

# Does Trade Reduce Infant Mortality? Evidence from Sub-Saharan Africa

Pallavi Panda

State University of New York, Geneseo

*panda@geneseo.edu*

June 5, 2016

\*I would like to thank Hewlett foundation/IIE for awarding the 2013-2015 Hewlett Foundation Dissertation Fellowship in Population, Reproductive Health and Economic Development for this research

# Motivation

- Many developing countries have opened their economies in the hopes of spurring growth - But does this translate into development?
- 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)
- This study:

- Many developing countries have opened their economies in the hopes of spurring growth - But does this translate into development?
- 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)
- This study:
  - estimates the effect of being exposed to a trade policy (African Growth and Opportunity Act) on infant and neonatal mortality

- Many developing countries have opened their economies in the hopes of spurring growth - But does this translate into development?
- 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)
- This study:
  - estimates the effect of being exposed to a trade policy (African Growth and Opportunity Act) on infant and neonatal mortality
  - analyzes heterogeneous effects both at the macro and micro level

# Motivation

- Many developing countries have opened their economies in the hopes of spurring growth - But does this translate into development?
- 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)
- This study:
  - estimates the effect of being exposed to a trade policy (African Growth and Opportunity Act) on infant and neonatal mortality
  - analyzes heterogeneous effects both at the macro and micro level
  - examines possible pathways

- Few empirical studies estimating the effect of trade on child health
- Empirically, it is difficult to identify causal effects due to endogeneity
  - Omitted Variables
  - Reverse Causality
- Identification in previous literature has come from using instrumental variables like predicting trade volumes as a ratio of GDP using geographic factors (Levine and Rothman (2006), Frankel and Romer (1999))
- Potential threats to validity as geographical trade share may be correlated with other factors that affect children's welfare

- Trade Policy
  - African Growth and Opportunity Act (AGOA): duty-free and largely quota-free access to US markets
  - Took effect in 2000 with 34 sub-Saharan African countries eligible for the trade benefits
  - Identification in this analysis is based on each country's exposure to the trade policy at different points of time

- Trade Policy

- African Growth and Opportunity Act (AGOA): duty-free and largely quota-free access to US markets
- Took effect in 2000 with 34 sub-Saharan African countries eligible for the trade benefits
- Identification in this analysis is based on each country's exposure to the trade policy at different points of time

- Health

- Uses the best available pan-Africa Health Surveys on fertility and child health, Demographic and Health Surveys (DHS)
- Using retrospective birth histories from DHS, I develop a micro panel dataset that spans 30 sub-Saharan African countries, and about 686,000 children born to 212,000 mothers
- The effect of trade policy on infant mortality is gauged by studying the varying exposure between the children born to same mothers but exposed to the trade policy or not in both policy-affected and non-affected countries

# Preview of Findings

- AGOA reduces
  - Infant mortality in sub-Saharan Africa by 0.7 percentage points, 9% of the sample mean
  - Neonatal mortality by 4.4 death per 1000, 12% of sample mean
- AGOA benefits rural and poor mothers more
- 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
- Decrease in infant mortality is operating through:
  - change in household income/assets
  - change in female employment in labor force
  - changing health seeking behavior of mothers

# AGOA Timeline

2000

- Benin, Cameroon, Chad, Republic of Congo, **Ethiopia**, Ghana, Kenya, Lesotho, Malawi, **Mozambique**, Namibia, Nigeria, Rwanda, Sao Tome & Principe, Senegal, Swaziland, Tanzania, Zambia
- Suspended: Guinea (2009), Madagascar (2009), Mali (2012), Niger (2009)

2002

- Sierra Leone

2003

- Angola, Democratic Republic of Congo, **Cote D'Ivoire**
- Suspended: Democratic Republic of Congo(2011), Cote D'Ivoire (2005)

2004-06

- 2004: Burkina Faso
- 2006: **Liberia**

Zimbabwe: Not AGOA Eligible

# Impact on Exports

- Frazer and Biesebroeck (2007), Condon and Stern (2011) and Collier and Venables (2007) find a positive and significant impact of AGOA on exports, without a decrease in trade share of European Union

