Impact of Special Economic Zones on Export Diversification in Sub-Saharan Africa

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Abstract

Export diversification is a major concern for policymakers in Sub-Saharan Africa (SSA). Over the past 30 years, many countries of the region have adopted special economic zone (SEZ) programs with the aim of fostering industrial development and export-led growth. By offering various pro-investment incentives, SEZs are expected to contribute to the improvement of the business climate and attract firms from traditional and new sectors. This study analyses the impact of SEZ adoption on overall export diversification and on extensive and intensive margins in the SSA region. For that purpose, a difference-in-differences approach has been implemented on a panel of 32 SSA countries covering the period 1970-2014. It appears that SEZ adoption has contributed to balancing export shares more equally among traditional sectors, resulting in greater export diversification in these countries. However, this policy tool has appeared to be less effective in fostering the creation of new activity sectors.

Keywords: SEZ, export diversification, difference-in-differences, TWFE

1. Introduction

Export diversification is a recurrent preoccupation and objective for policymakers in developing countries, especially those endowed with abundant natural resources (Cadot et al., 2011). This is because greater levels of export diversification tend to be associated with enhanced growth. Indeed, as export earnings are gathered from a wider range of sectors, countries protect themselves from volatility in GDP growth, employment rate and real exchange rate, which can be detrimental for social welfare and domestic productivity in traded sectors. Beyond these nice portfolio features, the path to greater degrees of diversification is also linked with enhanced learning by doing in a growing number of sectors. This is found to foster steady long-run growth (Agosin, 2008).

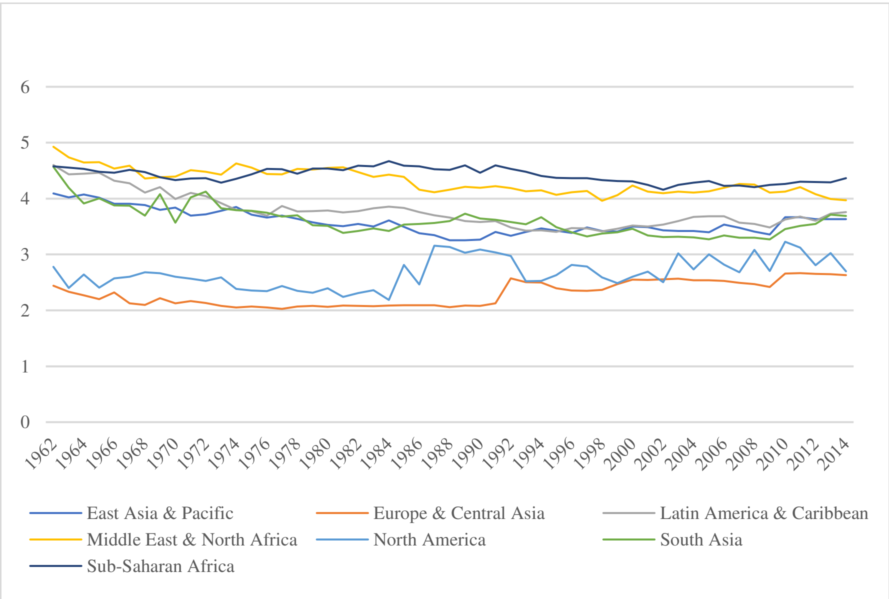

Figure 1. Theil index of export concentration per region. Source: IMF

Figure 1 displays the evolution of the Theil index measuring export concentration developed by Cadot et al. (2011) averaged by region over the period 1962-2014. The lowest levels of export concentration are observed in the Europe & Central Asia region with a mean of 2.37 for the period observed, followed by North America with a mean of 2.67. However, these two regions experienced trends of re-specialisation in the 1990s and in the 1980s, respectively. This is consistent with the U-shaped pattern in specialisation observed by Imbs & Wacziarg (2003), which predicts a progressive re-specialisation of more advanced economies. East Asia & Pacific (3.57), South Asia (3.59) and Latin America & Caribbean (3.75) then follow with mean levels of the Theil index below 4. The least diversified regions are Middle East & North Africa and Sub-Saharan Africa, with mean levels of export concentration of 4.31 and 4.41, respectively. Despite exhibiting the highest levels of concentration, Sub-Saharan Africa (SSA) is also the region that experienced the smallest evolution of the Theil index towards greater diversification (-0.21) over the period observed. Moreover, a trend of re-specialisation has been observed in SSA since the 2000s. Indeed, Table 1 shows that the Theil index has increased for the region by +0.21 over the period 2002-2014 after hitting its lowest level (4.16) in 2002. This step back in export diversification in SSA is attributable to various causes, including the tightening in trade and investments in the region during the global financial crisis and the industrial boom in Asian countries, which resulted in a higher demand for African natural resources and a concentration of exports of SSA countries in commodity sectors (Whitfield & Zalk, 2020 and UNCTAD, 2021). Note that concentration in resources sectors is found to be responsible for further sectoral concentration of the economic activity due to Dutch disease dynamics and the subsequent competitiveness issues for non-resource traded sectors (Corden & Neary, 1982). Additional structural challenges have crippled diversification efforts in SSA. Pitagala & Lopez-Cadix (2020) identify the prevalence of political instability and violent conflicts in the region as a key hurdle to diversification. Indeed, the subsequent negative effects on infrastructure and attractiveness for investors are utterly detrimental to the development of new industries. Other barriers to diversification in SSA include low human capital, low access to power, and multiple infrastructure and logistics gaps resulting in difficult access to foreign markets and high exporting costs.

