robust standard errors clustered at country level are reported in brackets. Employment is categorized into four major sectors: (1) Agriculture - if the mother is working either as Agricultural self-employed or Agricultural employee, (2) Manual Labor - if the mother is employed as skilled manual or unskilled manual, (3) Managerial - if the mother is employed as Professional and managerial, clerical or sales, and (4) Household and services - if the mother is working in household or domestic services or the services sector. F-stat and corresponding p-value for equality of coefficients on employment categories is reported. Omitted category is the unemployed mothers. Data for employment status is not available for mothers in Angola and Nigeria in the DHS survey used.
*** Significant at 1% level, ** significant at 5% level, * significant at 10% level.

AGOA may affect the recipient countries differentially based on their predominant commodity of export. I use the trade volumes data from the Office of the United States Trade Representative, by commodity classification, to determine the main commodity of export at the 3-digit level. In Table 8, it is seen that countries producing and exporting agricultural products as well as mineral ores and petrol and metals gain the most from AGOA. These countries see a higher relative decline in infant mortality than others. On further disaggregation, the five countries with highest declines in infant mortality are Rwanda, Kenya, Lesotho, Tanzania and Zambia.[36] These are also majorly agriculture, apparel or mineral exporting countries, which benefitted the most under AGOA. It has been argued that with Oil and Gas being the most valuable export to US with AGOA, it does not create long term benefits for the economy. The results are in line with this reasoning. In fact Table A7 shows that oil exporting countries like Angola and Nigeria see an increase in infant deaths (although statistically insignificant in case of Angola). It may well then be that resource rich countries are not able to effectively harness the developmental gains from trade.

Table 8 column (2) shows that low-income countries in sub-Saharan Africa experience a significant decline in infant mortality due to AGOA vis-à-vis the middle income countries. There are heterogeneous effects by predominant religion of the country. Predominantly Islamic countries experience a larger fall in infant mortality than predominantly Christian countries. Many of the Islamic countries are in West Africa, dealing with mineral and ore exports.[37] In terms of regional heterogeneity, East Africa experience larger gains in infant deaths. Four out of the five nations in East Africa are predominantly agricultural exporters, which corroborates the previous finding. Even at the macro level, AGOA helps in leveling the disparities.

The benefits and heterogeneity we see at the micro level are reflected in the country level heterogeneity analysis. The benefits to the poor and uneducated are consistent with low income countries and countries with agricultural product exports benefitting more than countries with predominantly oil exports. This is because countries with agricultural exports or mining must be employing unskilled labor which is depicted by greater benefits accruing to that section of the society. This is also reflected in the results showing larger falls in infant mortality accrue to women employed in the agriculture or manual labor. On the other hand, countries with predominantly oil and energy exports are not able to reap the benefits despite generating new revenues.

[36] The full set of results for country effects are shown in Appendix Table A5.
[37] Guinea, Niger, Sierra Leone are mineral exporters which saw a significant decline (refer Appendix Table A5)

Table 8: Heterogeneity across different country groupings

	(1)	(2)	(3)	(4)
Dependent Variable	**Infant Mortality**	**Infant Mortality**	**Infant Mortality**	**Infant Mortality**
Apparel	-0.00023 (0.0046)			
Oil	0.00142 (0.0034)			
Agricultural Products	-0.0132*** (0.0031)			
Mineral and ore	-0.0109** (0.0048)			
Others	-0.00764 (0.0057)			
Non-Islamic		-0.0038 (0.0026)		
Islamic		-0.0107*** (0.0034)		
Low income countries			-0.0094*** (0.0031)	
Middle income countries			0.00012 (0.0038)	
East				-0.0181*** (0.0031)
West				-0.0064 (0.0038)
Central				-0.0055 (0.0043)
South				0.0006 (0.0009)
F-Stat	4.40 (0.0066)	3.30 (0.079)	6.02 (0.0204)	20.21 (0.00)
Number of Countries	30	30	30	30
Number of mothers	212738	212738	212738	212738
Observations	686093	686093	686093	686093

Note: The regressions control for sex of child, whether born in multiple birth, birth order, birth month, mother fixed effects, country specific linear trends, mother's age and 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 separate effect of being affected by AGOA based on their predominant commodity of export. Countries with high volume of apparel exports are Kenya, Lesotho, Madagascar, Namibia, Malawi and Swaziland. Countries having majorly oil and gas exports are Angola, Congo, Cameroon, Nigeria and Democratic Republic of Congo. Countries which had highest share of agricultural products exports are Burkina Faso, Burundi, Rwanda, and Tanzania. Countries with major mineral and ore exports (includes petrol, coal, minerals and ores) were Guinea, Ghana, Niger, Sierra Leone, and Zambia. Products not being classified under these above categories have been labeled as "other exports". These include Forestry, animal and wood products, electronics chemicals etc. The countries exporting these types of products are Benin, Chad, Mali, Sao Tome and Principe, and Senegal. The data for predominant commodity of export from these countries into US has been collected from Office of the United States Trade Representative. Column (2) assesses heterogeneity in reduction in infant mortality for countries based on their predominant religion. Data for predominant religion of each country has been collected from CIA World Factbook. Column (3) divides the 30 countries based on World Bank's ranking of incomes into low and middle income countries. Column (4) analyzes the impact on the countries based on their geographic location in sub-Saharan Africa. F-stat and the corresponding p-values for equality of coefficients are also reported.
*** Significant at 1% level, ** significant at 5% level, * significant at 10% level.

6 Pathways

Table 9 delves into finding the possible pathways through which the effects are operating at the macro level. Country level macro data from World Development Indicators and Penn World Table has been used for this analysis.