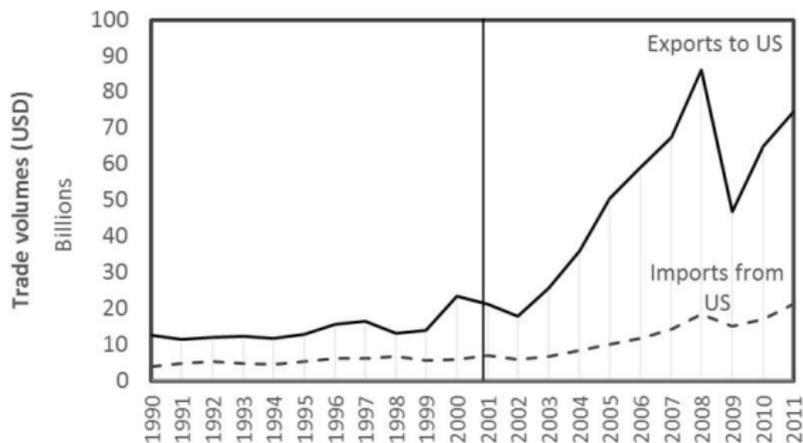


Figure: Total exports and imports between US and all the sub-Saharan African countries from 1990-2011

# Trade Linkages

|                           | Mechanism                  | Trade | Infant Deaths  |
|---------------------------|----------------------------|-------|--|
| <b>Macro Channels</b>     |                            |       |  |
| <b>GDP/Capita</b>         | Increased Exports          |       |  |
| <b>Health Expenditure</b> | Tax Revenues               | ?     |  |
| <b>Inequality</b>         |                            | ?     |  |
| <b>Pollution</b>          | Urbanization               |       |  |
| <b>Micro Channels</b>     |                            |       |  |
| <b>Employment</b>         | Income Effect              |       |  |
|                           | Substitution Effect        |       |  |
| <b>Healthcare access</b>  | Realignment of preferences |       |  |
| <b>Bargaining Power</b>   | Increased Income           |       |  |
| <b>Variety Gains</b>      | Opening of markets         |       |  |

- The micro level health data for the sub-Saharan African countries comes from the Demographic and Health Surveys (DHS)
- 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
- There are 36 DHS Surveys publically available
  - Central African Republic, Comoros, Gabon, South Africa, Sudan and Togo were all carried out before AGOA
  - 30 surveys are included in this analysis
- Datasets across 30 sub-Saharan African countries from DHS collated using the recall data to get a micro-dataset, which runs across the sub-Saharan African countries, with the time dimension being the child birth year

## Linear Probability Model, Specification 1

$$IMR_{imct} = \alpha_m + \beta_t + \theta T_{ct} + X_{imct}\delta + \mu_c \cdot t + \epsilon_{imct}$$

- IMR is a dummy which takes the value 1 if child  $i$  born to mother  $m$  in country  $c$  at time  $t$  dies before reaching the age of 1 year

## Linear Probability Model, Specification 2

$$IMR_{imbct} = \alpha_m + \beta_{bt} + \theta T_{ct} + X_{imbct}\delta + \mu_c \cdot t + \epsilon_{imbct}$$

- $b$ : Mother's birth cohort
- Standard errors clustered at the country level to take into account any correlation of the error across space and time within each country

- Residual contains no mother-specific time-varying shocks that might drive a correlation between mortality and AGOA

$$E(\epsilon_{imbct} | T_{ct}, \beta_{bt}, \alpha_m, \mu_{c \cdot t}, X_{imbct}) = 0$$

- To account for this, I include child birth year dummies interacted with mother's cohort to non-parametrically control for cohort-year fixed effects
- Also control for observable country specific time varying shocks (like GDP per capita, political regime, commodity prices etc.)

$$IMR_{imbct} = \alpha_m + \beta_{bt} + \theta T_{ct} + X_{imbct} \delta + \mu_{c \cdot t} + \lambda Z_{ct} + \epsilon_{imbct}$$

# Disentangling the Effects

- Difficulty of disentangling the effect of this policy from the prerequisites for being a signatory on the AGOA
  - Time-invariant heterogeneity regarding geography, history, culture, politics and attitudes etc. are taken care of by the mother fixed effects ( $\alpha_m$ )
  - The year fixed effects ( $\beta_t$ ) control for an aggregate time variation involving improvement of health technology and year shocks
  - ( $\beta_{bt}$ ) controls for changing time of mothers age at birth
  - Country-specific time trends ( $\mu_{c.t}$ ) also allow for differential states of development of the countries