Table 1. Theil export concentration index per region.

Region	Mean	Std. Dev.	Min. *(Year)*	Max. *(Year)*	2014	Frequency
East Asia & Pacific	3.5706	1.0921	3.2541 *(1988)*	4.0915 *(1962)*	3.6297	1,385
Europe & Central Asia	2.3656	1.0168	2.0264 *(1977)*	2.6660 *(2011)*	2.6315	1,801
Latin America & Caribbean	3.7543	0.8660	3.4041 *(1995)*	4.5993 *(1962)*	3.7603	1,820
Middle East & North Africa	4.3082	1.3196	3.9604 *(1998)*	4.9266 *(1962)*	3.9706	1,058
North America	2.6692	1.3648	2.1867 *(1984)*	3.2272 *(2010)*	2.6996	159
South Asia	3.5938	0.9483	3.2694 *(2009)*	4.5681 *(1962)*	3.6905	360
Sub-Saharan Africa	4.4094	0.8989	4.1581 *(2002)*	4.6696 *(1984)*	4.3652	2,217

To overcome these barriers and to foster export-led growth and export diversification, many countries in SSA have proceeded to create special economic zones (SEZs) (Newman & Page, 2017). SEZs are instruments of industrialisation policies that consist of geographically delimited areas that are ruled by some specific administrative, regulatory and fiscal regimes that are more liberal than those prevailing in the rest of the country. Special treatments for firms inside SEZs include the alleviation of customs duties, tax, and regulatory requirements, and privileged access to scarce inputs and to high-quality infrastructures and social services (Farole, 2011; Bost, 2019).

By influencing agents' location choices toward some attractive areas, SEZs are breading grounds for the formation of industrial clusters with interconnected firms and agglomeration economies (Combes & Gobillon, 2015; Newman & Page, 2017). These zones are thus expected to provide favourable environments for the development of new industries and to contribute positively to exports. The aim of this study is to evaluate the impact of embarking on SEZ programs on export diversification in SSA countries. To do so, a difference-in-differences impact evaluation approach is applied to a sample of 32 SSA countries over the period 1970-2014.

The next section of the paper provides some theoretical complements about the notion of SEZ and presents a portrait of SEZ adoption in the African context. The empirical analyses are performed in section 3, and conclusions from the findings are drawn in section 4.

2. Background

2.1. Types of SEZs

The broad definition of SEZs provided in the previous section encompasses various specifications that may vary based on the attributes of each SEZ. Five types of SEZs are commonly identified in the literature, namely, free trade zones, export processing zones, freeports, special economic zones (in a narrower sense than the broad concept) and industrial parks (Zeng, 2016; Lavissière & Rodrigue, 2017; Bost, 2019; UNCTAD, 2021):

- Free trade zones (FTZs) consist of delimited duty-free areas usually located near international transport notes (e.g., ports and airports) or land borders, offering warehousing, storage and distribution facilities for the logistic support of trade.

- Export processing zones (EPZs) are fenced-in areas with industrial activities aimed at foreign markets. These zones provide incentives such as free-trade conditions and alleviated regulation constraints for export-oriented firms.

- Freeports are very similar to FTZs in the sense they are developed in proximity to ports and major trade routes. However, they occupy larger areas than FTZs and are not limited to logistic and warehousing activities, as they provide incentives to firms operating in wider ranges of industrial activities.

- Special economic zones are large zones that can encompass an entire city or region. Beyond providing incentives and facilities to enhance exports and attract investments, these zones serve broader objectives such as regional industrial development.

- Industrial parks (or industrial zones) are small-scale areas with a concentration of firms usually operating in manufacturing activities. These smaller zones also provide incentives and benefits to firms.

Note that the term special economic zone is employed both as a generic term that covers all the different types of zones and in a narrower sense to refer to the specific type of zone presented in this subsection (UNCTAD, 2021). The potential denomination imbroglio resulting from this double usage of the term SEZ is avoided in this study, as SEZ will be used only as a generic term for all types of zones throughout the analyses.

2.2. Adoption of SEZs in Africa

Special economic zone programs have proliferated in Africa over the past 30 years. The number of SEZs on the continent has increased from 20 in 1990 to 238 in 2020. As of 2020, 31 out of 54 countries in Africa had embarked on SEZ deployment, and 7 additional countries were planning to do so. Approximately half of the zones on the continent are concentrated in East Africa, with Kenya itself hosting 61 SEZs. The subregion is followed by West Africa, accounting for approximately 24% of African SEZs boosted by Nigeria and its 38 zones. Other major SEZ hosts on the continent include Ethiopia (38 SEZs), Egypt (10 SEZs), and Cameroon (9 SEZs) based on 2020 figures (UNCTAD, 2021).

