# What Makes a Trade Agreement Effective? The case of the AfCFTA

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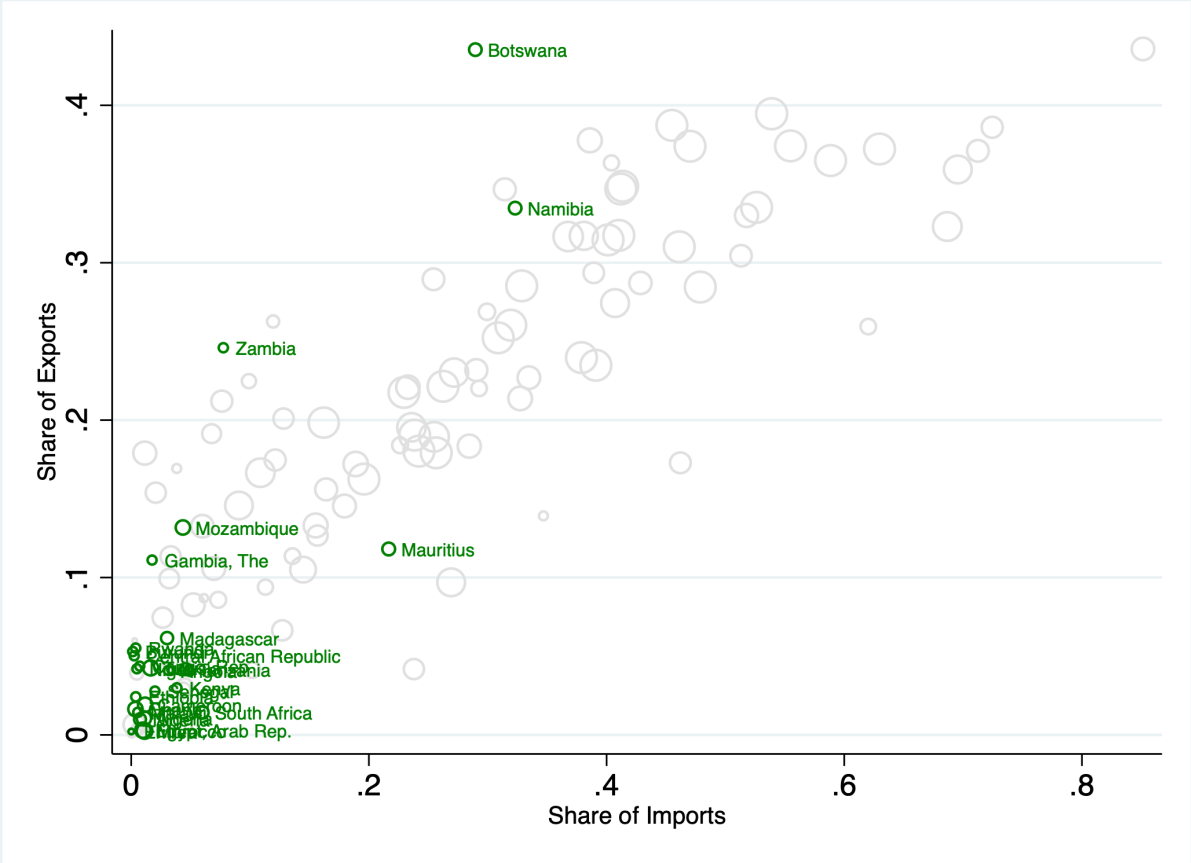
*Disclaimer:* The perspectives and opinions presented in this paper are solely those of the authors and do not necessarily represent the views of their respective institutions.

# Motivation

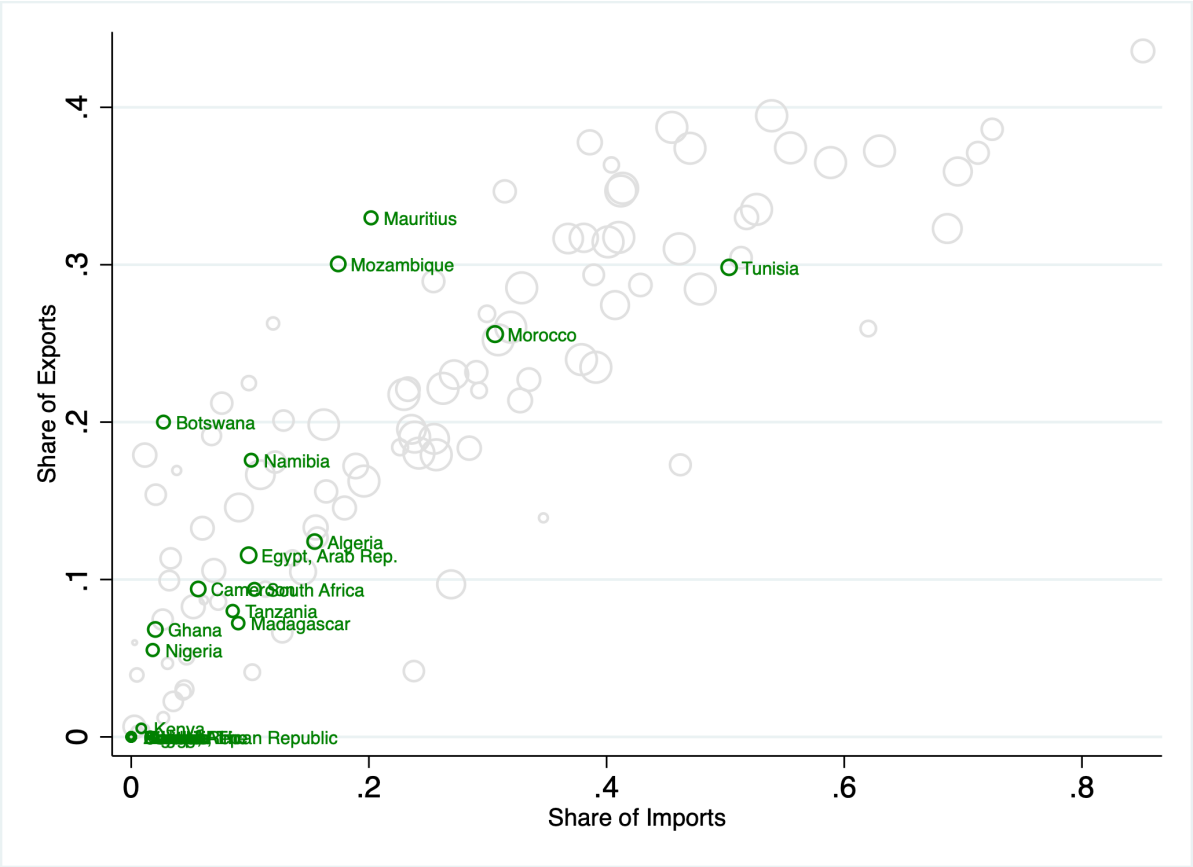
- The popularity of deep preferential trade agreements as instruments of trade diplomacy keeps growing, as is their scope.
- The signing of the African Continental Free Trade Area illustrates this trend and offers a unique laboratory to explore how provisions beyond tariff liberalization affect the ability of countries to participate in international trade and benefit from it.
- Evidence points out to greater elasticity of trade to deep preferential trade agreements (PTAs) compared to less ambitious efforts. Still, there is little guidance for policymakers on which specific policy areas and provisions contribute to achieving those objectives.
- https://datatopics.worldbank.org/dta/