# Event-Time Study

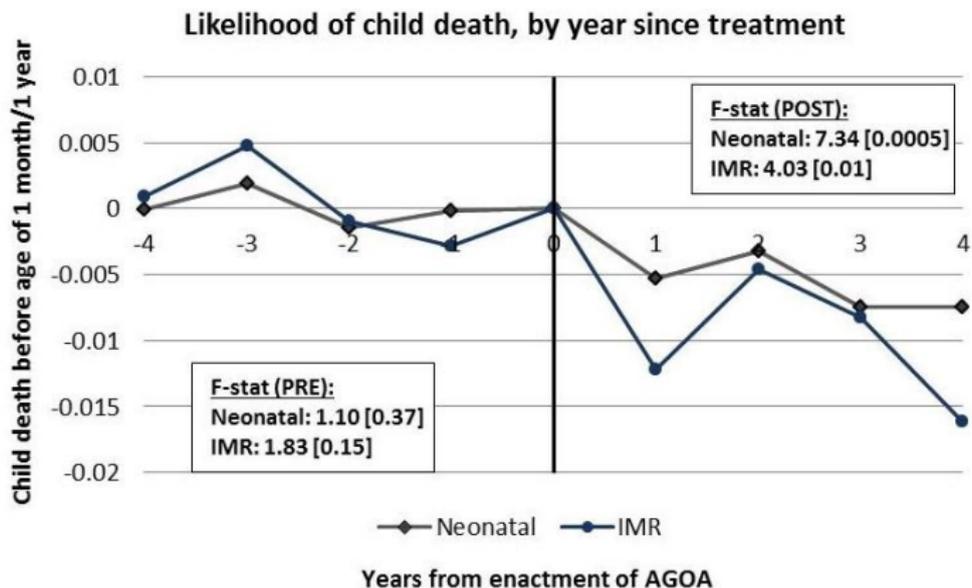


Figure: These are the  $\theta_j$  estimates plotted from estimating this equation:

$$Death_{imct} = \alpha_c + \beta_t + \sum_{j=-4}^4 \theta_j T_{c,t+j} + X_i \delta + \epsilon_{imct}$$

# Infant Mortality decreases after AGOA

|                              | (1)                 | (2)                    | (3)                   | (4)                    | (5)                    | (6)                    | (7)                     |
|------------------------------|---------------------|------------------------|-----------------------|------------------------|------------------------|------------------------|-------------------------|
| Dependent Variable           | Infant Mortality    | Infant Mortality       | Infant Mortality      | Infant Mortality       | Infant Mortality       | Infant Mortality       | Neonatal Mortality      |
| <b>Treatment</b>             | -0.0071<br>(0.0028) | -0.0081***<br>(0.0028) | -0.0071**<br>(0.0028) | -0.0079***<br>(0.0019) | -0.0079***<br>(0.0028) | -0.00693**<br>(0.0027) | -0.00456***<br>(0.0011) |
| <b>Explanatory Variables</b> | YES                 | YES                    | YES                   | YES                    | YES                    | YES                    | YES                     |
| <b>Country time trend</b>    | NO                  | YES                    | YES                   | YES                    | YES                    | YES                    | YES                     |
| <b>Country FE</b>            | YES                 | YES                    | NO                    | NO                     | YES                    | NO                     | NO                      |
| <b>Mother FE</b>             | NO                  | NO                     | YES                   | NO                     | NO                     | YES                    | YES                     |
| <b>Cohort-year FE</b>        | NO                  | NO                     | NO                    | YES                    | YES                    | YES                    | YES                     |
| <b>Number of countries</b>   | 30                  | 30                     | 30                    | 30                     | 30                     | 30                     | 30                      |
| <b>Number of mothers</b>     | 212738              | 212738                 | 212738                | 212738                 | 212738                 | 212738                 | 212738                  |
| <b>Observations</b>          | 686093              | 686093                 | 686093                | 686093                 | 686093                 | 686093                 | 686093                  |