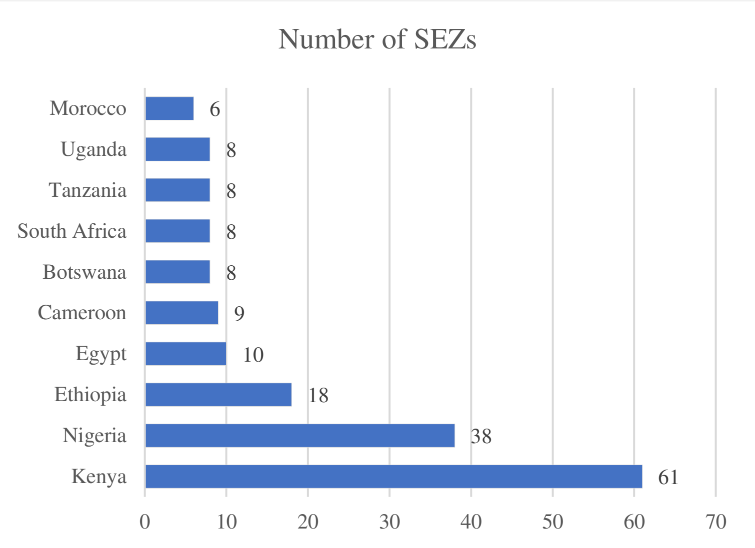

Figure 2. African countries with the most SEZs. Source: UNCTAD

The most common type of SEZ on the African continent is the EPZ (31%), followed by the FTZ (27%), industrial parks (21%) and the "narrow sense" SEZ (19%). Freeports are the least widespread types of SEZs in Africa, accounting for only 5 zones in 2020, namely, the Mauritius freeport, the Mtware freeport in Tanzania, the freeport of Monrovia in Liberia, and the Assab and Massaura freeports in Eritrea (Newman & Page; 2017; AEZO, 2019; UNCTAD, 2021).

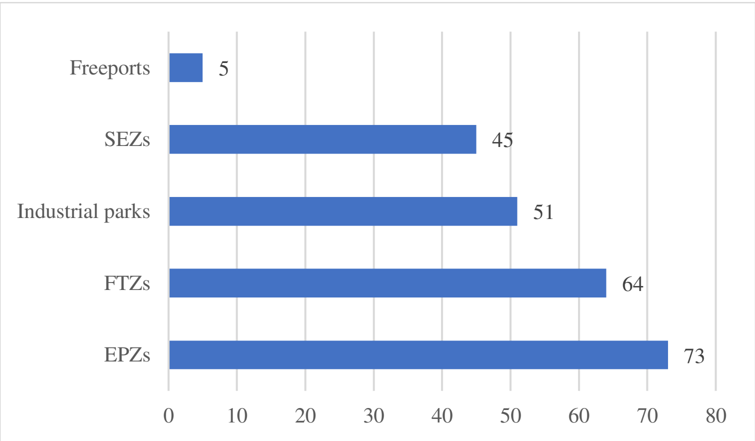

Figure 3. Number of SEZs by type. Source: UNCTAD

As depicted in Figure 4, fiscal incentives are the most common instruments used in African SEZ programs to attract firms and investments. As of 2020, such incentives were provided by 87% of SEZs on the continent. Typical fiscal incentives include the exemption of tax for up to 10 years, reduced tax rates, and tax deduction for skill improvement programs destined to local workers employed in SEZs. The second most employed instrument in African SEZ policies (73%) is the application of special custom regimes, which usually consist of duty-free imports of raw material, machinery, equipment and furniture for companies operating in SEZs. The third and fourth most common instruments are investment protection and facilitation measures. These are directly linked to the high level of risk taken by investors in the context of political instability and institutional weakness in African countries compared to other regions of the world. Protection measures typically include protection against expropriation and guarantees of equal treatment of foreign and domestic investors. Facilitation measures, on the other hand, often consist of the simplification of establishment procedures and in the provision of technical assistance to firms in SEZs. Other investment facilitation actions include the waiving of constraints on the employment of foreign workers in SEZs and on the repatriation of profits for foreign-owned firms. Then, follow the trade facilitation measures that aim at soothing trade flows by reducing and clarifying import and export formalities. Examples of actions include the removal of import license requirements or the development of online platforms for import and export tax procedures aimed at reducing bureaucratic heaviness. To further influence firms' location decisions, some SEZ programs offer preferential land use to firms hosted in SEZs. These can take the form of reduced lease and rent payments, which can be temporary or permanent. Approximately 20% of African SEZs intend to attract firms by providing access to some infrastructures. This can go from guaranteed provision of water, electricity and telecommunication services to preferred access to ports and airports. The least employed attraction tool in African SEZ programs (7%) is the provision of social amenities such as hospitals, educational institutions, recreational areas, banks, praying centers, shopping malls, etc. (UNCTAD, 2021; Newman & Page, 2017).