# Figure 1: Share of African trade covered by intra Africa PTAs



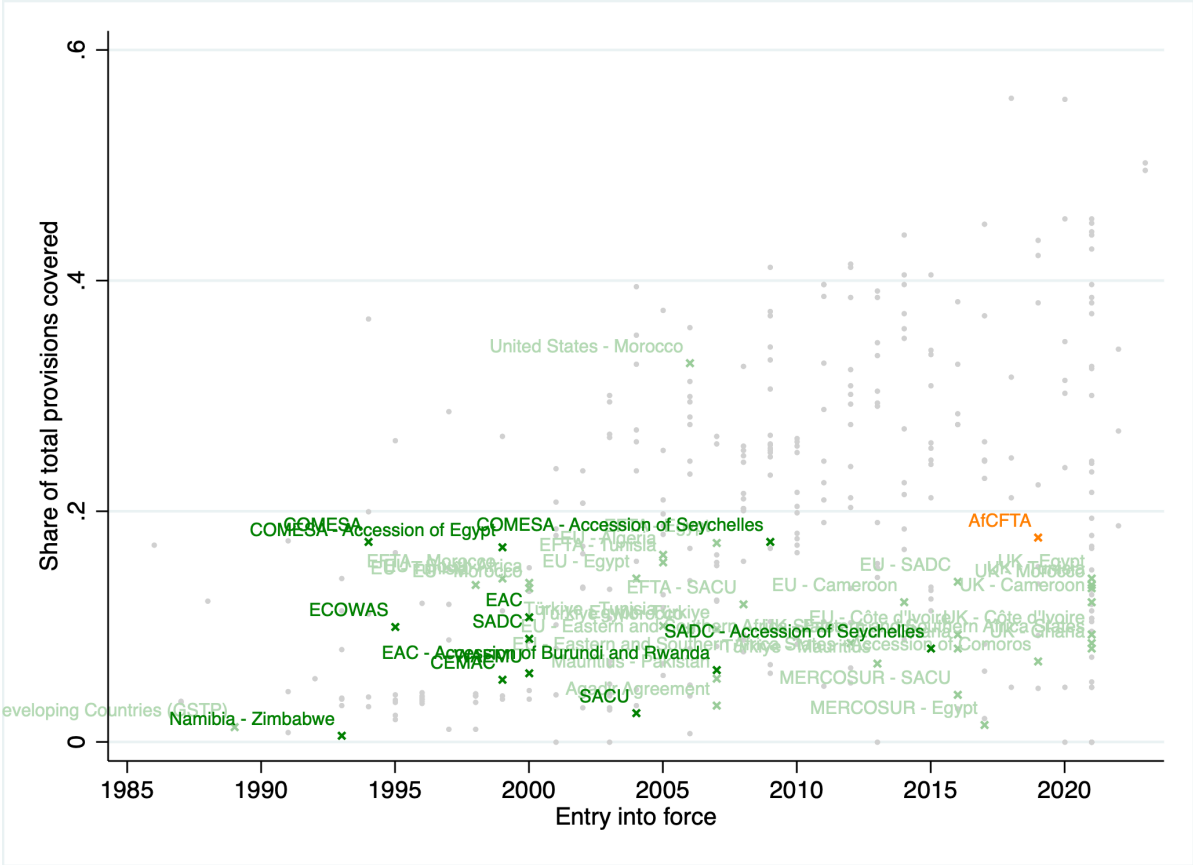

*Note:* The bubble size reflects the number of PTA partners. Authors' calculation based on manufacturing and agricultural trade data for 125 economies from UN Comtrade, UNIDO, and FAO Stat. Authors' calculation.

# Figure 2: Share of African trade covered by extra Africa PTAs




*Note:* The bubble size reflects the number of PTA partners. Authors' calculation based on manufacturing and agricultural trade data for 129 economies from UN Comtrade, UNIDO, and FAO Stat. Authors' calculation.

# Figure 3: Share of all provisions covered by Africa PTAs




*Note:* The y-axis indicates the share of provisions covered by each PTA, out of 1071 provisions. Agreements in green and grey are intra-Africa PTAs and, extra-Africa respectively. Authors' calculation based on the Deep PTA database.

# This paper

- Updates the results from Fontagné et al. (2023) identifying clusters of PTA agreements in the universe of world agreements based on their provision content. Reestimate the elasticities of individual clusters on trade and welfare.
- Evaluates the GE welfare impact of PTAs' for African economies and simulate the impact of the AfCFTA and of the deepening of PTAs.
- Explores new methodologies to identify the key policies that contribute to make a PTA deep.

# Clustering PTA based on their content

- We follow Fontagné et al. (2023) using a data-driven identification of classes of PTAs, unlike a simple count of provision methodology.
- We exploit an updated version of the Deep PTA database (World Bank), which codifies 372 PTAs along 18 policy areas (1071 distinct provisions)
- We add a feature relating to the enforceability of the agreement, identified by biding language or existence of dispute mechanisms.

▸ List of policy areas

- For each of the 18 policies a binary indicator indicates whether individual provisions are included in PTAs. Scores for each provision in each PTA are normalized by the mean across all PTA and then aggregated at the policy level using the simple average across all the provisions that are included in each of the 18 policies.

# Clustering PTA based on their content

- Using a clustering algorithm (kmeans++), we identify three optimal clusters of PTAs. Overall, 31 of the 372 agreements included in the database belongs to cluster #1, 183 to cluster #2, and 158 to cluster #3.
- Few agreements with zero or negative silhouette score, confirming that clusters are well defined. ▸ Silhouette scores

# Different PTA clusters, different impact on trade

- Based on the structural gravity model of trade, one can estimate the elasticity of different classes (clusters) of PTAs with the following specification using the PPML estimator:

$$X_{ijt} = exp[\beta_0 + \beta'_z(PTA^z_{ijt}) + \beta' OtherGravity'_{ijt} + \mu'_{it} + \sigma'_{jt} + \gamma'_{ij}] \times \epsilon_{ij}$$

- $\mu'_{it}$, $\sigma'_{jt}$, $\gamma'_{ij}$ are origin-year, destination-year and dyad FE respectively.
- $PTA^z_{ijt}$ are dummies for our three clusters of trade agreements.

▸ Details on trade data

# Table 1: Partial equilibrium estimates

| | (1) | (2) | (3) |
|---|---|---|---|
| Dependent variable: | Agri. Trade | Manuf. Trade | Combined Trade |
| #1 (Deep) | 0.922*** | 0.439*** | 0.449*** |
| | (0.116) | (0.050) | (0.050) |
| #2 (Medium) | 0.184 | 0.295*** | 0.299*** |
| | (0.121) | (0.066) | (0.064) |
| #3 (Shallow) | -0.031 | 0.099** | 0.093* |
| | (0.117) | (0.050) | (0.049) |
| Transitory PTA | -0.358 | 0.153** | 0.151** |
| | (0.295) | (0.065) | (0.063) |
| PSA | -0.250** | 0.004 | -0.003 |
| | (0.127) | (0.134) | (0.131) |
| Estimator | PPML | PPML | PPML |
| Country pair FE | ✓ | ✓ | ✓ |
| Origin × Year FE | ✓ | ✓ | ✓ |
| Destination × Year FE | ✓ | ✓ | ✓ |
| Observations | 417,309 | 589,998 | 590,185 |
| Pseudo $R^2$ | 0.99 | 0.99 | 0.99 |

*Note*: Clustered standard errors at the country-pair level are in parentheses. International border dummies (effect decreasing over time) are included in all specifications, capturing the globalization effects as in Bergstrand et al. (2015) and Yotov et al. 2016). * p-value $<$ 0.1, ** p-value $<$ 0.05, *** p-value $<$ 0.01.

# GE implications of new and deeper agreements in Africa.

- We follow Yotov et al. (2016) and Anderson et al. (2018) and perform a GE assessment of deepening existing African PTAs.
  ▸ More details
- We investigate three scenarios:

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  - The implementation of the AfCFTA as currently signed
  - The deepening of the AfCTA
  - The deepening of all existing agreements signed by African countries

# GE implications of new and deeper agreements in Africa.

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  ▸ More details
- We investigate three scenarios:
  - The implementation of the AfCFTA as currently signed
  - The deepening of the AfCTA
  - The deepening of all existing agreements signed by African countries
- Specifically, we simulate a deepening of the AfCFTA on trade and welfare.
- Caveat: We implicitly assume that Deepening a PTA only affects the iceberg variable trade costs (strong assumption to a given extent).

# GE analysis: results

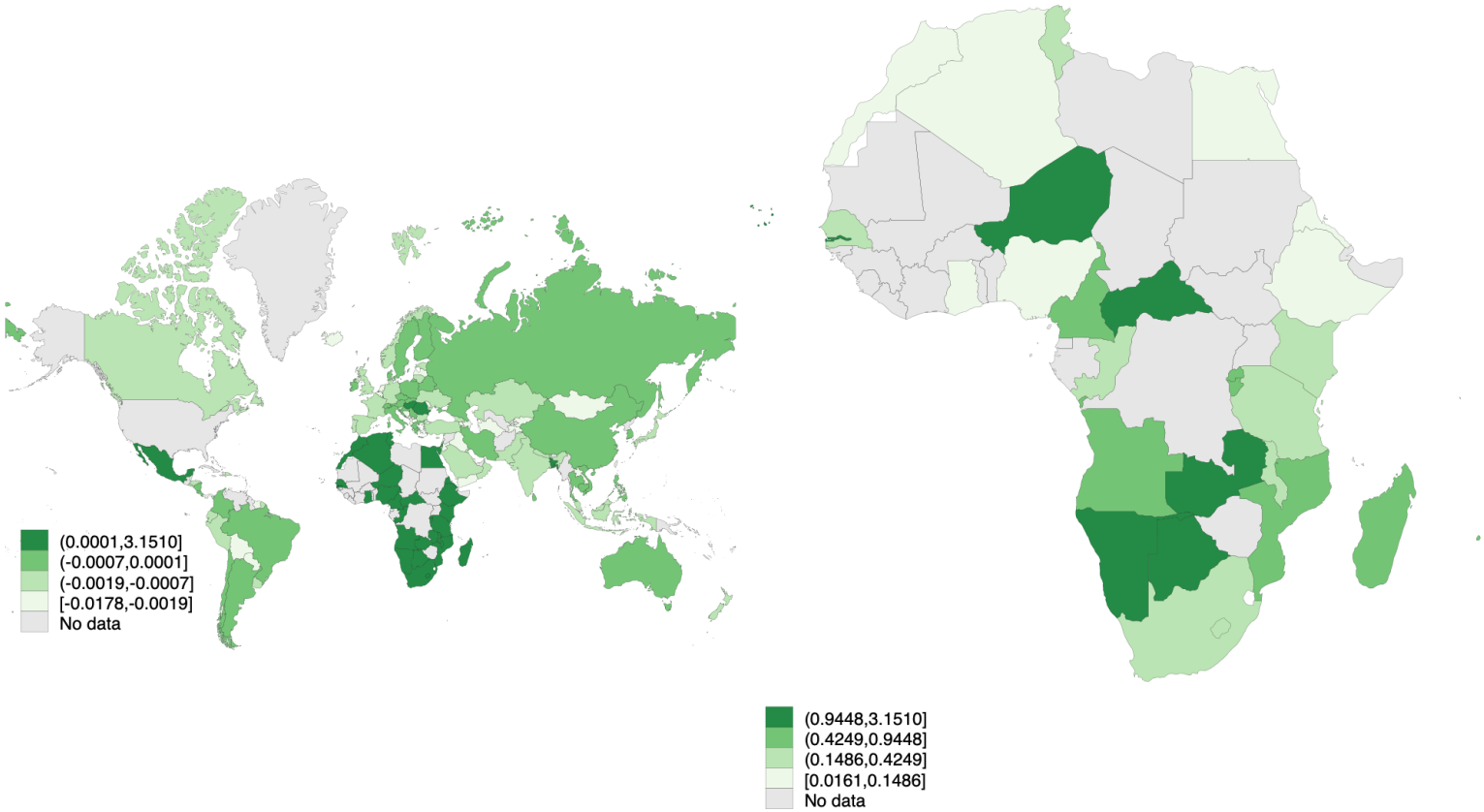
## Table 2: Impact of deepening AfCFTA on Trade and MRTs (Scenario 2)