# Time-Variant Factors

|                              | (1)                   | (2)                    | (3)                    | (4)                    | (5)                  | (6)                   | (7)                   |
|------------------------------|-----------------------|------------------------|------------------------|------------------------|----------------------|-----------------------|-----------------------|
| Dependent Variable           | Infant Mortality      | Infant Mortality       | Infant Mortality       | Infant Mortality       | Infant Mortality     | Infant Mortality      | Infant Mortality      |
| <b>Treatment</b>             | -0.0068**<br>(0.0025) | -0.0076***<br>(0.0026) | -0.0082***<br>(0.0025) | -0.00697**<br>(0.0026) | -0.0067*<br>(0.0032) | -0.009***<br>(0.0025) | -0.0066**<br>(0.0028) |
| <b>Log GDP per capita</b>    | -0.0099*<br>(0.0054)  |                        |                        |                        |                      |                       | -0.0175*<br>(0.0094)  |
| <b>Democracy</b>             |                       | -0.0041<br>(0.0029)    |                        |                        |                      |                       | -0.0043<br>(0.0028)   |
| <b>ODA</b>                   |                       |                        | 0.00009<br>(0.0001)    |                        |                      |                       | -0.00003<br>(0.00007) |
| <b>Openness</b>              |                       |                        |                        | -0.00002<br>(0.00007)  |                      |                       | 0.00009<br>(0.00005)  |
| <b>Female Education</b>      |                       |                        |                        |                        | 0.0029<br>(0.0053)   |                       | -0.001<br>(0.0048)    |
| <b>Commodity Price Index</b> |                       |                        |                        |                        |                      | 0.0327***<br>(0.0067) | 0.0311***<br>(0.0066) |
| <b>Number of countries</b>   | 30                    | 30                     | 29                     | 30                     | 21                   | 29                    | 21                    |
| <b>Number of mothers</b>     | 212738                | 209721                 | 205420                 | 212738                 | 134952               | 206137                | 131959                |
| <b>Observations</b>          | 686093                | 673646                 | 655443                 | 686093                 | 410833               | 663838                | 394715                |

# Heterogeneity

- Trade policy helped boost exports in apparel and mining; which have been shown to be major employers of women in sub-Saharan Africa
- These sectors, along with agriculture, employ rural and poor women as they provide cheap labor
- I check for heterogeneity based on these characteristics of mother

# Micro Heterogeneity

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

# Employment

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

Note: 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.

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

▶ Macro Heterogeneity

▶ Time and Country

▶ Child Gender

- Assets/Income  
AGOA → Incomes increase → child health investment → infant mortality falls
- Health Care  
AGOA → Increased infrastructure → availability of health care interventions / Mothers health seeking behavior
- Employment  
AGOA → Change in type of employment → Increased bargaining power for women

# Data for Mechanism Analysis

- No data retrospectively for variables like possession of assets and employment
- Repeated cross-section sample of infants at each survey is created by collating data for various rounds of survey for each country
- Data on assets, employment and health care variables for 22 countries, where DHS survey has been carried out more than once
- 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)

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

Note: These estimates 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.

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

# Channels: Maternal Labor Force

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

Note: These estimates 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.

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

# Channels: Ownership of Assets

|                     | (1)                 | (2)                  | (3)               | (4)                 | (5)                  |
|---------------------|---------------------|----------------------|-------------------|---------------------|----------------------|
| Dependent Variable  | Radio               | Refrigerator         | Bike              | Scooter             | Poor                 |
| Treatment           | 0.078***<br>(0.017) | -0.024***<br>(0.007) | 0.041*<br>(0.019) | 0.051***<br>(0.009) | -0.063***<br>(0.014) |
| Number of countries | 22                  | 22                   | 22                | 22                  | 22                   |
| Observations        | 119206              | 113511               | 119149            | 117921              | 119148               |

Note: These estimates 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.