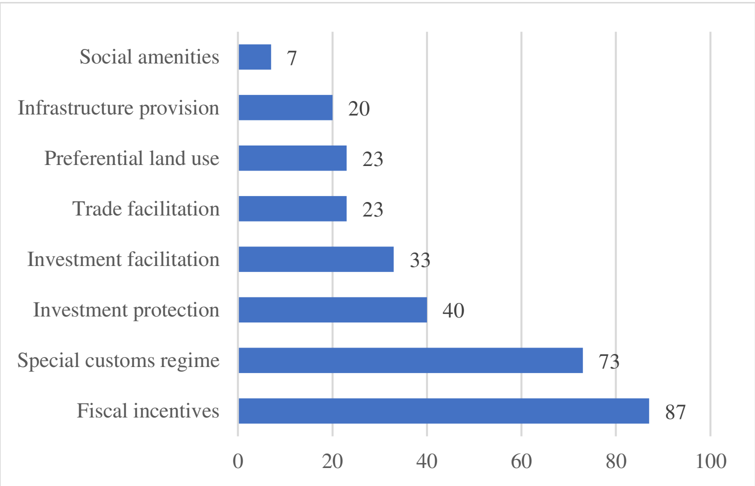

Figure 4. Incentives and services offered by SEZs (in percent). Source: UNCTAD

2.3. Performances of African SEZs

Special economic zones aim to enhance trade and economic growth by serving several intermediary goals, such as attracting firms and foreign direct investments (FDI), in a more efficient way than in the absence of these instruments. Farole (2011) provides evidence on the propensity of African SEZs to be catalysts for FDI. The author shows that African SEZs tend to be outperformed by SEZ programs outside of the continent in terms of FDI inflows generated. However, Farole (2011) finds that African SEZs tend to account for relatively high shares of national inflows of FDI. This suggests that the failure of African SEZs to attract FDI compared to non-African SEZs may not be imputable to malfunctions of the SEZs on the continent per se but rather to poor overall business environments. This also tends to indicate that African SEZs may fail to fully compensate for the negative impacts of poor national investment climates.

Based on a sample of 63 African SEZs, the UNCTAD (2021) provided some evidence on the capacity of SEZs on the continent to attract firms. The analyses show a median of 50 firms and a mean of 60 firms per SEZ. The largest SEZs in Africa based on 2020 figures include the Tanger Free Zone in Morocco (750 firms) and the Alexandria Free Zone in Egypt (405 firms), while some SEZs on the continent host less than 10 firms (e.g., Maluku SEZ in the Democratic Republic of Congo, Vipingo EPZ in Kenya and Sandiare SEZ in Senegal). The study highlights the cases of some SEZs in relatively small economies that have been able to attract large numbers of firms. These include the Nkok SEZ in Gabon and the Kigali SEZ in Rwanda with more than 80 firms, the Chambishi Multi-Facility Economic Zone in Zambia with 45 firms and the Luba Freeport in Equatorial Guinea with over 30 firms.

Regarding employment, approximately half of African SEZs have brought between 1,001 and 10,000 jobs. In addition to the incentives provided by the SEZs, an important determinant of job creation is the focus of the zone. The concentration of SEZs in firms operating in highly labour-intensive industries (e.g., garments and textiles) tends to be correlated with job creation. For instance, by 2020, the Hawasse IP and the Bole Lemi IP SEZs in Ethiopia had created, respectively, more than 30,000 and 20,000 jobs in the garments, textiles and leather industries, while high-tech SEZs such as the green tech ASEZ in South Africa had created fewer than 500 jobs (AEZO, 2019; UNCTAD, 2021). Note, however, that the outlook on African SEZs provided by the African Economic Zones Organization (AEZO, 2019) states that SEZs have supported the creation of jobs in skilled and highly skilled industries on the continent. This is illustrated with the case of the Tanger Med Zone in Morocco, of which top-notch port facilities and dynamic labour market have contributed to attracting firms in high value and export-oriented industries such as automotive, aeronautics and electronics.

Another important point to be raised here is that African SEZs tend to also be outperformed by non-African SEZs in terms of their contribution to national industrial employment. Indeed, the UNCTAD (2021) finds that beside the notable exception of Djibouti, where SEZs accounted for 48% of national employment in 2020, typical figures for African countries lie between 1% and 5%. This indicator was substantially higher for many countries outside of the continent, such as China (14%), the Philippines (16%), Vietnam (19%), Malaysia (23%), Honduras (30%) and the Dominican Republic (36%), based on 2020 figures.

3. Empirical analyses

The expansion of SEZs is expected to result in the attraction of firms from a wider range of sectors and in the generation of technology spillovers and agglomeration economies that may contribute to enhancing export diversification. In this section, a difference-in-differences approach is employed to evaluate the impact of SEZ programs on export diversification in SSA countries. In addition to the main model specification, several alternative estimation techniques are used to check for the robustness of the results.

3.1. Econometric model

The approach followed in this study consists of comparing periods pre- and post-embarking on SEZ programs to assess the impact of these policy instruments on export diversification in the SSA region. For that purpose, a difference-in-differences (DiD) research design is implemented as commonly done to evaluate the causal effects of implemented policies (Angrist & Pischke, 2009).

The original configuration of DiD is that of a model with two periods (i.e., pre- and post-treatment or policy implementation) and two groups (i.e., a treated group and a control group that is not exposed to the treatment). Such a format allows us to estimate the average treatment effect on the treated group (ATT) under the assumption that if the treatment were not provided, both groups would have followed parallel trends. The current analysis departs from this canonical DiD format in several ways. First, the study includes multiple periods both before and after treatment. Second, the time of treatment varies among treated units, as countries' SEZ adoption periods can differ. Finally, the parallel trends assumption may hold only after controlling for some covariates. Following Angrist & Pischke (2009), such a DiD setup with staggered treatment can be apprehended by the estimation of a two-way fixed effect (TWFE) model. The corresponding econometric model takes the following form:

$$Y_{i,t} = \alpha_i + \tau_t + \beta D_{i,t} + X'_{i,t}\Gamma + \varepsilon_{i,t} \quad (1)$$