| | X (Δ% Cdl) | X (Δ% Full) | F-G price (Δ% Full) | IMR (Δ% Full) | OMR (Δ% Full) |
|---|---|---|---|---|---|
| Algeria | 3.94 | 3.95 | 0.07 | -0.06 | -0.08 |
| Angola | 1.41 | 1.51 | 0.23 | -0.23 | -0.27 |
| Botswana | 1.66 | 2.12 | 0.57 | -2.51 | -0.68 |
| Burundi | 4.48 | 4.64 | 0.45 | -0.48 | -0.54 |
| Cameroon | 6.14 | 6.18 | 0.13 | -0.31 | -0.15 |
| Cape Verde | 1.42 | 2.04 | 0.91 | -0.04 | -1.08 |
| Central African Republic | 8.48 | 8.56 | 0.23 | -1.30 | -0.28 |
| Congo | 3.86 | 3.84 | -0.14 | -0.55 | 0.17 |
| Egypt | 2.14 | 2.13 | 0.13 | 0.07 | -0.16 |
| Eritrea | 0.02 | 0.04 | 0.03 | 0.01 | -0.03 |
| Ethiopia | 2.32 | 2.33 | -0.11 | -0.20 | 0.13 |
| Gambia | 1.96 | 2.61 | 0.90 | -0.68 | -1.08 |
| Ghana | 5.20 | 5.24 | -0.35 | -0.45 | 0.42 |
| Kenya | 4.54 | 4.59 | 0.04 | -0.15 | -0.05 |
| Madagascar | 2.90 | 2.96 | 0.21 | -0.26 | -0.26 |
| Malawi | 5.52 | 5.52 | -0.16 | -0.51 | 0.20 |
| Mauritius | 2.95 | 3.34 | 0.82 | -0.04 | -0.97 |
| Morocco | 1.10 | 1.10 | 0.06 | -0.00 | -0.07 |
| Mozambique | 6.11 | 6.13 | 0.02 | -0.67 | -0.03 |
| Namibia | 6.11 | 6.36 | 0.42 | -1.88 | -0.50 |
| Niger | 3.63 | 3.81 | 0.35 | -0.89 | -0.41 |
| Nigeria | 5.88 | 5.88 | -0.10 | -0.23 | 0.12 |
| Rwanda | 5.48 | 5.61 | 0.41 | -0.53 | -0.49 |
| Senegal | 4.74 | 4.75 | -0.10 | -0.41 | 0.12 |
| South Africa | 1.21 | 1.30 | 0.35 | 0.18 | -0.42 |
| Tanzania | 3.63 | 3.68 | 0.24 | -0.04 | -0.29 |
| Tunisia | 0.93 | 0.99 | 0.13 | -0.11 | -0.16 |
| Zambia | 2.15 | 2.43 | 0.41 | -1.10 | -0.49 |

*Note*: Values expressed in percentage. Are reported African economies only. Authors' calculations.

▸ Other scenarios

# Figure 4: AfcFTA Deepening Welfare Impact (Scenario 2)




▸ Other scenarios

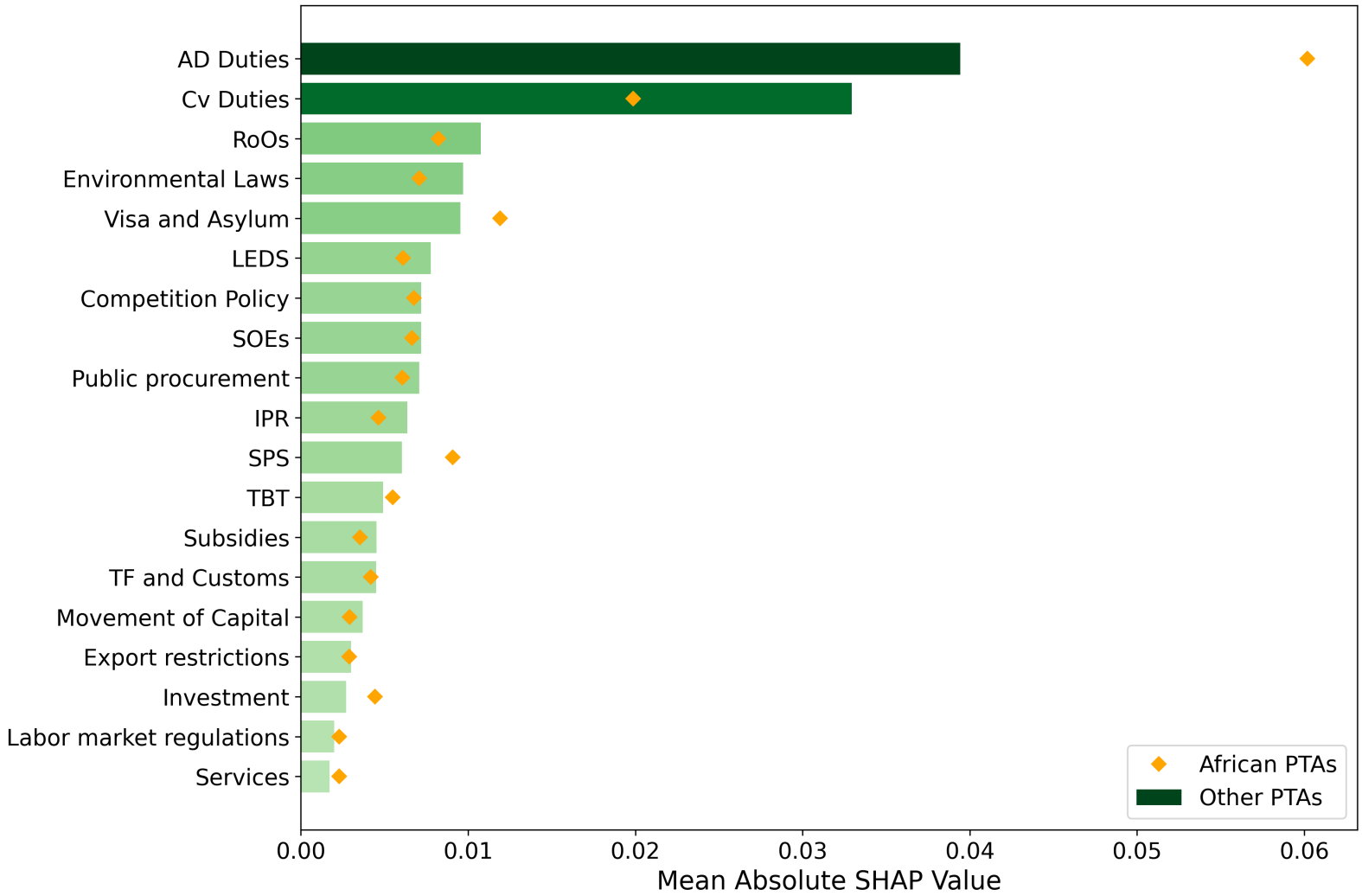
# Which policies are driving the probability of a PTA being 'Deep'?

- Identifying the importance of each policy in determining the PTA types is difficult due to multicollinearity issues.
- We first translate the clustering into a prediction model (Random forest/Logit), controlling for the decade of the agreement and share of Northern economies.
- We calculate Shapley values: the contributions of each policy toward determining the PTA type identified in the clustering.