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

▶ Macro Pathways

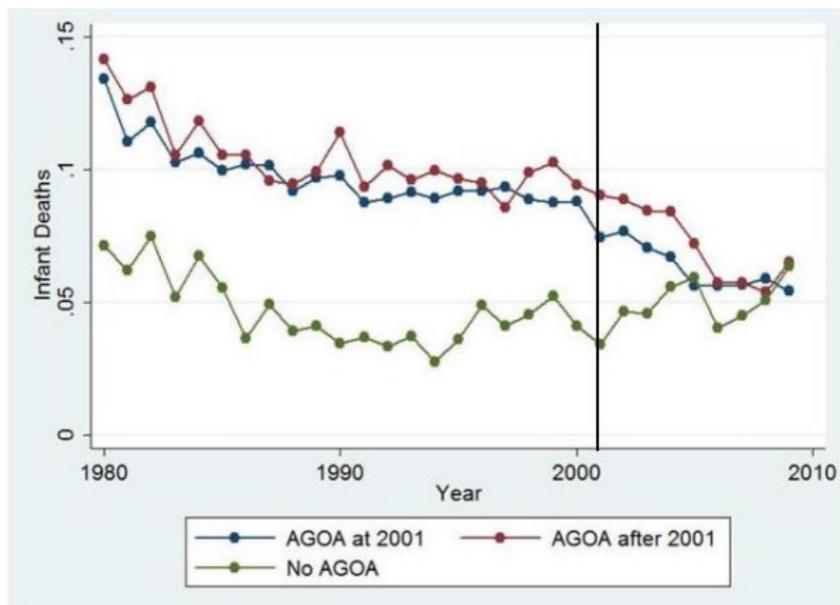
- Fertility Selection Effect: Mothers affected by AGOA in AGOA affected countries behave differently than mothers in non-AGOA countries, if they had been AGOA affected - possibly timing their birth [▶ Fertility](#)
- Fake AGOA Treatment [▶ Placebo Test](#)
- Dynamics of AGOA [▶ Dynamics](#)
- Early adopters vs. late adopters - Those who got AGOA in 2001 benefit more
- Different year of birth cutoffs
- Change in definition of "treatment" [▶ Robustness Table](#)
- Outliers - Dropping one country at a time [▶ Outliers](#)
- Country-specific birth order [▶ Birth Order](#)

# Conclusion

- Empirical study of the effect of trade on development has been limited, and in many cases confounding
- 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, by 9-12% of sample mean
- Mechanisms through which these effects take place are a shift of employment from agriculture to manual labor and managerial services and increased assets
- Analysis suggests that the income effect dominates the substitution effect of mother's opportunity cost of time

Thank You

# Infant Mortality Rates



**Figure:** 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.





# 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**<br>(0.0025) | -0.0071**<br>(0.0025)  | -0.0086***<br>(0.0026)  | -0.0087***<br>(0.0026) | -0.0066**<br>(0.0027) | -0.0086***<br>(0.0029) |
| Log GDP per capita            | -0.0099*<br>(0.0054)  |                        |                         |                        |                       |                        |
| Health expenditure per capita |                       | 0.00010**<br>(0.00004) |                         |                        |                       |                        |
| Paved Roads Access            |                       |                        | -0.00043**<br>(0.00016) |                        |                       |                        |
| Female LFPR                   |                       |                        |                         | -0.00032<br>(0.0007)   |                       |                        |
| Inequality                    |                       |                        |                         |                        | 0.000028<br>(0.00044) |                        |
| Fertility                     |                       |                        |                         |                        |                       | -0.00017<br>(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                 |

# Macro Heterogeneity

|                                  | (1)                     | (2)                     |
|----------------------------------|-------------------------|-------------------------|
| <b>Dependent Variable</b>        | <b>Infant Mortality</b> | <b>Infant Mortality</b> |
| <b>Apparel</b>                   | -0.00023<br>(0.0046)    |                         |
| <b>Oil</b>                       | 0.00142<br>(0.0034)     |                         |
| <b>Agricultural<br/>Products</b> | -0.0132***<br>(0.0031)  |                         |
| <b>Mineral and<br/>Ore</b>       | -0.0109**<br>(0.0048)   |                         |
| <b>Others</b>                    | -0.00764<br>(0.0057)    |                         |
| <b>East</b>                      |                         | -0.0181***<br>(0.0031)  |
| <b>West</b>                      |                         | -0.0064<br>(0.0038)     |
| <b>Central</b>                   |                         | -0.0055<br>(0.0043)     |
| <b>South</b>                     |                         | 0.0006<br>(0.0009)      |
| <b>F-Stat</b>                    | 4.40<br>(0.0066)        | 20.21<br>(0.00)         |
| <b>Number of Countries</b>       | 30                      | 30                      |
| <b>Number of Mothers</b>         | 212738                  | 212738                  |
| <b>Observations</b>              | 686093                  | 686093                  |