Table 9: Possible Macro Pathways

	(1)	(2)	(3)	(4)	(5)	(6)
Dependent Variable	**Infant Mortality**	**Infant Mortality**	**Infant Mortality**	**Infant Mortality**	**Infant Mortality**	**Infant Mortality**
Treatment	-0.0067** (0.0025)	-0.0071** (0.0025)	-0.0086*** (0.0026)	-0.0087*** (0.0026)	-0.0066** (0.0027)	-0.0086*** (0.0029)
Log GDP per capita	-0.0099* (0.0054)					
Health expenditure per capita		0.00010** (0.00004)				
Paved Roads Access			-0.00043** (0.00016)			
Female LFPR				-0.00032 (0.0007)		
Inequality					0.000028 (0.00044)	
Fertility						-0.00017 (0.016)
Number of countries	30	29	29	29	27	29
Number of mothers	212738	194638	190014	206137	163946	206137
Observations	686093	519738	593076	663838	526782	663838

Note: The control variables 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) is taken from PWT 7.0, (2), (3), (4) and (5) are taken from World Bank Development Indicators. Inequality is measured by Gini Index and varies from 0 to 100 with 0 being perfect equality. Even though Gini Index numbers are available from World Bank, the data is sparse between years and therefore an interpolated Gini Index has been constructed as a measure of inequality. 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.

As seen in Table 9, controlling for GDP per capita and health expenditure per capita at country level does not change the magnitude of the effect of AGOA on infant mortality much. The magnitude of the coefficient on AGOA does not change may be due to the use of aggregate country-level data. The effects of AGOA on the country-level variables are hard to decompose since these variables are highly correlated with aggregate trends. Results suggest that increasing GDP per capita, health expenditure per capita and access to paved roads are important in themselves in reducing infant mortality. Apart from income boost, AGOA possibly brings about changes in public and private health expenditures that are benefiting the individuals in those countries. AGOA does not seem to operate via increase in labor force participation rates as well as changing fertility.[38] The pathway findings are similar to Levine and Rothman (2006).[39]

Due to availability of micro level data, I can further verify at the household level if increase in income and increasing health expenditures after AGOA has been implemented contribute to this reduction in infant mortality. Families can increase investments in children's health if income increases due to AGOA, thereby reducing infant mortality. Moreover, AGOA may directly affect the availability of health care interventions that are also known to affect the probability of infant survival, for instance tetanus toxoid injections to pregnant mothers, skilled delivery assistance, and access to piped water and toilets.[40] AGOA may also affect the employment and distribution of employment in various sectors, thereby having an impact on infant mortality. Women working more as manual labor or managerial services may earn more or have better bargaining power affecting health of children than women staying at home.[41]

DHS does not collect data retrospectively for other variables like possession of assets by the household and employment.[42] These are collected only at the time of survey. Information on health care variables is available for live births for last five years. Therefore, mother fixed effects on a retrospective panel dataset created previously, can no longer be employed for

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[38] Since the data from these data sources (World Bank and PWT) are sparse for some of the indicators, these results should be interpreted as more of a correlation than causation.

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

[40] Black et al (2003), Jones et al (2003)

[41] Aguayo-Tellez et al (2010) show in the Mexican case of trade liberalization that employment of women increased and household bargaining power shifted in favor of women

[42] DHS does not have data on total income of the household. Instead it asks if the household possess certain assets at the time of survey. Accordingly I define a household as poor if it possesses no assets at the time of survey.

this analysis. To gain more variation, a repeated cross-section sample of infants at each survey is created by collating data for various rounds of survey for each country. I have data on assets, employment and health care variables for 22 countries, where DHS survey has been carried out more than once.[43] Since mother fixed effects cannot be controlled for, I instead create 'mother-cohorts' defined by their year of birth, place of residence (country and urban/rural), and level of education (attended primary school or not). In the estimation of the effect of AGOA on change in health care services, assets of household and maternal labor force supply, I control for fixed effects by these mother cohort categories.

Since tetanus toxoid injections are given to pregnant mothers, I estimate the effect of AGOA on probability of getting more tetanus toxoid injections if AGOA was present in the year when the mother was pregnant. Hence, the coefficient of interest is of $T_{c,t-1}$. For other healthcare variables like skilled delivery assistance, access to piped water and access to flush toilet, the treatment is the same as before as these help in reducing infant mortality after a child is born. The regressions control for birth year fixed effects, multiple births, gender, birth order and mother cohort characteristics fixed effects. The standard errors are clustered at the country level.

Table 10 shows the results for healthcare and sanitation. The evidence suggests that mothers are more likely to get immunization and get a skilled delivery birth attendant for their deliveries after AGOA. This may be brought about by increased availability of infrastructure or by behavioral changes in mothers due to perception of giving birth in better times. In this sense, if trade shock is considered a positive income boost (or an upturn), health seeking behavior of mother changes according to the environment.[44] The significant increase in health care access also points to the fact that we observe a big decline in neonatal mortality. On the other hand, the access to flush toilets and piped drinking water decreases after AGOA. The increase in health care expenditure per capita at the macro level indicates better access to health care facilities rather than improving infrastructure at homes.

[43] I drop Angola MIS surveys, which do not have data on the required variables and Burundi and Guinea do not have data on employment at time of survey. For more details of surveys used, see Appendix A4.
[44] Paxson and Schady (2005) point out cyclicality in health seeking due to income cycle.

Table 10: Micro Pathways – Health Care and Sanitation

	(1)	(2)	(3)	(4)
Dependent Variable	Tetanus Toxoid	Delivery Assistance	Piped Water	Flush Toilets
Treatment	0.132***	0.102***	-0.069**	-0.008*
	(0.044)	(0.032)	(0.025)	(0.0048)
Number of countries	22	22	22	22
Observations	118784	121797	119705	119657

Table 11: Micro Pathways – Maternal Labor Force

	(1)	(2)	(3)	(4)	(5)
Dependent Variable	Agriculture	Manual Labor	Managerial Services	Household and Services	Not Working
Treatment	-0.149***	0.095**	0.061*	-0.009	-0.044
	(0.015)	(0.037)	(0.034)	(0.019)	(0.039)
Number of countries	22	22	22	22	22
Observations	74478	74478	74478	74478	122053

Table 12: Micro Pathways –Ownership of Assets

	(1)	(2)	(3)	(4)	(5)	(6)	(6)	(7)
Dependent Variable	Electricity	Radio	Refrigerat or	Bike	TV	Scooter	Car	Poor
Treatment	-0.055***	0.078***	-0.024***	0.041*	-0.033**	0.051***	0.001	-0.063***
	(0.014)	(0.017)	(0.007)	(0.019)	(0.013)	(0.009)	(0.005)	(0.014)
Number of countries	22	22	22	22	22	22	22	22
Observation	115771	119206	113511	119149	117053	117921	117869	119148

Note: These estimates in Table 10, 11 and 12 are derived from a pooled sample of mothers in multiple surveys across 22 countries. The sample includes all babies, both living and dead, born within twelve months of survey date. For details on the surveys included, refer to Appendix Table A4. The models control for sex of child, whether born in multiple births, birth order, country specific linear trends, mother's age at birth, dummy for year and mother group fixed effects. Standard errors clustered at country level are reported in brackets. For definition on employment categories, see notes in Table 7. Description of how health care and sanitation variables are created and definition of mother group is described in Section 6.
*** Significant at 1% level, ** significant at 5% level, * significant at 10% level.