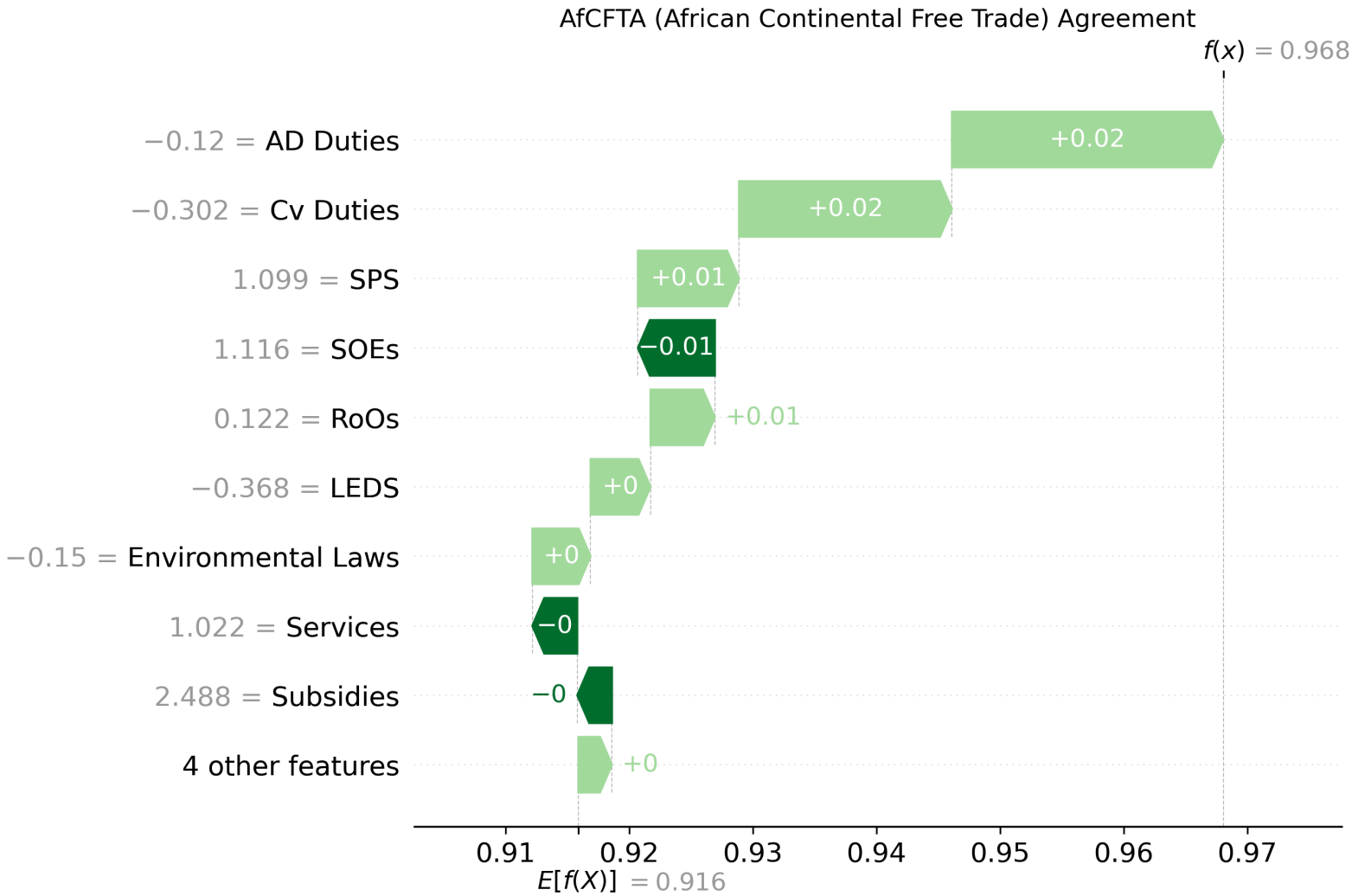
▸ Shapley values calculation ▸ Summary plot for African

- Shapley values vary for each PTA and provide guidance on the policies that make 'Deep' agreements.
- Shapley values are defined by two scores: **the marginal contribution** that a given characteristic **ambition** on the prediction that an agreement will be 'Deep' or 'non-Deep'.

## Figure 5: Mean absolute Shapley values for each policy area



# Figure 6: Shapley values for AfCFTA

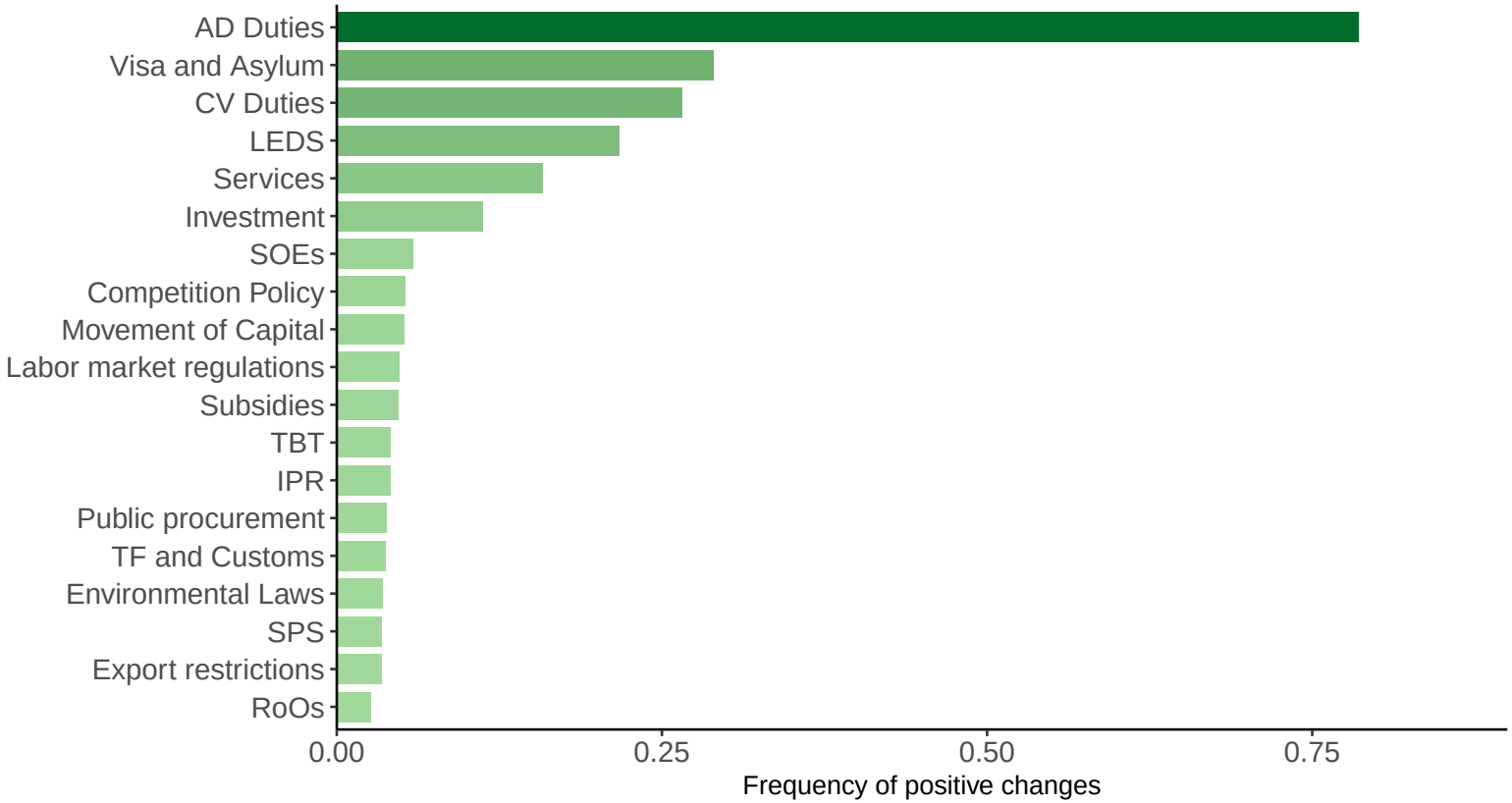



Note: Values in gray are the standardized score of each policy for the AfCFTA.

# Which policies are driving the probability of a PTA being 'Deep'? Going further

- A limitation of the Shapley value approach is that it falls short of identifying the possible compact of policies that could move PTAs from one cluster to the next.
- Use Multi Objective Counterfactual methodology to understand which policies are most often associated to a switch from a non-deep PTA to a Deep PTA.
- We implement Dandl et al. (2020) counterfactual explanation approach identifying what minimal policy changes would be needed to yield a different outcome (PTA classification). ▸ MOC methodology

## Figure 7: Frequency of inclusion of policies in MOCs




Note: The share is for each policy area the share of identified counterfactuals that include the policy in the PTA policy package

# Conclusion

- Large effect of 'Deep PTAs' on average, we confirm previous results with an extended PTA database and added legal enforcement dimension.
- Africa could benefit from deepening their PTA (0.6% GDP gains on average).
- We implement new techniques in the context of trade analysis to identify which policy areas matter for 'Deep' PTAs.
- Our analysis provides robust results suggesting that contingent protection disciplines, legal enforceability and policies favoring investment and movement of persons matter for 'Deep' agreements.
- Policy recommendations will vary for any individual PTAs and improving a single policy will not be sufficient to make a PTA 'Deep'.