The dependent variable $Y_{i,t}$ is the level of export diversification. It corresponds to the inverse of the Theil index of concentration proposed by Cadot et al. (2011). This index includes two components, namely, an extensive margin index (EMI) and an intensive margin index (IMI). The EMI measures the part of diversification resulting from the export of new products, while the IMI measures the balance of the mix of already exported products (IMF, 2014). The computation of the index is discussed in appendix 5.1. Note that the inverse of the Theil index is taken here so that higher values correspond to higher degrees of export diversification. Data on export diversification are obtained from the IMF's Export Diversification and Quality database. α_i and τ_t are country and time fixed effects, respectively. $D_{i,t}$ is a treatment dummy that switches on when a country creates its first SEZ and stays on for all periods onward. Note that $D_{i,t} = 0$ for all observations in the control group. Information on SEZ creation periods is obtained from the work of Newman & Page (2017), while the control group is identified based on the list of SSA countries with zero SEZ by 2020 provided by the UNCTAD (2021). Details on the treated and control groups are provided in appendix 5.2. X' is a vector of control time-varying control covariates. It includes the logarithm of real GDP per capita, grossed fixed capital formation (in % of GDP), trade openness (i.e., the sum of exports and imports as % of GDP), real effective exchange rate (REER) and domestic credit to the private sector (in % of GDP). Some descriptive statistics for the variables are provided in appendix 5.3.

The choice of control variables falls from previous empirical studies on the determinants of export diversification. Many studies (e.g., Imbs & Wacziarg, 2003; Cadot et al., 2011) show that countries at early stages of development tend to diversify as their income level increases and then start to re-specialise after reaching a certain threshold. IMF (2014) evaluates this inflection point at levels of GDP per capita around $25,000-$30,000. In the case of SSA countries, the logarithm of GDP per capita is expected to have a positive sign in the estimation. No clear-cut expectation can be made about the sign of trade openness. As emphasized by Espoir (2020), on the one hand, Ricardian trade models suggest that openness to trade should lead countries to specialise in their comparative advantage. On the other hand, greater openness to trade may also be associated with less protectionism, which tends to foster the expansion of tradable sectors. Espoir (2020) finds a positive impact of trade openness on export diversification in the SADC[1], while based on a large panel of countries, Agosin et al. (2012) provide strong evidence that trade openness induces specialisation rather than export diversification.
Gross fixed capital formation includes investments in production capacities and infrastructures. This indicator is expected to have a positive influence on export diversification. Increases in credits to the private sector contribute to the reduction of liquidity constraints for firms and show improvements in the health of the financial sector (Agosin et al., 2012). It should thus exhibit a positive sign in the estimation. REER appreciation is associated with competitiveness issues for domestic traded sectors vis a vis foreign firms due to Dutch disease effects (Corden & Neary, 1982). This covariate is thus expected to come with a negative sign in the estimation. Other potential determinants of export diversification include the level of endowment in human capital or the prevalence of corruption. However, these indicators were discarded due to a lack of data for the SSA region. The study spans over the period 1970-2014 and covers 32 SSA countries.

3.2. Parallel pre-treatment trends assumption

Consider the observations $\{(Y_{i,1}, \dots, Y_{i,T}, D_{i,1}, \dots, D_{i,T}, X_{i,t})\}_{i=1}^{N}$ are independent and identically distributed. Following Callaway & Sant'Anna (2021), let $G_{i,g}$ be a cohort dummy variable taking value 1 if country i is first treated in period g, and zero otherwise; and let C be a dummy variable taking value 1 for the "never treated" countries (i.e., the control group). Recall that once a country receives the treatment (i.e., starts a SEZ program), it remains treated for all periods onward.

[1] Southern African Development Community (16 countries)

DiD implementation aims at estimating the average treatment effect on the treated units given by

$$ATT(g,t) = \mathbb{E}\left[\, Y_{i,t}(g) - Y_{i,t}(0) \mid X, G_g = 1 \,\right], \forall\, t \geq g \tag{2}$$

The identification of $ATT(g,t)$ requires pre-treatment parallel trends between the treated and the control group conditional on observed covariates. This implies that

$$\mathbb{E}\left[\, Y_{i,t}(0) - Y_{i,t-1}(0) \mid X, G_g = 1 \,\right] = \mathbb{E}\left[\, Y_{i,t}(0) - Y_{i,t-1}(0) \mid X, C = 1 \,\right], \tag{3}$$

$\forall\, g \in G$ and $t \geq 2$.

Following Jacobson et al. (1993) and He & Wang (2017), the conditional parallel pre-treatment trends assumption is tested by estimating the following equation:

$$Y_{i,t} = \alpha_i + \tau_t + \textstyle\sum_{k\geq-6,k\neq-1}^{5} \gamma_k\, D_{i,t}^{k} + X_{i,t}'\Gamma + \varepsilon_{i,t}, \tag{4}$$

with dummies $D_{i,t}^{k} = 1\{t - G_i = k\}$ indicating that country i is k periods away from the initial treatment time G_i. Five periods prior to and after the treatment are considered here. Note that $k = -1$ is omitted so that the post-treatment effects are relative to the last period before the start of the SEZ program. The parallel treatment assumption is said to hold if $\gamma_k = 0$ for all $k \leq 2$, meaning that the leads of treatment have no significant impact on $Y_{i,t}$ (He & Wang, 2017).

Figure 4 plots the coefficients from the estimation of Equation 4 with the 95% confidence interval as vertical lines. It appears that all pre-treatment coefficients are nonsignificant for the three dependent variables. This tends to suggest that the conditional parallel trends assumption holds. Note that over the five years following the implementation of the treatment, no significant effects of SEZ adoption appear to be detected on the overall diversification index and on the intensive diversification index. On the other hand, SEZ programs seem to contribute significantly to balancing more evenly the mix of already exported products. Indeed, some significant coefficients are observed for the intensive component of diversification already at the year of adoption and two years later. This preliminary analysis tends to suggest that SEZ adoption may have contributed to fostering export diversification in SSA countries more through the enhancement of already existing export lines rather than via the development of new sectors.