Maternal labor supply is likely to change after AGOA as the policy changes the opportunities available for women. After AGOA, more women are likely to be working in apparel or mineral and ores sector as manual labor since AGOA increased labor opportunities in those export sectors. This is reflected in the results presented in Table 11. After AGOA, the probability of a woman working in agriculture decreases while probability of work in manual labor and managerial services increases. It is documented that children of mothers in agricultural work are more likely to contract diseases and less likely to be treated in downturns (Bhalotra, 2010). This shift away from agricultural work into manual labor and managerial services, points towards a benefit in terms of reduced infant deaths.

AGOA also affects possession of assets by women. Since data on wealth index is not available for all surveys, I instead create an indicator for being poor as mother not owning any assets. Though it is not clear why some assets increase while others decrease after AGOA, results suggest a decrease in probability of being "poor" by 6.3 percentage points in Table 12. AGOA seems to be increasing affluence of mothers and hence help in decreasing infant deaths. Due to non-availability of data on consumption and food intake, I cannot estimate the effect of AGOA on that channel. But, since AGOA mainly increased exports, a greater increase in availability of food or decrease in consumer prices across the country via increased imports do not seem to be plausible channels in this case.

7 Robustness Checks

One concern in this analysis may be that AGOA may have affected fertility differently so that mothers who gave birth in those years in AGOA countries are not the same as the mothers who gave birth in the same year in non-AGOA countries. This may also differ by socio-economic status of women. To test this, I calculate the percentage of women of socio-economic status z giving birth in each country-cohort in year t by creating a panel for women aged 15 to 49 years of age.[45] The regression estimates the effect of AGOA on this fertility indicator. To account for changes in maternal age by year of child birth, differing by 'type' of woman, the regression controls for cohort-year-type fixed effects. These regressions also control for effect of birth cohort of women on fertility differing by country and 'type' using cohort-country-type fixed effects. The results, presented in Table 13, show that the

[45] Fertility(Z) = number of births(Z)/total number of women(Z)*100 where Z refers to socio-economic type of woman being uneducated, poor or rural. The types are segregated as there is evidence of these types of women systematically differing in their fertility/mortality behavior (Paxson and Schady, 2005).

coefficients are not significantly different from zero. Fertility selection bias does not seem to be a major concern in the estimations.

Table 13: Fertility Selection Effect

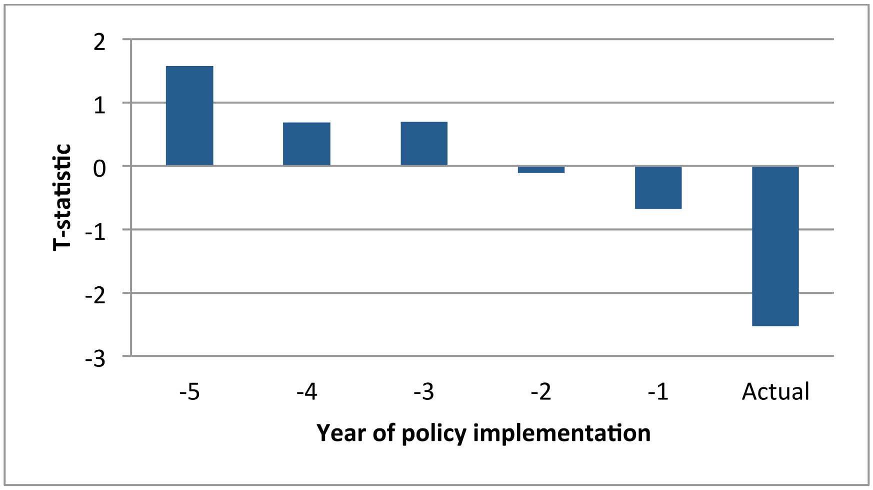
	(1)	(2)	(3)	(4)
	Fertility (All)	**Fertility (Uneducated)**	**Fertility (Poor)**	**Fertility (Rural)**
AGOA	-1.242 (1.07)	-0.567 (0.981)	-1.261 (1.07)	-1.252 (1.135)
AGOA*Woman's type		-0.265 (0.712)	0.338 (0.839)	-0.101 (1.04)
F-stat		0.39 [0.54]	0.5 [0.48]	1.18 [0.29]
Number of Countries	30	30	30	30
Observations	19250	38199	38290	38325

Note: The dependent variable is percentage of ('type' of) women giving birth. Woman's type is a dummy variable referring to if the woman is uneducated, poor or rural. For definitions of these, check notes in Table 1. (1) refers to all types of women, (2) to uneducated women, (3) to poor women and (4) to rural women. Standard errors clustered at the country level are reported in brackets. F-test reports F-statistics and its associated p-values in brackets for the null that the sum of coefficients on AGOA and on its interaction term with Woman's type is zero. All regressions control for country by woman's birth cohort fixed effects and year of giving birth by woman's birth cohort fixed effects which are also allowed to differ by woman's type.
*** Significant at 1% level, ** significant at 5% level, * significant at 10% level.

Placebo tests by allocating fake timing of AGOA is also carried out to rule out spurious effects of policy change.[46] I re-estimate the effect of AGOA on infant mortality by assuming that AGOA has been implemented 1 to 5 years before the actual implementation. The t-statistics for each of the regressions is plotted in Figure 5. I expect to observe no significant effect of the fake treatment. None of the t-statistics for the previous periods are significant at the standard levels.[47]

[46] I also carry out another test where I allocate AGOA treatment and year of the treatment to the countries in the sample, randomly from a uniform distribution. I do not find any significant results. Results are available on request.
[47] Point estimates are in Appendix Table A6.