THANK YOU

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# Appendix

# Robustness: IV strategy

- The instrument is constructed as follows:

$$Jaffe^{IV}_{ijt,z} = \left( \frac{\frac{1}{K}\sum_{k \neq j} Jaffe_{ikt-5,z} + \frac{1}{K}\sum_{k \neq i} Jaffe_{kjt-5,z}}{2} \right) \times 100$$

The two terms in parentheses represent, respectively, the mean similarity of country $i$ and country $j$ agreements of type $z$ with third countries, in periods up to $t-5$.The intuition being that the higher the Jaffe similarity of a given agreement with all others that pertain to $i$ and $j$ (i.e., the exact content, hence the copy-paste argument), the higher the probability of finding a type $z$ agreement between $ij$ in the future. ▸ Placebo-like checks

# Table 3: PTA types: IV strategy

| | (1) | (2) | (3) | (4) | (5) |
|---|---|---|---|---|---|
| Dependent variable: | Deep | Medium | Shallow | Combined Trade | |
| $Jaffe^{Deep}$ | 0.108*** | -0.011*** | -0.007*** | | |
| | (0.010) | (0.002) | (0.001) | | |
| $Jaffe^{Medium}$ | -0.008*** | 0.244*** | -0.011*** | | |
| | (0.002) | (0.026) | (0.001) | | |
| $Jaffe^{Shallow}$ | -0.003*** | -0.005*** | 0.098*** | | |
| | (0.000) | (0.000) | (0.005) | | |
| $\hat{v}^{Deep}$ | | | | | -0.036 |
| | | | | | (0.150) |
| $\hat{v}^{Medium}$ | | | | | -0.075 |
| | | | | | (0.067) |
| $\hat{v}^{Shallow}$ | | | | | -0.081 |
| | | | | | (0.052) |
| Deep | | | | 0.502*** | 0.468*** |
| | | | | (0.086) | (0.105) |
| Medium | | | | 0.131** | 0.345*** |
| | | | | (0.057) | (0.058) |
| Shallow | | | | 0.067 | 0.127* |
| | | | | (0.043) | (0.047) |
| Transitory PTA | -0.287*** | -0.047*** | 0.022** | 0.022 | 0.165* |
| | (0.030) | (0.018) | (0.011) | (0.157) | (0.086) |
| PSA | 0.004 | -0.185*** | -0.025*** | 0.186*** | 0.010 |
| | (0.003) | (0.012) | (0.009) | (0.058) | (0.154) |
| Estimator | First-stage OLS | First-stage OLS | First-stage OLS | Second-stage OLS | Control function PPML |
| Country pair FE | ✓ | ✓ | ✓ | ✓ | ✓ |
| Origin × Year FE | ✓ | ✓ | ✓ | ✓ | ✓ |
| Destination × Year FE | ✓ | ✓ | ✓ | ✓ | ✓ |
| Observations | 590,185 | 590,185 | 590,185 | 590,185 | 590,185 |
| F-stat | 141.44 | 133.08 | 206.51 | / | / |
| $R^2$ | | | | | |

# Table A1: List of Policy areas

| **Policy area** | **Code** |
|---|---|
| Antidumping Duties | 1 |
| Competition Policy | 2 |
| Countervailing Duties | 3 |
| Environmental Laws | 4 |
| Export Restrictions | 5 |
| Intellectual Property Rights (IPR) | 6 |
| Investment | 7 |
| Enforceability | 8 |
| Labor Market Regulations | 9 |
| Movement of Capital | 10 |
| Public Procurement | 11 |
| Rules of Origin | 12 |
| Sanitary and Phytosanitary Measures (SPS) | 13 |
| Services | 14 |
| State Owned Enterprises | 15 |
| Subsidies | 16 |
| Technical Barriers to Trade (TBT) | 17 |
| Trade Facilitation and Customs | 18 |
| Visa and Asylum | 19 |

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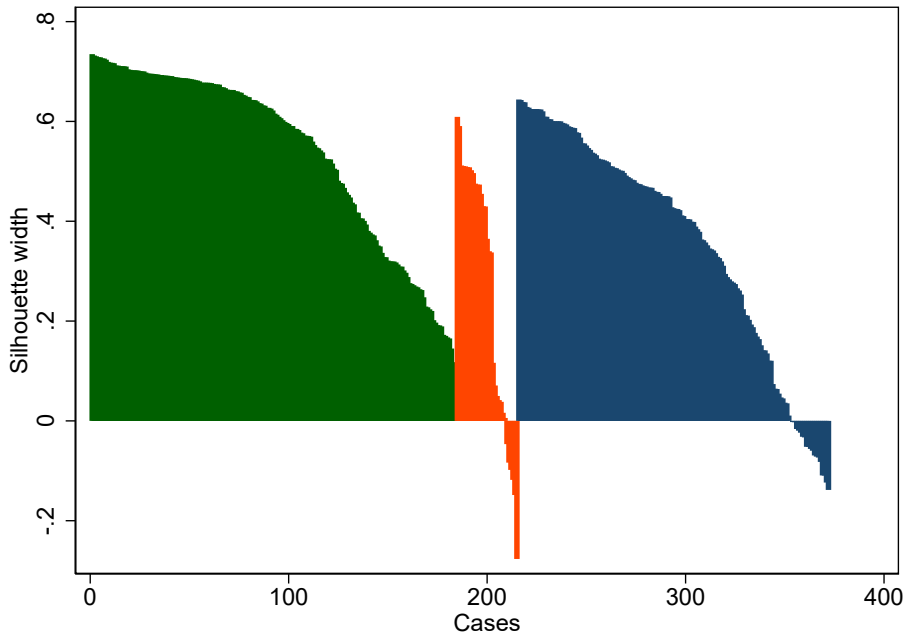
# Figure A1: Silhouette score




*Note:* The silhouette score evaluates clustering quality by maximizing the Euclidean distance between clusters (separation) while minimizing the distance within the same cluster (cohesion), ranging from -1 (poor clustering) to 1 (well-separated clusters).

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# Trade data

- Balanced bilateral trade data on agriculture and manufacturing from FAO Stat and UNIDO, including intra-country trade (Gross output - Total exports). 140 countries (29 African), from 1986 to 2022.
- Additional gravity controls from CEPII data (e.g. Joint WTO membership)

# Trade data

- To ensure wide coverage and to replace some missing values, we proceeded in two steps. First, we linearly interpolated production values between available data points. Second, for remaining gaps, we extrapolate production values based on the ratio of agricultural to manufacturing production in the nearest available year.
- For example, if Chile had missing data for domestic agricultural sales in 2012, but reported manufacturing sales for the same year, the ratio of agricultural to manufacturing production from 2013 would be used. This ratio would then be multiplied by the 2012 manufacturing sales figure to approximate the missing agricultural sales value.
- In addition, to maximize coverage, missing import declarations were imputed using mirror flows.
- Final dataset of 140 countries, including 29 in sub-Saharan Africa, with annual observations from 1986 to 2022.