# Time and Country Heterogeneity

## Time effects:

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

## 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                |
| <b>Treatment</b>   | 0.0043<br>(0.0026)     | -0.0022<br>(0.0043)     | -0.0068**<br>(0.0027)  | -0.0148***<br>(0.0024) | 0.0029<br>(0.0044)     | -0.0089*<br>(0.0044)   |
|                    | (7)Congo               | (8)Congo, Dem.          | (11)Ghana              | (12)Guinea             | (13)Kenya              | (14)Lesotho            |
| <b>Treatment</b>   | -0.0154***<br>(0.0037) | -0.0019<br>(0.0033)     | 0.0175***<br>(0.0045)  | -0.0157***<br>(0.0039) | -0.0217***<br>(0.0043) | 0.0179***<br>(0.0044)  |
|                    | (16)Madagascar         | (17)Malawi              | (18) Mali              | (20)Namibia            | (21)Niger              | (22)Nigeria            |
| <b>Treatment</b>   | 0.0026<br>(0.0044)     | -0.00073<br>(0.0043)    | -0.0209***<br>(0.0042) | -0.00668<br>(0.0044)   | -0.0104**<br>(0.0042)  | 0.00858*<br>(0.0044)   |
|                    | (23)Rwanda             | (24)Sao Tome & Principe | (25)Senegal            | (26)Sierra Leone       | (27)Swaziland          | (28)Tanzania           |
| <b>Treatment</b>   | -0.0223***<br>(0.0043) | 0.0057<br>(0.0045)      | -0.0037<br>(0.0044)    | -0.0175***<br>(0.0030) | 0.0072<br>(0.0043)     | -0.0176***<br>(0.0044) |
|                    | (29)Zambia             |                         |                        |                        |                        |                        |
| <b>Treatment</b>   | -0.0186***<br>(0.0044) |                         |                        |                        |                        |                        |

# Heterogeneity by Child's Gender

|                       | (1)                   | (2)                   | (3)                   |
|-----------------------|-----------------------|-----------------------|-----------------------|
| Dependent Variable    | Infant Mortality      | Infant Mortality      | Infant Mortality      |
| AGOA                  | -0.0072**<br>(0.0028) | -0.0062**<br>(0.0026) | -0.0062**<br>(0.0025) |
| AGOA*Son              | -0.0017<br>(0.0012)   | -0.0017<br>(0.0017)   | -0.015<br>(0.0017)    |
| Son                   | 0.0138***<br>(0.0011) | 0.014***<br>(0.0011)  | 0.014***<br>(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                |

# Robustness Table

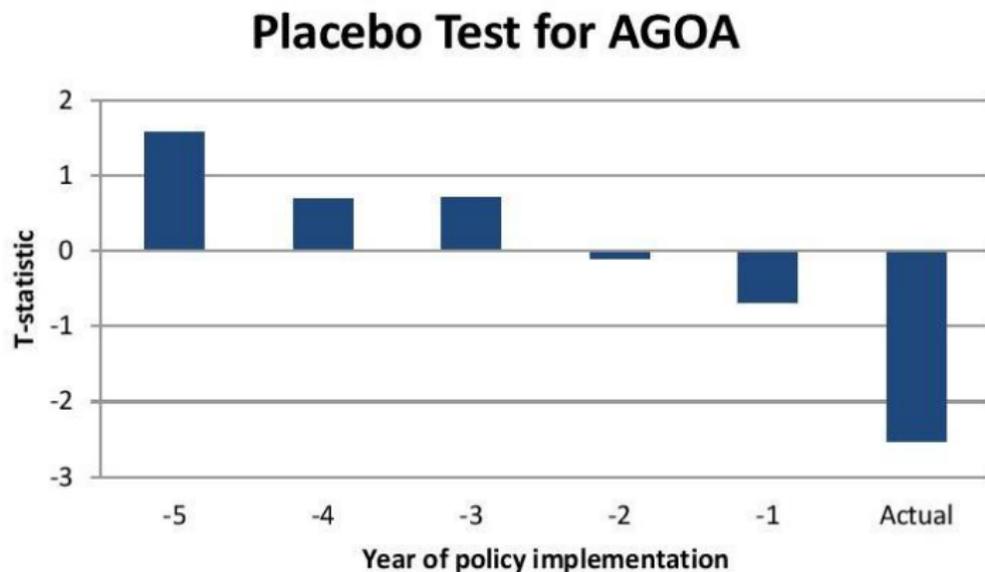
|                              | (1)                    |                     | (2)                         |                         | (3)                                |                        | (4)                          |
|------------------------------|------------------------|---------------------|-----------------------------|-------------------------|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