Figure 5: Placebo Test – t-statistics for effect of policy change

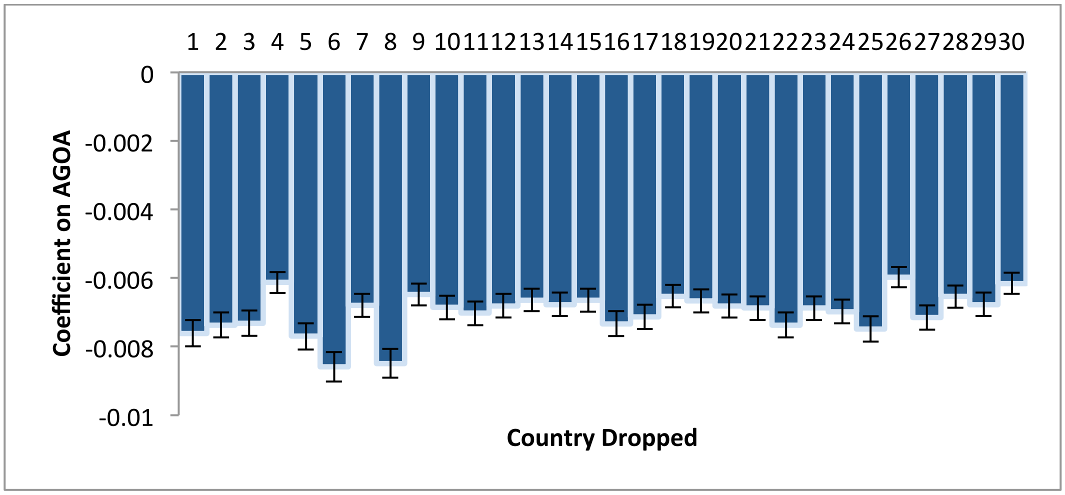


Note: In each of the separate regressions, the effect of AGOA is estimated at false policy timings. The graph depicts the t-statistic of the effect of "policy change" on infant mortality controlling for sex of child, whether born in multiple birth, birth order, birth month, mother's age, year of birth fixed effects, mother fixed effects, and country specific linear trends. None of the years before the actual policy change give statistically significant results. The point estimates are provided in Appendix Table A6.

To alleviate the concern that the results may be driven by one outlier country, Figure 6 shows that the result is robust to dropping one country at a time implying that these are not driven by changes due to an outlier country.[48] Also, since there are 30 countries and there may be country specific differences in birth order or mother's age trend, Table 14 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.

[48] Point estimates are shown in Appendix Table A3.

Figure 6: Robustness Check – Dropping one country at a time



Note: In each of the separate regressions, one of the countries is dropped at a time in alphabetical order. The graph depicts the point estimates of the effect of treatment on infant mortality controlling for 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 are clustered at country level. All the estimates are significant at least at 5% significance level. The point estimates are provided in Appendix Table A3.

Table 14: Robustness Checks

	(1)	(2)
Dependent Variable	**Infant Mortality**	**Infant Mortality**
Specification	Country Specific Birth Order	Country Specific mother's age quadratic trends
Treatment	-0.00688**	-0.00681**
	(0.0025)	(0.0026)
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

Note: The other control variables included in the specifications are sex of child, whether born in multiple birth, year of birth, mother's age at 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.

There may be concerns about whether it is the pre-conditions that are required for a sub-Saharan African country to become AGOA eligible that is bringing about the change or it is implementation of AGOA and the changes in government policies thereafter which is helping in reducing infant mortality. This has been addressed in Figure 4. If it were the pre-conditions that were making infant mortality fall then we would have seen the drop even before AGOA was implemented; which is not the case. As an additional check I divide the group of countries into two – one who got AGOA status in 2001 and in the other group those who got later. It may be argued that countries who got the AGOA status in 2001, were already "ready" while those which got later, needed to work on pre-requisites to get themselves an AGOA Beneficiary status. Hence, the estimates for the latter group should be bigger and significant if in fact it is the preconditions which lead to a fall in infant deaths. Table 15 (1) shows the results. It is observed that the group of countries which got AGOA status later does not significantly do better than those countries which got their AGOA status earlier in 2001 and in fact the group of countries which got the status earlier is more effective in decreasing infant mortality.

I run additional robustness tests to include different cut offs for dropping the sample based on various year of birth of kids in Table 15 (2). The result is robust to using different years as cut offs on both ends. There may exist bunching of deaths at 12 months in the data in DHS. To account for this, I redefine the infant mortality variable to include children who died at 12 months as well. The results are presented in Table 15 (4). This does not change the effect of AGOA on infant mortality and the effect is still statistically significant with a fall in 0.8 percentage points in infant mortality.

Lastly, I re-estimate the models using different definitions for treatment to AGOA. In my first specification in Table 15 (3), a model is estimated where in instead of choosing an indicator variable to indicate the presence of AGOA policy, percentage change in trade volumes interacted with an indicator of the country becoming AGOA eligible, is used as the independent variable. Table 15 (3) indicates that the coefficient is still negative and significant. A 1% increase in percentage in trade volumes in AGOA affected countries decreases the probability of an infant dying by 0.0014 percentage points. With year-to-year increases about 100% for some countries, this means it decreases the probability of infant dying by 0.14 percentage points. But, as pointed out earlier, it should be kept in mind that trade volumes in fact embody different aspects of an economy which may correlate with infant mortality and hence may not provide the best estimate.