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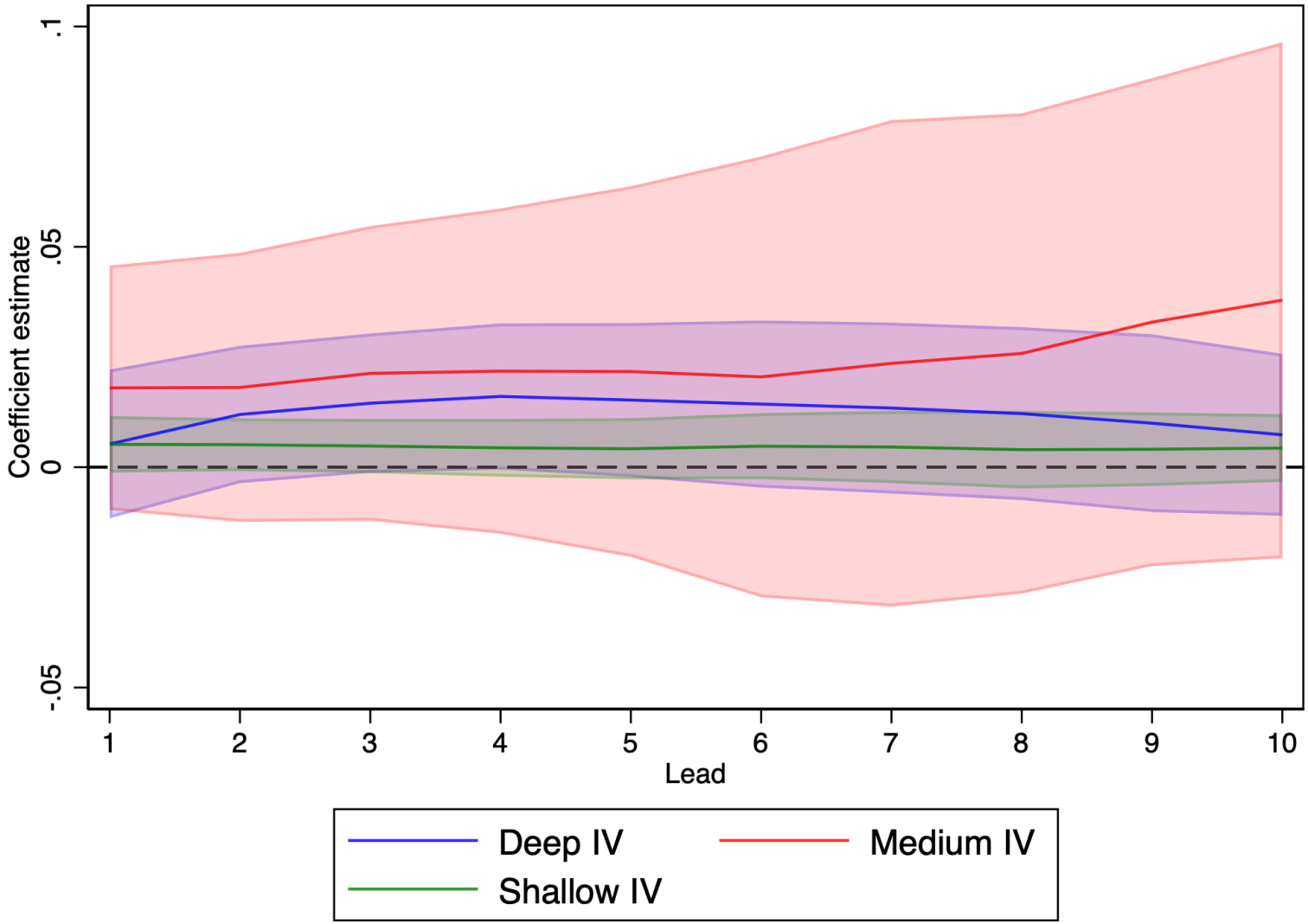
## Figure A2: Effect of lead instruments on trade.




*Note:* Authors' calculation. Confidence interval at the 95% level.

# GE-PPML framework

- We depart from the structural gravity system of equation:

$$X_{ij} = \frac{Y_i E_j}{Y} \left( \frac{t_{ij}}{\Pi_i P_j} \right)^{1-\sigma}$$

$$P_j^{1-\sigma} = \sum_i \left( \frac{t_{ij}}{\Pi_i} \right)^{1-\sigma} \frac{Y_i}{Y}$$

$$\Pi_i^{1-\sigma} = \sum_j \left( \frac{t_{ij}}{P_j} \right)^{1-\sigma} \frac{E_j}{Y}$$

$$p_i = \left( \frac{Y_i}{Y} \right)^{\frac{1}{1-\sigma}} \frac{1}{\alpha_i \Pi_i}$$

$$E_i = \varphi_i Y_i = \varphi_i p_i Q_i$$

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# GE-PPML framework

- The econometric counterpart of $X_{ij}$ in PPML:

$$X_{ij} = exp[\beta_0 + \beta_z'(PTA_{ij}^z) + \beta' OtherGravity_{ij}' + \mu_i' + \sigma_j' + \gamma_{ij}'] \times \epsilon_{ij}$$

- Unique properties of the PPML dictate that the terms $\mu_i'$ and $\sigma_j'$ exactly identify the MRTs (Anderson et al. 2015).
- In short, we constrain the elasticity obtained for each PTA type and re-predict the model by changing the PTA classification of the AfCFTA. Next, we solve the model with the new trade values.

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# GE-PPML framework

- A change in the trade cost $\downarrow t_{ij}$ will affect the $\downarrow MRTs$,$\uparrow$ factory gate prices, and ultimately $\uparrow$ expenditure and $\uparrow$ output.
- However, changes in output and expenditure further affect the MRTs, and the factory-gate prices, and so on.
- Once the model stabilizes, we can compute changes in output before and after the shock, this constitutes our welfare gains from trade ($Y_i^{full} = \Delta p_i * Y_i^{baseline}$).

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# GE analysis: results

## Table A2: Impact of AfCFTA on Trade and MRTs (Scenario 1)

| | X (Δ% Cdl) | X (Δ% Full) | F-G price (Δ% Full) | IMR (Δ% Full) | OMR (Δ% Full) |
|---|---|---|---|---|---|
| Algeria | 1.74 | 1.74 | 0.03 | -0.03 | -0.04 |
| Angola | 0.34 | 0.39 | 0.11 | -0.00 | -0.13 |
| Botswana | 0.05 | 0.11 | 0.08 | 0.01 | -0.09 |
| Burundi | 0.40 | 0.47 | 0.19 | 0.11 | -0.23 |
| Cameroon | 2.39 | 2.40 | -0.01 | -0.17 | 0.01 |
| Cape Verde | 0.64 | 0.91 | 0.41 | -0.01 | -0.49 |
| Central African Republic | 3.20 | 3.27 | 0.21 | -0.35 | -0.25 |
| Congo, Rep. | 1.71 | 1.71 | -0.06 | -0.24 | 0.07 |
| Egypt | 0.34 | 0.34 | 0.05 | 0.04 | -0.05 |
| Eritrea | -0.45 | -0.69 | -0.34 | 0.01 | 0.41 |
| Ethiopia | 0.50 | 0.50 | -0.01 | -0.03 | 0.01 |
| Gambia | 0.89 | 1.17 | 0.41 | -0.30 | -0.48 |
| Ghana | 2.31 | 2.33 | -0.15 | -0.20 | 0.19 |
| Kenya | -0.22 | -0.20 | -0.06 | -0.06 | 0.08 |
| Madagascar | 0.25 | 0.28 | 0.12 | 0.08 | -0.14 |
| Malawi | 0.33 | 0.33 | 0.15 | 0.13 | -0.17 |
| Mauritius | -0.34 | -0.36 | -0.05 | 0.04 | 0.06 |
| Morocco | 0.48 | 0.48 | 0.03 | 0.00 | -0.03 |
| Mozambique | 0.99 | 1.02 | 0.16 | 0.06 | -0.20 |
| Namibia | 0.45 | 0.54 | 0.19 | 0.04 | -0.23 |
| Niger | 1.62 | 1.69 | 0.16 | -0.38 | -0.19 |
| Nigeria | 2.61 | 2.62 | -0.04 | -0.10 | 0.05 |
| Rwanda | 1.03 | 1.08 | 0.18 | 0.01 | -0.22 |
| Senegal | 2.05 | 2.06 | -0.05 | -0.18 | 0.06 |
| South Africa | 0.21 | 0.22 | 0.06 | 0.03 | -0.07 |
| Tanzania | 0.34 | 0.35 | 0.02 | -0.00 | -0.03 |
| Tunisia | 0.41 | 0.44 | 0.06 | -0.05 | -0.07 |
| Zambia | -0.01 | 0.01 | 0.03 | 0.04 | -0.04 |

*Note*: Values expressed in percentage. Are reported African economies only. Authors' calculations.

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# GE analysis: results

## Table A3: Impact of Deepening all intra and extra African PTAs on Trade and MRTs (Scenario 3)

| | X (Δ% Cdl) | X (Δ% Full) | F-G price (Δ% Full) | IMR (Δ% Full) | OMR (Δ% Full) |
|---|---|---|---|---|---|
| Algeria | 47.27 | 46.49 | -0.60 | -2.21 | 0.72 |
| Angola | 1.09 | 1.26 | 0.17 | -0.18 | -0.20 |
| Botswana | 2.62 | 4.33 | 1.74 | -3.20 | -2.05 |
| Burundi | 3.74 | 3.97 | 0.26 | -0.51 | -0.31 |
| Cameroon | 22.81 | 23.23 | 0.24 | -1.41 | -0.29 |
| Cape Verde | 1.09 | 1.71 | 0.71 | 0.00 | -0.84 |
| Central African Republic | 7.75 | 7.77 | 0.03 | -1.36 | -0.03 |
| Congo | 3.16 | 3.03 | -0.20 | -0.55 | 0.24 |
| Egypt | 32.68 | 31.43 | -0.69 | -1.64 | 0.84 |
| Eritrea | -0.34 | -0.53 | -0.27 | -0.04 | 0.33 |
| Ethiopia | 0.89 | 0.92 | -0.12 | -0.16 | 0.14 |
| Gambia | 1.63 | 2.25 | 0.71 | -0.59 | -0.84 |
| Ghana | 40.23 | 39.00 | -0.69 | -1.56 | 0.84 |
| Kenya | 3.22 | 3.37 | -0.03 | -0.16 | 0.03 |
| Madagascar | 5.98 | 6.24 | 0.25 | -0.73 | -0.29 |
| Malawi | 4.60 | 4.39 | -0.24 | -0.54 | 0.29 |
| Mauritius | 6.66 | 7.60 | 1.00 | -0.97 | -1.19 |
| Morocco | 24.94 | 25.39 | 0.26 | -1.20 | -0.31 |
| Mozambique | 25.84 | 26.59 | 0.63 | -2.40 | -0.75 |
| Namibia | 8.96 | 10.14 | 1.22 | -2.17 | -1.45 |
| Niger | 3.31 | 3.50 | 0.17 | -0.96 | -0.20 |
| Nigeria | 25.03 | 23.79 | -0.73 | -1.29 | 0.88 |
| Rwanda | 4.60 | 4.80 | 0.22 | -0.56 | -0.26 |
| Senegal | 3.85 | 3.78 | -0.12 | -0.37 | 0.14 |
| South Africa | 5.00 | 5.44 | 0.35 | -0.35 | -0.42 |
| Tanzania | 20.39 | 21.41 | 0.73 | -0.85 | -0.86 |
| Tunisia | 11.56 | 12.87 | 1.44 | -1.75 | -1.70 |
| Zambia | 1.90 | 2.11 | 0.25 | -1.08 | -0.30 |

*Note*: Values expressed in percentage. Are reported African economies only. Authors' calculations.