Figure 5. Time passage relative to year of SEZ adoption (vertical bands represent 95% confidence interval).

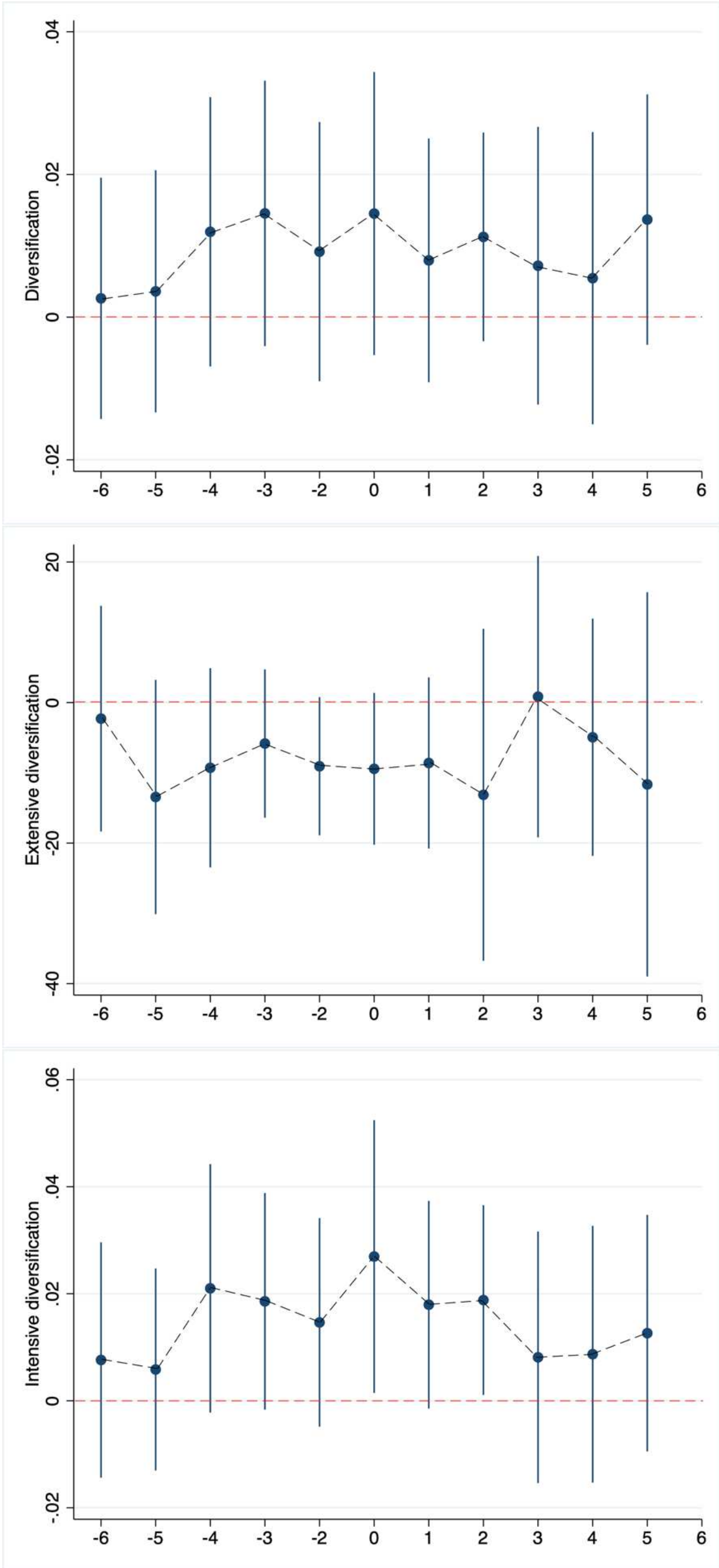

Figure 5. Time passage relative to year of SEZ adoption (vertical bands represent 95% confidence interval).

3.3. Results

Table 2 presents the results obtained from the TWFE estimations for the three diversification indices. The analyses show some positive effects of SEZ adoption on the overall export diversification measure (0.0137), while the ATTs associated with the extensive and intensive margins appear to be non-significant. Unexpectedly, increases in the income level are found to induce further sectoral concentration of exports. The significant negative coefficient of GDP per capita in the intensive diversification equation tends to indicate that SSA countries appear to exhibit a less balanced mix of export shares among the already traded sectors as their development level increases. Trade openness is found to be a significant covariate of the three diversification measures analysed. It appears that as countries in the region become more open to foreign markets, they tend to re-center around a fewer number of sectors, as suggested by Ricardian trade models. Moreover, trade openness appears to undermine the development of new industries given the significant negative effect on the extensive diversification measure. As expected, increased levels of capital investments are associated with greater degrees of export diversification overall. In addition, gross fixed capital formation is found to foster a more even distribution of exports among the traditional sectors. Although REER appreciation appears to have no significant impact on the global index of diversification, the TWFE estimation shows that the subsequent competitiveness issues of domestic traded sectors vis-à-vis foreign producers may induce a greater concentration of traditional exports. This tends to indicate the presence of some Dutch disease dynamics in the region. In line with expectations, increases in domestic credits to the private sector tend to enhance export diversification. This indicator is found to contribute to equalising the shares of already traded goods in the mix of exports.

Table 2. TWFE estimations.