Table 15: Effect of AGOA on different specifications

	(1)		(2)		(3)		(4)
Dependent Variable	**Infant Mortality**	**Infant Mortality**	**Infant Mortality**	**Infant Mortality**	**Infant Mortality**	**Infant Mortality**	**Infant Mortality**
Sample	AGOA in 2001	AGOA after 2001	YOB cutoff = 1991	1993< YOB< 2008	% change in trade volumes	Intensity of treatment	Including death at 12 months
Treatment	-0.0163***	-0.0029	-0.0070**	-0.0082***	-0.000014**	-0.0041**	-0.0085***
	(0.0039)	(0.0065)	(0.0028)	(0.0028)	(0.0027)	(0.0019)	(0.0030)
Explanatory Variables	YES	YES	YES	YES	YES	YES	YES
Country time trend	YES	YES	YES	YES	YES	YES	YES
Mother FE	YES	YES	YES	YES	YES	YES	YES
Cohort Year FE	NO	NO	NO	NO	NO	NO	NO
Number of countries	25	10	30	30	30	30	30
Number of mothers	176295	69667	209970	197072	209970	212738	212738
Observations	559498	218110	635844	536137	635844	686093	686093

Note: YOB stands for year of birth. The covariates are sex of child, whether born in multiple birth, birth order, birth month, mother's age, birth year. Standard errors clustered at country level are reported in brackets. (1) includes effect of trade on infant mortality in AGOA affected countries vis-à-vis no-AGOA countries, where AGOA was implemented in 2001 in column 1 vis-à-vis those nations where AGOA was implemented after 2001. (2) includes robustness check for birth year cut off for children in sample. (3) redefines the independent variable to percentage change in trade volumes from previous year for AGOA vs. non-AGOA countries and another definition of treatment, with treatment taking the value 2 for AGOA affected countries in 2001, 1 for countries getting AGOA after 2001 and 0 for not being AGOA affected in the sample. (4) redefines the dependent variable to include deaths at 12 months as well.
*** Significant at 1% level, ** significant at 5% level, * significant at 10% level.

It could be argued that countries that got treated with AGOA earlier in 2001 are different from countries that got AGOA later and hence a treatment variable is defined such that it takes the intensity of treatment into account. In Table 15 (3), I redefine the treatment variable such that it differs by number of years exposed to AGOA. The countries that got AGOA earlier in 2001 get a value 2 for treatment while those that got AGOA after 2001, get a value of 1. The never treated countries in the sample get a value of zero. The resulting coefficient remains statistically significant at about 0.4 percentage points fall in infant deaths. This fall in magnitude could be due to the heterogeneity in fall in infant mortality for those countries that got AGOA in 2001 vis-à-vis later.

8 Conclusion

The empirical study of the effect of trade on development has been limited, and in many cases confounding. By creating a micro panel dataset for 30 sub-Saharan African countries in DHS, this study is able to better control for confounding factors at the country and mother level like poor institutions, macroeconomic instability, geography etc. and hence is able to derive a causal estimate of trade on infant mortality. The reduced-form results indicate trade policy has a positive developmental effect on the population in terms of reducing probability of infant and neonatal deaths. It should be noted that this does not imply that the trade policy leads to overall decrease in infant mortality rates; rather it changes the household experience of child death.

I also find evidence of differential benefits to different sections of the population. 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, countries with predominantly agricultural exports benefit more than others and so do low-income countries. Some oil and gas exporting countries see an increase in infant deaths after the policy.

The fall in infant deaths accrues via a change in response to AGOA by mothers by increasing maternal labor supply in non-agricultural sectors and increased health seeking behavior. The results also indicate the presence of income channel in decreasing infant deaths as AGOA decreases the probability of being “poor”. The decrease in infant and neonatal deaths is observed immediately after AGOA is implemented. The increased health seeking behavior of mother could bring about immediate changes in neonatal mortality. The improved health seeking behavior of the women could be attributed to increase in relative bargaining power for women due to increased income (Aguayo-Tellez et al., 2010) or realignment of preferences due to changing environment (Paxson and Schady, 2005).

This study emphasizes that macroeconomic policies could have a positive causal effect on microeconomic development outcomes like health. With such a large policy change, which affects so many countries, 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 in AGOA. It is important to 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.