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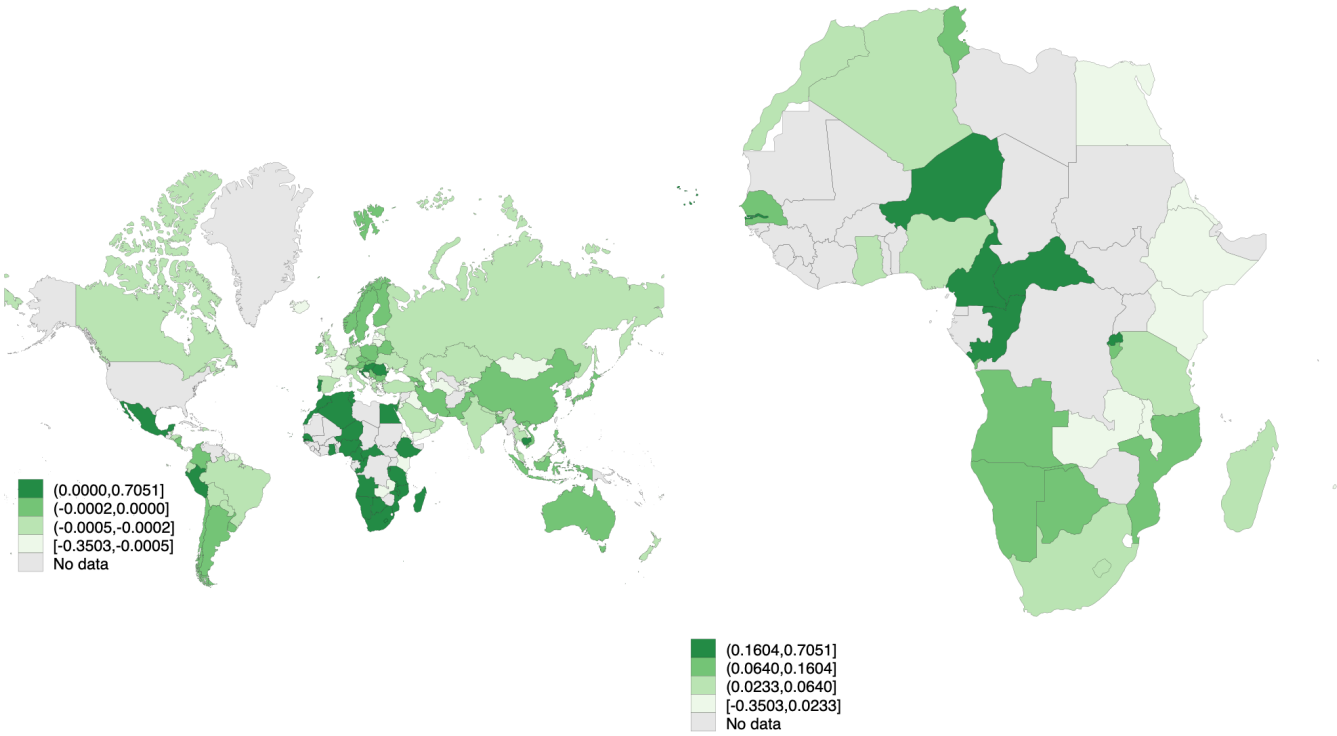
# Figure A3: Welfare gains from trade: AfCFTA implementation (Scenario 1)




*Note:* Increase in real GDP (full endowment GE effects). Highest gain for Niger, CAF, Namibia, Zambia, and The Gambia.

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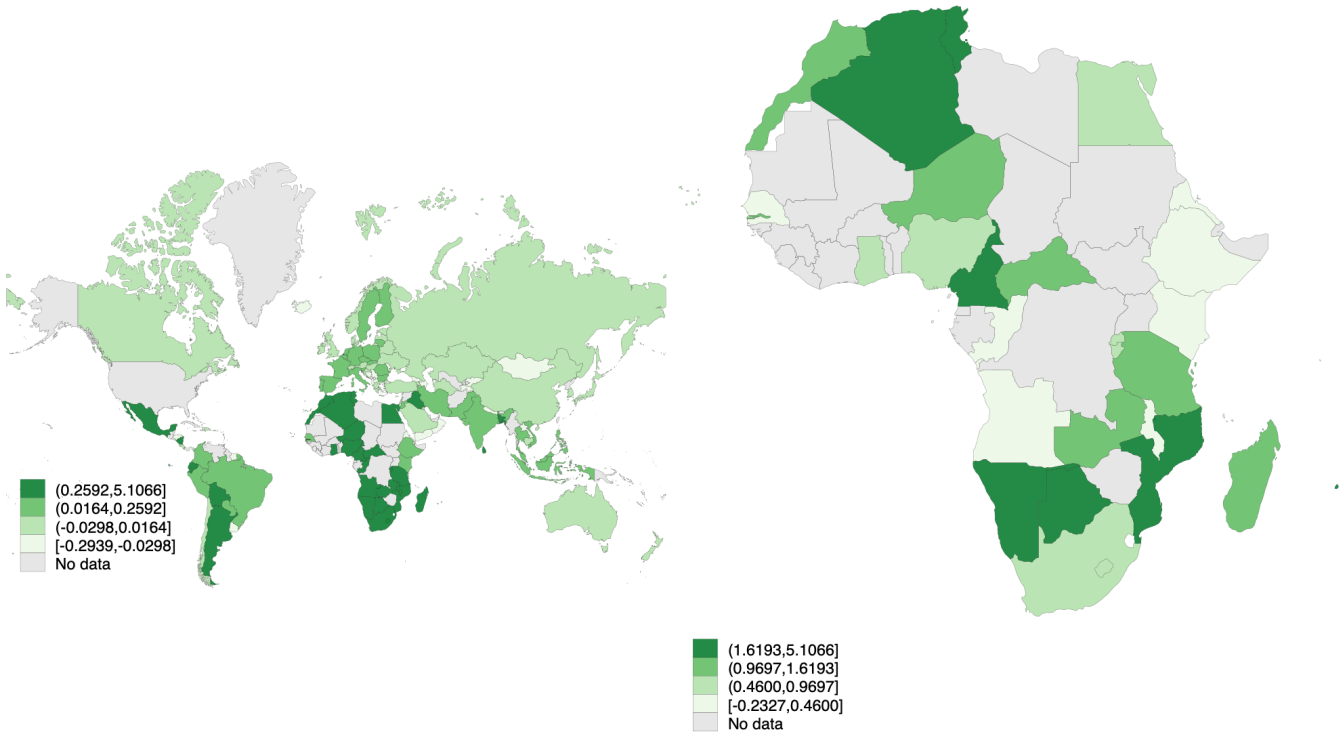
# Figure A4: All African PTAs (Scenario 3)

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# SHAP Values: Explaining policy importance

- It quantifies the marginal contribution of each policy area to the predicted outcome:

$$f(x) = f_0 + \sum_{i=1}^{n} \phi_i$$

- The SHAP value $\phi_i$ for a policy area $x_i$ is computed as:

$$\phi_i = \sum_{S \subseteq N \setminus \{i\}} \frac{|S|!(|N| - |S| - 1)!}{|N|!} [f(S \cup \{i\}) - f(S)]$$

- The formula evaluates every possible policy combination to compute fair contributions of each policy area.
- $[f(S \cup \{i\}) - f(S)]$ is the marginal effect of policy $x_i$ if added to the subset of policy S.
- The weighting term ensures fair averaging by accounting for all possible policy orderings.