	Diversification	Extensive diversification	Intensive diversification
Variables	(1)	(2)	(3)
Constant	0.428***	93.93	0.691***
	(0.0798)	(92.95)	(0.143)
ATT	0.0137*	1.786	0.0136
	(0.00796)	(5.055)	(0.0119)
Log (GDP per capita)	-0.0271**	-12.18	-0.0524**
	(0.0120)	(13.56)	(0.0211)
Trade openness	-0.000341***	-0.130*	-0.000304**
	(8.79e-05)	(0.0672)	(0.000138)
Investment	0.000647***	0.440	0.000748**
	(0.000200)	(0.259)	(0.000328)
REER	-2.31e-05	-0.0248	-6.83e-05**
	(1.84e-05)	(0.0166)	(2.87e-05)
Domestic credit	0.000838***	0.0141	0.000914***
	(0.000242)	(0.0688)	(0.000312)
Observations	1,015	1,015	1,015
Adj. R-squared	0.239	0.053	0.180

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

3.4. Robustness checks

A recent literature on DiD has shown that although the TWFE estimator performs well in the canonical two groups/two periods configuration, it has several flaws in cases of staggered treatment and heterogeneous treatment effects (see Borusyak et al., 2021; Sun & Abraham, 2021; De Chaisemartin & D'Haultfoeuille, 2020; Goodman-Bacon, 2021; Callaway & Sant'Anna, 2021).

One of the main pitfalls of TWFE outside of the canonical context is the "negative weight problem" associated with the ATT. Theorem 1 in Goodman-Bacon (2021) states that the ATT from TWFE estimation is a weighted average of all possible two-by-two DiD estimators. De Chaisemartin & D'Haultfoeuille (2020) argue that some of these weights can be negative despite summing up to one. It is thus possible to obtain negative ATT from TWFE estimation, while the effect of participating in the treatment is in fact positive for all units in all periods (Callaway & Sant'Anna, 2021). Beyond this, theorem 1 in Goodman-Bacon (2021) also implies that TWFE estimation is sensitive to the time length of the panel, to the size of each group and to the moment at which the treatment is administered.

To overcome these flaws, the ATT is estimated using some alternative robust approaches proposed by Gardner (2021) and Callaway & Sant'Anna (2021). The first one consists of a two-stage DiD estimation procedure for the multiple group/multiple treatment period case, which separates the estimation of group and time effects from the estimation of the ATT. The first stage of the procedure consists of estimating the following equation:

$$Y_{g,i,t} = \lambda_g + \gamma_t + X'_{i,t}\Gamma + \varepsilon_{i,t}, \quad (5)$$

using only nontreated and not-yet-treated observations and retaining the adjusted outcomes $\hat{Y}_{g,i,t} = Y_{g,i,t} - \hat{\lambda}_i - \hat{\gamma}_t - \hat{X}'_{i,t}$. The second stage then consists of regressing $\hat{Y}_{g,i,t}$ on $D_{g,i,t}$.

Callaway & Sant'Anna (2021) propose a doubly robust estimation of ATT that, instead of averaging all possible 2x2 DiD estimates, only focuses on a subset of comparisons that matter. For each cohort g, the only baseline period considered is the period $g-1$. Additionally, for each cohort's average effect estimation, the data that do not belong to the concerned cohort or to the control group are dropped. In the case where no covariates are included[2], Callaway & Sant'Anna (2021) identify the ATTs as follows:

$$ATT(g,t) = \mathbb{E}\left[Y_t - Y_{g-1} \middle| G_g = 1\right] - \mathbb{E}\left[Y_t - Y_{g-1} \middle| C = 1\right]. \quad (6)$$

The authors also provide an alternative estimation of the treatment effects using the not-yet-treated units as a control group:

$$ATT(g,t) = \mathbb{E}\left[Y_t - Y_{g-1} \middle| G_g = 1\right] - \mathbb{E}\left[Y_t - Y_{g-1} \middle| D_t = 0\right]. \quad (7)$$

Tables 3 and 4 present the results of estimations based on two-stage difference-in-differences and on the Callaway & Sant'Anna (2021) approach, respectively.[3] Like in the TWFE estimation, significant positive treatment effects of SEZ adoption on export diversification are found with the two-stage DiD approach. Moreover, this alternative estimation design detects some significant effects of SEZ on intensive diversification, while the extensive component of export diversification shows no reaction to SEZ deployment in SSA countries. Similar results are found with the Callaway & Sant'Anna DiD estimation approach. Note, however, that significant effects are detected only in the specification using not-yet-treated units as the comparison group. It should also be noted that the results from these alternative approaches tend to suggest that the TWFE estimation may have underestimated the size of the ATTs. In

[2] See Callaway & Sant'Anna (2021) for identification of ATTs with covariates included.
[3] Two-stage DiD estimations are performed using the "did2s" R package (Butts & Gardner, 2021) and the Callaway & Sant'Anna estimators are obtained via the Stata module "csdid" (Callaway & Sant'Anna, 2021; Sant'Anna & Zhao, 2020; Rios-Avila et al., 2021). Note that all equations account for control covariates. However, the corresponding coefficients are not provided after the use of "did2s" and "csdid" which only display the ATTs.

Table 3. ATTs based on Gardner's (2021) two-stage DiD approach.