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Appendix

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

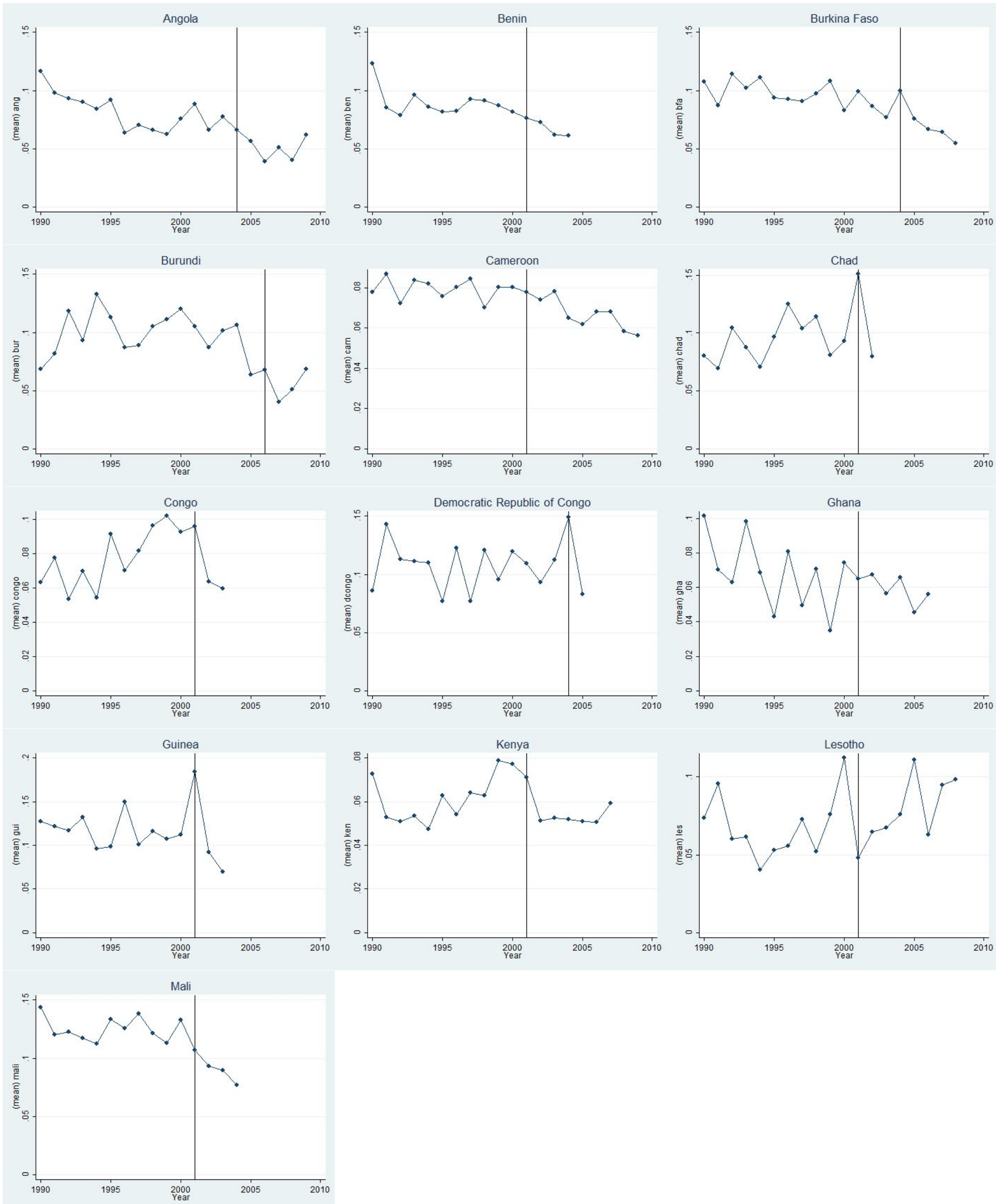

Figure A2(a): Sample mean infant mortality rates by country for AGOA affected countries overtime, 1990 onwards

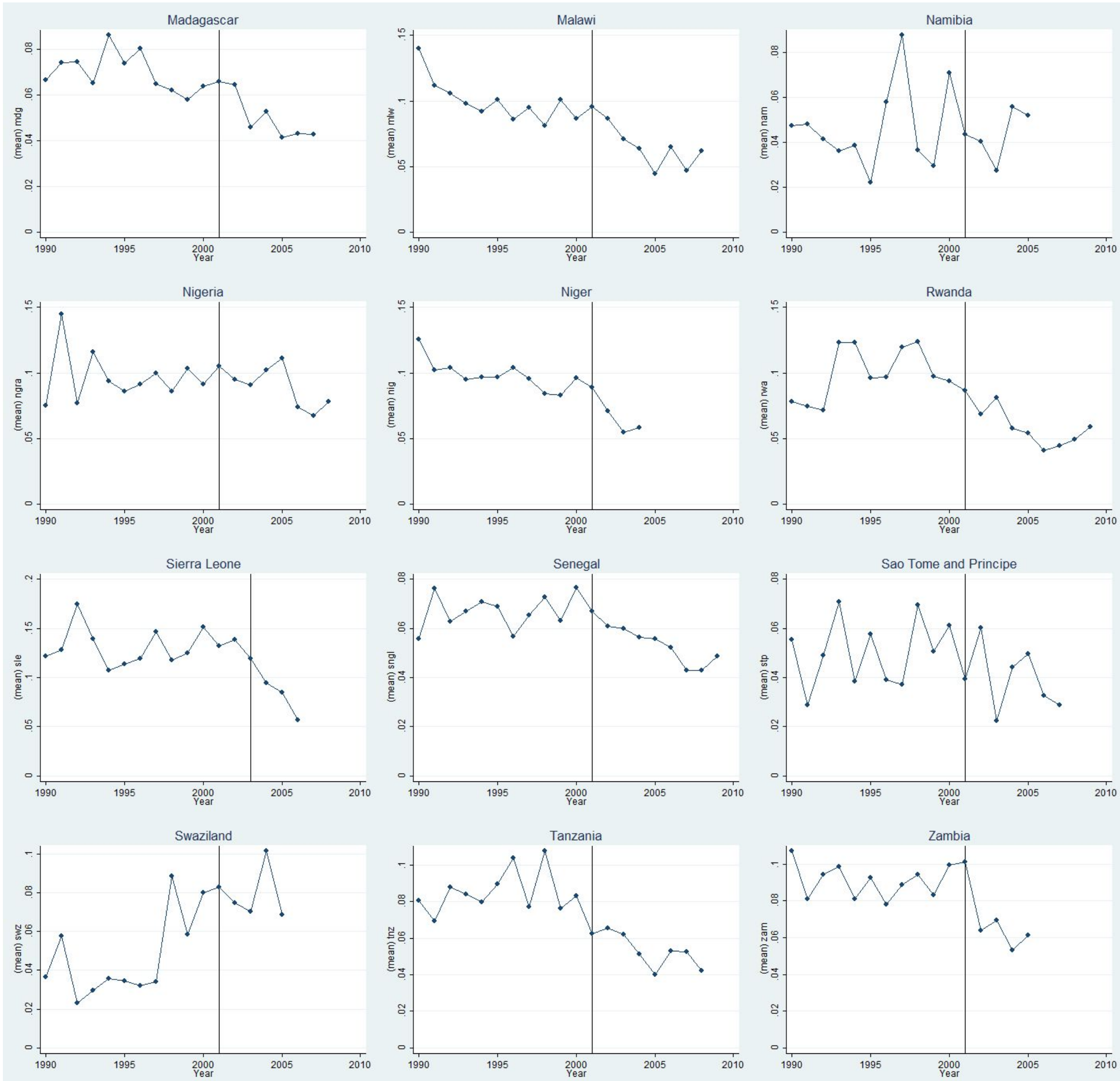

Figure A2(b): Sample mean infant mortality rates by country for AGOA affected countries overtime, 1990 onwards