- We apply SHAP values in a random forest prediction model to predict PTA depth (controlling for the decade of the agreement and share of north economies).
- Each SHAP value $\phi_i$ measures how much a policy increases or decreases the probability of belonging to a given PTA cluster.
- Example: The SHAP value for **Investment Policy** for a given PTA is:

$$\phi_{\text{inv}} = \sum_{S \subseteq N \setminus \{\text{inv}\}} \frac{|S|!(|N| - |S| - 1)!}{|N|!} [f(S \cup \{\text{inv}\}) - f(S)]$$

- The results are robust using a Logit model

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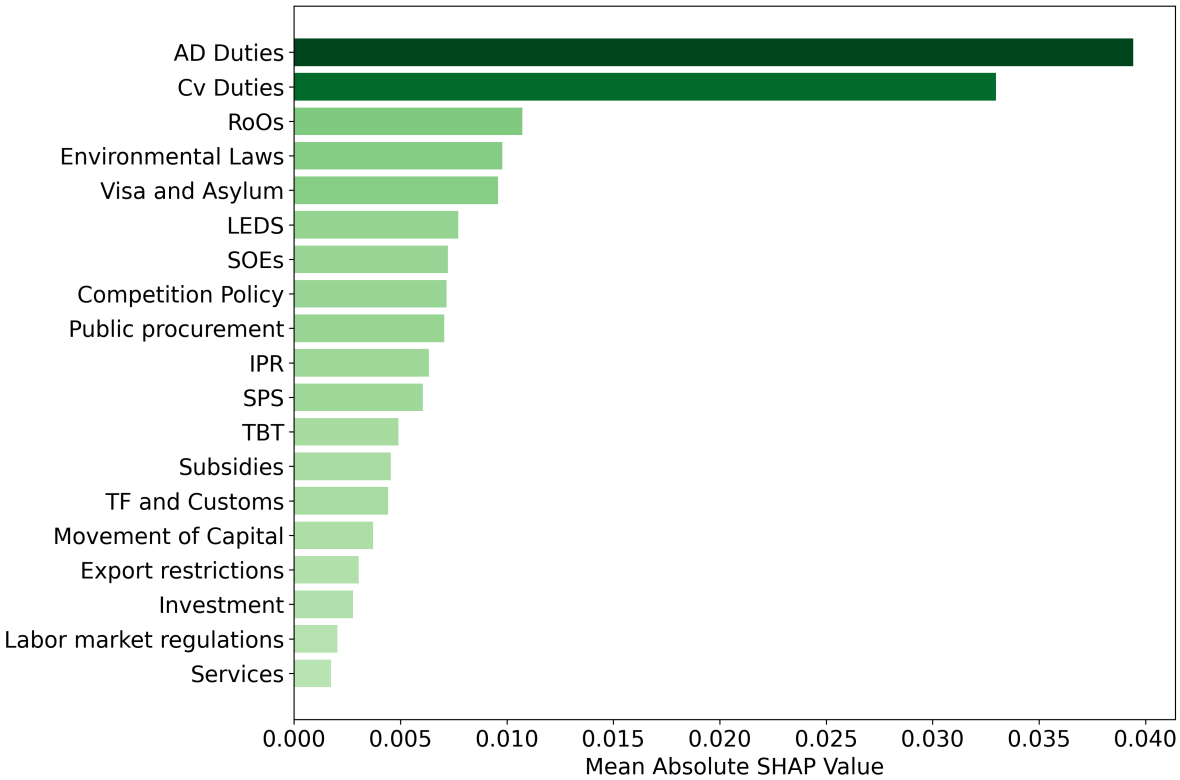
# Figure A5: Policies driving PTA types




*Note:* Average of shapley values by PTA types.

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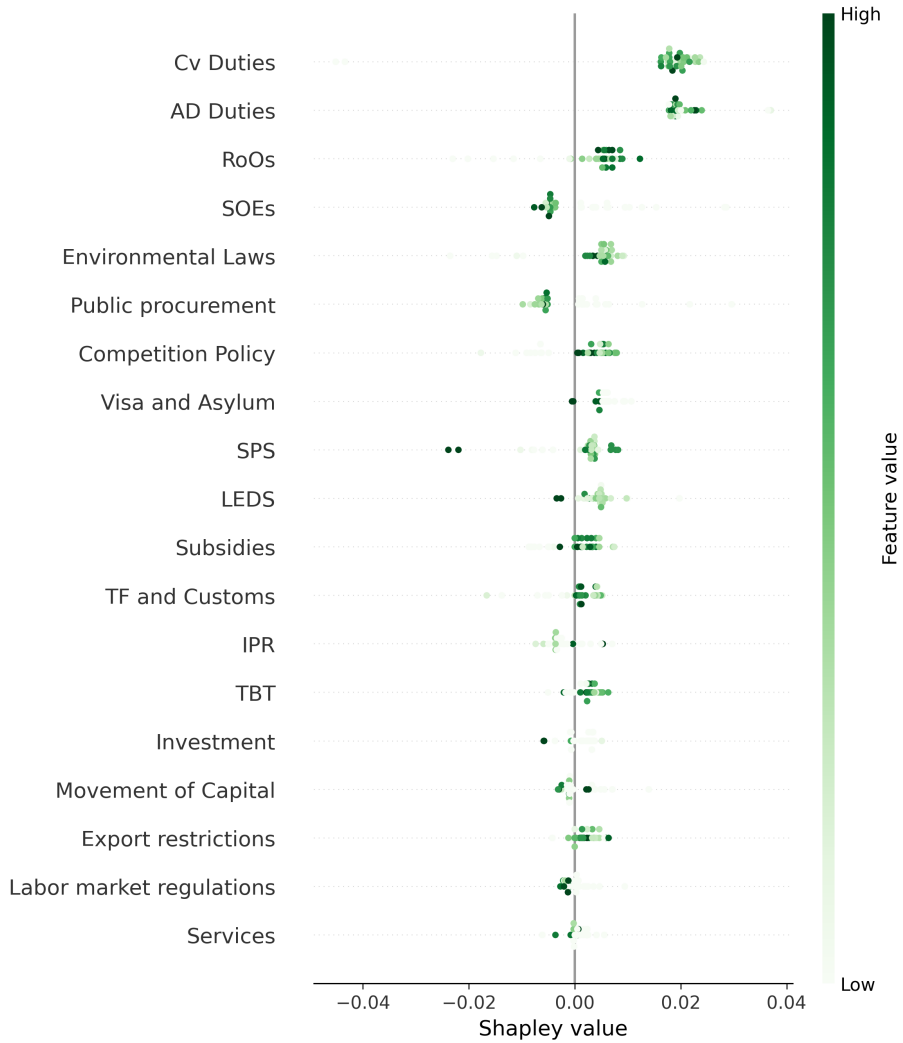
# Figure A6: Summary plot for all African shallow and medium PTAs




Interpretation: Low values (light green) of AD duties or SOEs pushed the agreement towards non-Deep classification.

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# Multi-objective counterfactuals

We seek to minimize this multi-objective function when looking for counterfactuals solutions (details for each subcomponents in Dandl et al. 2020):

$$\min o(x) = \min(o_1, o_2, o_3, o_4)$$

- Prediction Proximity, $o_1$: The prediction is close to the desired outcome ('Deep' in our case).
- Feature Proximity, $o_2$: The counterfactual is close to the original observation in the feature space.
- Sparsity, $o_3$: The counterfactual differs in only a few features.
- Plausibility, $o_4$: A plausible data point according to the probability distribution. This ensures that the counterfactual is realistic and likely to occur in the real world.

The optimal balance in this multi-objective optimization problem is typically found using the Pareto front, which consists of solutions that cannot be improved in one objective without worsening another. This means that there isn't a single "best" counterfactual explanation, but rather a set of optimal trade-offs (non-dominated solutions).

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## Table A4: MOC for AfCFTA: Frequency of changes by policy

| Policy | Negative | Unchanged | Positive |
|---|---|---|---|
| AD Duties | 0.00 | 16.28 | 83.72 |
| Competition policy | 0.00 | 100.00 | 0.00 |
| CV Duties | 0.00 | 65.12 | 34.88 |
| Environmental laws | 4.65 | 93.02 | 2.33 |
| Export restrictions | 0.00 | 100.00 | 0.00 |
| IPR | 6.98 | 93.02 | 0.00 |
| Investment | 6.98 | 93.02 | 0.00 |
| LEDS | 2.33 | 76.74 | 20.93 |
| Labor market regulations | 0.00 | 100.00 | 0.00 |
| Movement of capital | 4.65 | 95.35 | 0.00 |
| Public procurement | 2.33 | 95.35 | 2.33 |
| RoOs | 0.00 | 100.00 | 0.00 |
| SPS | 0.00 | 97.67 | 2.33 |
| Services | 2.33 | 97.67 | 0.00 |
| SOEs | 0.00 | 90.70 | 9.30 |
| Subsidies | 0.00 | 100.00 | 0.00 |
| TBT | 2.33 | 97.67 | 0.00 |
| TF and Customs | 4.65 | 93.02 | 2.33 |
| Visa and Asylum | 0.00 | 90.70 | 9.30 |

*Note*: Authors' calculation based on Dandl et al. (2020) methodology. The total number of counterfactuals is 43.