# Fertility

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

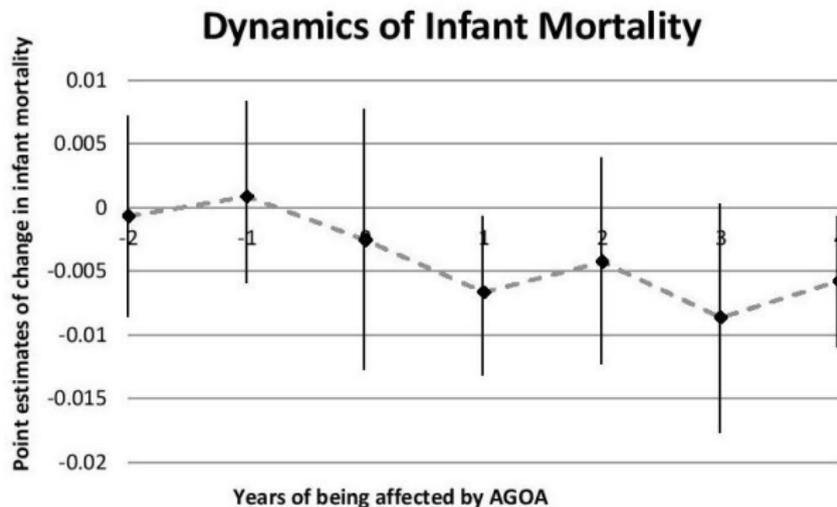
\*\*\* Significant at 1% level, \*\* significant at 5% level, \* significant at 10% level.



**Figure:** In each of the separate regressions, the effect of AGOA is estimated at false policy timings

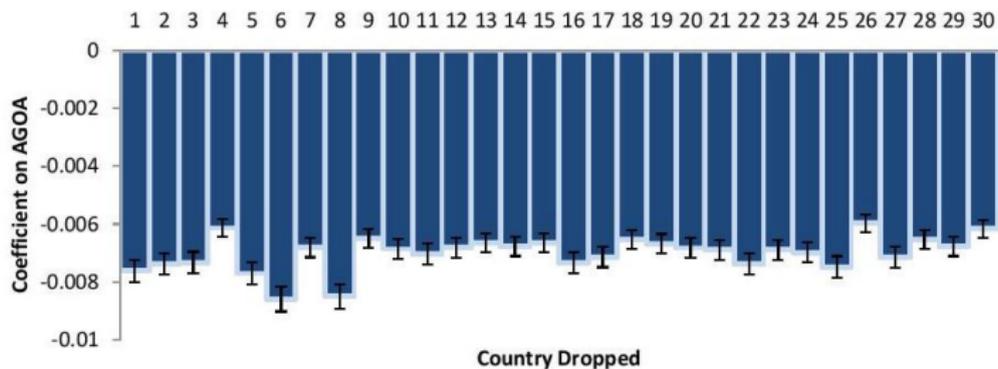
# Dynamics

- 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
- Change in infant mortality compared to three years before



# Drop one country at a time

## Robustness to dropping one country at a time



← Go Back

# Country-Specific Birth Order

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

# Dataset

| 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     |

- 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
- The sample average infant mortality rate is 8.15% of live births while the sample neonatal mortality rate is 3.8% of live births

▶ Infant Mortality Rates



# Data

| Country  | AGOA Year | Mother | Birth History |      |      |      |      |
|----------|-----------|--------|---------------|------|------|------|------|
|          |           |        | 1997          | 2000 | 2002 | 2005 | 2008 |
| Angola   | 2003      | M1     | 1             | 2    | 3    |      |      |
| Benin    | 2000      | M2     |               |      |      | 1    | 2    |
| Angola   | 2003      | M3     |               |      | 1    | 2    | 3    |
| Kenya    | 2000      | M4     | 1             |      |      | 2    |      |
| Zimbabwe | NA        | M5     |               | 1    |      | 2    |      |
| Liberia  | 2006      | M6     | 1             |      | 2    |      |      |

# Pathway Analysis Dataset

| 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                                    |