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	December 30, 2003	2011	1990-2010
Benin	Y	October 2, 2000	2006	1990-2005
Burkina Faso	Y	December 10, 2004	2010	1990-2009
Burundi	Y	January 1, 2006	2010	1990-2010
Cameroon	Y	October 2, 2000	2011	1990-2010
Chad	Y	October 2, 2000	2004	1990-2003
Republic of the Congo	Y	October 2, 2000	2005	1990-2004
Democratic Republic of the Congo	Y	October 31, 2003 – Suspended 2011	2007	1990-2006
Cote d'Ivoire	Y	2003 – Suspended 2005; restored 2011	2005	1990-2003
Ethiopia	Y	October 2, 2000	2011	1990-2002
Ghana	Y	October 2, 2000	2008	1990-2007
Guinea	Y	2000- Suspended 2009; restored 2011	2005	1990-2004
Kenya	Y	October 2, 2000	2008-09	1990-2008
Lesotho	Y	October 2, 2000	2009	1990-2009
Liberia	Y	December 29, 2006	2007	1990-2006
Madagascar	Y	2000-Suspended 2009; restored 2014	2008-09	1990-2008
Malawi	Y	October 2, 2000	2010	1990-2009
Mali	Y	2000 – Suspended 2012; restored 2014	2006	1990-2005
Mozambique	Y	October 2, 2000	2003	1990-2002
Namibia	Y	October 2, 2000	2006-07	1990-2006
Niger	Y	2000-Suspended 2009; restored 2011	2006	1990-2005
Nigeria	Y	October 2, 2000	2010	1990-2009
Rwanda	Y	October 2, 2000	2010	1990-2009
Sao Tome and Principe	Y	October 2, 2000	2008-09	1990-2008
Senegal	Y	October 2, 2000	2010-11	1990-2010
Sierra Leone	Y	October 23, 2002	2008	1990-2007
Swaziland	Y	October 2, 2000	2006-07	1990-2006
Tanzania	Y	October 2, 2000	2010	1990-2009
Zambia	Y	October 2, 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. Similarly for Cote d'Ivoire, Ethiopia and Mozambique, since I merge the last year data with previous year due to few data points in the final year, these countries effectively behave as not affected by AGOA.

Table A2: Point estimates for Dynamics of infant mortality

	Pre 2	Pre 1	Pre 0	Post1	Post2	Post3	Post 4
Infant Mortality	-0.0007	0.0008	-0.0026	-0.0067**	-0.0043	-0.0087*	-0.006**
	(0.0037)	(0.0036)	(0.0050)	(0.0032)	(0.0039)	(0.0043)	(0.0024)
F-test	0.15 [0.924]						
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, mother's age, country specific linear trends, year fixed effects and mother fixed effects. Standard errors clustered at country level are reported in brackets. F-test is for the coefficients on years before AGOA implementation are all zero.
*** Significant at 1% level, ** significant at 5% level, * significant at 10% level.

Table A3: 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)Angola	**(2)Benin**	**(3) Burkina Faso**	**(4)Burundi**	**(5)Cameroon**	**(6)Chad**	**(7)Congo**
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)Congo, Dem.	**(9)Cote d'Ivoire**	**(10)Ethiopia**	**(11)Ghana**	**(12)Guinea**	**(13)Kenya**	**(14)Lesotho**
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)Liberia	**(16)Madagascar**	**(17)Malawi**	**(18) Mali**	**(19)Mozambique**	**(20)Namibia**	**(21)Niger**
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)Nigeria	**(23)Rwanda**	**(24)Sao Tome & Principe**	**(25)Senegal**	**(26)Sierra Leone**	**(27)Swaziland**	**(28)Tanzania**
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)Zambia	**(30)Zimbabwe**					
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 A4: List of countries and surveys used in Pathway Analysis

Sub-Saharan Africa	Year made AGOA Eligible	Infant mortality DHS used	Pathway Analysis DHS Used
Angola	2003	2011	No data for employment - dropped
Benin	2000	2006	1996, 2001, 2006
Burkina Faso	2004	2010	1993, 1998-99, 2003, 2010
Burundi	2006	2010	No employment data - dropped
Cameroon	2000	2011	1991, 1998, 2004, 2011
Chad	2000	2004	1996-97, 2004
Republic of the Congo	2000	2005	2005, 2011-12
Democratic Republic of the Congo	2003	2007	Two surveys not available - dropped
Cote d'Ivoire	2003 – Suspended 2005; restored 2011	2005	1994, 2011-12 (1998/2005 do not have data on toxoid injections)
Ethiopia	2000	2011	2000, 2005, 2011
Ghana	2000	2008	1993, 1998, 2003, 2008
Guinea	2000- Suspended 2009; restored 2011	2005	No employment data - dropped
Kenya	2000	2008-09	1993, 1998, 2003, 2008-09
Lesotho	2000	2009	2004, 2009
Liberia	2006	2007	No employment data for 2 rounds of survey - dropped
Madagascar	2000-Suspended 2009; restored 2014	2008-09	1992, 1997, 2003-04, 2008-09
Malawi	2000	2010	1992, 2000, 2004, 2010
Mali	2000 – Suspended 2012; restored 2014	2006	1995-96, 2001, 2006
Mozambique	2000	2003	1997, 2003, 2011
Namibia	2000	2006-07	1992, 2000, 2006-07
Niger	2000-Suspended 2009; restored 2011	2006	1992, 1998, 2006
Nigeria	2000	2010	1990, 1999, 2008 (2010 is MIS Data)
Rwanda	2000	2010	1992, 2000, 2005, 2010
Sao Tome and Principe	2000	2008-09	Two surveys not available - dropped
Senegal	2000	2010-11	1992-93, 1997, 2005, 2010-11
Sierra Leone	2002	2008	Two surveys not available - dropped
Swaziland	2000	2006-07	Two surveys not available - dropped
Tanzania	2000	2010	1991-92, 1996, 1999, 2010
Zambia	2000	2007	1992, 1996, 2001-02, 2007
Zimbabwe	Non-AGOA	2010-11	1994, 1999, 2005-06, 2010-11

Note: Later survey has been included in the pathway analysis, if a newer survey is available at the time of the analysis, than the infant mortality analysis. The surveys needed to have information on health care variables, maternal employment and possession of assets to be included in the analysis.

Table A5: Effect of AGOA on infant mortality by year and country

Time effects:

	2002	2003	2004	2005	2006	2007	2008	2009
Infant	-0.0059	-0.0069**	-0.0118	-0.0028	0.0028	-0.0084**	-0.014***	-0.0104*
Mortality	(0.0042)	(0.0030)	(0.0073)	(0.0102)	(0.0082)	(0.0034)	(0.0048)	(0.0061)
Number of countries	30							
Number of mothers	212738							
Observa-tions	686093							

Note: These are estimates of AGOA interacted with the year dummies for each AGOA year. The explanatory variables included in the specifications are sex of child, whether born in multiple birth, birth order, birth month, mother's age at birth, country time trend and mother fixed effects. Standard errors clustered at country level are reported in brackets.
*** Significant at 1% level, ** significant at 5% level, * significant at 10% level.

Country effects:

Dependent Variable	**Infant Mortality**	**Infant Mortality**	**Infant Mortality**	**Infant Mortality**	**Infant Mortality**	**Infant Mortality**
	(1)Angola	**(2)Benin**	**(3)Burkina Faso**	**(4)Burundi**	**(5)Cameroon**	**(6)Chad**
Treatment	0.0043 (0.0026)	-0.0022 (0.0043)	-0.0068** (0.0027)	-0.0148*** (0.0024)	0.0029 (0.0044)	-0.0089* (0.0044)
	(7)Congo	**(8)Congo, Dem.**	**(11)Ghana**	**(12)Guinea**	**(13)Kenya**	**(14)Lesotho**
Treatment	-0.0154*** (0.0037)	-0.0019 (0.0033)	0.0175*** (0.0045)	-0.0157*** (0.0039)	-0.0217*** (0.0043)	0.0179*** (0.0044)
	(16)Mada-gascar	**(17)Malawi**	**(18) Mali**	**(20)Namibia**	**(21)Niger**	**(22)Nigeria**
Treatment	0.0026 (0.0044)	-0.00073 (0.0043)	-0.0209*** (0.0042)	-0.00668 (0.0044)	-0.0104** (0.0042)	0.00858* (0.0044)
	(23)Rwanda	**(24)Sao Tome & Principe**	**(25)Senegal**	**(26)Sierra Leone**	**(27)Swazi-land**	**(28)Tanzania**
Treatment	-0.0223*** (0.0043)	0.0057 (0.0045)	-0.0037 (0.0044)	-0.0175*** (0.0030)	0.0072 (0.0043)	-0.0176*** (0.0044)
	(29)Zambia					
Treatment	-0.0186*** (0.0044)					

Note: These are estimates of AGOA interacted with the country dummies for each 25 AGOA affected country in the sample. The explanatory variables included in the specifications are sex of child, whether born in multiple birth, birth order, birth month, mother's age at birth, country time trend and mother fixed effects. Standard errors clustered at country level are reported in brackets.
*** Significant at 1% level, ** significant at 5% level, * significant at 10% level.

Table A6: Placebo test – False timing of AGOA

	5 years before	4 years before	3 years before	2 years before	1 year before	Actual
Infant	0.006	0.0030	0.0032	-0.0004	-0.0023	-0.0071**
Mortality	(1.58)	(0.69)	(0.70)	(-0.11)	(-0.68)	(-2.53)
Number of countries	30					
Number of mothers	212738					
Observations	686093					

Note: Each cell represents a different regression. The explanatory variables included in the specifications are sex of child, whether born in multiple birth, birth order, birth month, mother's age, country specific linear trends, year fixed effects and mother fixed effects. Standard errors are clustered at country level. Resulting t-statistics 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 actually implemented.
*** Significant at 1% level, ** significant at 5% level, * significant at 10% level.

Table A7: Heterogeneity in effects by child's gender

	(1)	(2)	(3)
Dependent Variable	**Infant Mortality**	**Infant Mortality**	**Infant Mortality**
AGOA	-0.0072** (0.0028)	-0.0062** (0.0026)	-0.0062** (0.0025)
AGOA*Son	-0.0017 (0.0012)	-0.0017 (0.0017)	-0.015 (0.0017)
Son	0.0138*** (0.0011)	0.014*** (0.0011)	0.014*** (0.0011)
Explanatory Variables	YES	YES	YES
Country time trend	YES	YES	YES
Country FE	YES	NO	NO
Mother FE	NO	YES	YES
Cohort-year FE	NO	NO	YES
Number of Countries	30	30	30
Number of mothers	212738	212738	212738
Observations	686093	686093	686093

Note: The control variables are whether born in multiple birth, birth order, birth month, and country specific linear trends. Mother's age at birth and year of birth of child fixed effects is included in specifications (1) and (2), and it is subsumed in Cohort-year fixed effects in (3). AGOA is interacted with the gender of child (if the child is a male). Standard errors clustered at country level are reported in brackets.
*** Significant at 1% level, ** significant at 5% level, * significant at 10% level.

Table A8: Effect on the likelihood of child death

	(1)	(2)
Dependent Variable	**Infant Mortality**	**Neonatal Mortality**
T-4	0.0009 (0.0024)	-0.00005 (0.0021)
T-3	0.0047* (0.0027)	0.0019 (0.0013)
T-2	-0.0009 (0.0029)	-0.0014 (0.0019)
T-1	0.0028 (0.0048)	-0.0015 (0.0027)
F-stat **PRE**	1.83 (0.1569)	1.10 (0.378)
T+1	-0.0122** (0.0053)	-0.0052*** (0.0016)
T+2	-0.0046 (0.0043)	-0.0032 (0.0022)
T+3	-0.0082*** (0.0028)	-0.0074*** (0.0018)
T+4	-0.0161** (0.0059)	-0.0075** (0.0034)
F-stat **POST**	4.03 (0.0122)	7.34 (0.0005)
Number of countries	25	25
Observations	594560	594560

Note: These are the θj estimates derived from estimating this equation:
$Death_{imct} = \alpha_c + \beta_t + \sum_{j=-4}^{4} \theta_j T_{c,t+j} + X_i'\delta + \varepsilon_{imct}$. All coefficients are from the same regression. The sample is restricted to treated countries. The standard errors are clustered at the country level and reported in brackets. The control variables are whether born in multiple birth, birth order, birth month, mother's age at birth, mother's education, place of residence, asset index. Both the specifications control for year and country fixed effects. F-statistics and the corresponding p-values are reported for the joint significance of pre-treatment years and post-treatment years.
*** Significant at 1% level, ** significant at 5% level, * significant at 10% level.

Highlights

- African Growth and Opportunity Act reduces infant mortality by 9% of sample mean
- Dynamics reveal that there exists no effect prior to AGOA being implemented
- Benefits of AGOA are not equally distributed across countries and across households
- Change in household income and female labor supply act as potential mechanisms
- AGOA led to a significant change in health seeking behavior of mothers