	Diversification	Extensive diversification	Intensive diversification
Variables	(4)	(5)	(6)
ATT	0.02388**	3.22813	0.03062*
	(0.01014)	(6.87012)	(0.01835)
Observations	1,015	1,015	1,015
Adj. R-squared	0.099	0.0032	0.080

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Table 4. ATTs based on Callaway & Sant'Anna (2021) with non-treated and not-yet-treated as control groups.

	CS (Non-treated)			CS (Not-yet-treated)		
	Diversification	Extensive diversification	Intensive diversification	Diversification	Extensive diversification	Intensive diversification
Variables	(7)	(8)	(9)	(10)	(11)	(12)
ATT	0.00123	-7.259	0.0122	0.0357*	-11.92	0.0385**
	(0.0119)	(7.397)	(0.0227)	(0.0206)	(15.64)	(0.0189)
Observations	645	645	645	931	931	931

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

4. Conclusions

This study aimed to measure the impact of SEZ adoption on export diversification in SSA countries. For that purpose, a difference-in-differences design was set up to estimate the causal effect of SEZ policies on the export diversification index proposed by Cadot et al. (2011) and on the two components of the index, namely, the extensive and intensive diversification indicators. The analyses were performed on a sample of 32 SSA countries organised into a treated group of 20 SEZ-active countries and a control group of 12 countries devoid of SEZ programmes over the period 1970-2014. TWFE estimations along with some recently developed more robust estimation techniques for difference-in-differences with staggered treatment, namely, Gardner's two-stage DiD and Callaway and Sant'Anna's DiD estimator, were employed to measure the average treatment effect of SEZ adoption on the group of treated countries. The results indicate that SEZ policies have fostered export diversification in SSA countries. Moreover, estimations for the extensive and intensive components of export diversification show that the impact of SEZ on export diversification likely manifests through the balancing of shares of already existing sectors in total exports rather than through the creation of new sectors.

The analyses performed in this paper provide SSA policymakers with evidence on the efficiency of SEZs in attaining the goal of enhancing export diversification. By contributing to the creation of oases of favourable trade environments, SEZ programmes appear to foster export diversification at the national level in weakly diversified African economies. The results tend to indicate that the multiplication of these zones may help compensate for the negative impact of poor national investment climates prevailing in many SSA countries. Nevertheless,

5. Appendices

5.1. Computation of the export diversification index

Following Cadot et al. (2011), let N be the total number of potential export lines and μ be the export value in USD for each line. Note that N will depend on the export categorization system and on the level of aggregation of items.[4] Consider K subgroups within the entire set of potential export lines. The first subgroup includes the products traditionally exported by country i. This corresponds to products that were exported in the first period observed. The second subgroup includes nontraded products. These are items for which no exports are observed for all periods observed for country i. The last subgroup is composed of new export lines. These correspond, at time t, to products that have been nontraded in at least the two previous years and then exported in the two following years by country i. Note that while the "New" subgroup may vary overtime for country i, the "Traditional" and "Non-traded" subgroups remain unchanged.

Let N_k be the total number of products in each subgroup and μ_k the average export value per subgroup. The intensive and extensive margin indices are country i in year t as follows:

$$EMI_{i,t} = \sum_k \left(\frac{N_{k,i,t}}{N}\right)\left(\frac{\mu_{k,i,t}}{\mu_{i,t}}\right) ln\left(\frac{\mu_{k,i,t}}{\mu_{i,t}}\right) \tag{5.1}$$

and

$$IMI_{i,t} = \sum_k \left(\frac{N_{k,i,t}}{N}\right)\left(\frac{\mu_{k,i,t}}{\mu_{i,t}}\right)\left[\frac{1}{N_k}\sum_{j\in k}\left(\frac{x_j}{\mu_k}\right) ln\left(\frac{x_j}{\mu_k}\right)\right], \tag{5.2}$$

where x_j represents the export value of product j. The Theil index of exports is the sum of the two margins.

[4] The IMF Export Diversification and Quality database from which data for diversification indices are extracted for this study, uses trade flows at the 4-digit STIC (Revision 1) level. This corresponds to 625 potential export lines.

5.2. Treatment and control groups

Country	Treatment	SZE adoption
Togo	1	1989
Cameroon	1	1990
Kenya	1	1990
Mauritius	1	1990
Nigeria	1	1992
Ghana	1	1995
Zimbabwe	1	1996
Mozambique	1	1998
South Africa	1	1999
Tanzania	1	2002
Gambia	1	2005
Senegal	1	2007
Zambia	1	2007
Cote d'Ivoire	1	2008
Madagascar	1	2008
Angola	1	2009
Gabon	1	2010
Rwanda	1	2011
Congo, Dem. Rep.	1	2012
Sierra Leone	1	2012
Benin	0	-
Burundi	0	-
Central African Republic	0	-
Chad	0	-
Comoros	0	-
Guinea-Bissau	0	-
Malawi	0	-
Mali	0	-
Niger	0	-
Sao Tome and Principe	0	-
Seychelles	0	-
Somalia	0	-

5.3. Descriptive statistics

Variable	Mean	Std. Dev.	Min	Max	Observations
A. Full sample					
Diversification	.2452342	.0645461	.1579624	.5604497	1,440
Extensive diversification	-41.59168	1912.23	-68493.15	9468.711	1,438
Intensive diversification	.3001199	.0838011	.1677752	.6374843	1,440
log (GDP per capita)	6.907431	.9341371	5.119464	9.628238	1,312
Trade openness	59.13072	28.65666	6.320343	225.0231	1,182
Investment	20.02317	9.948408	-2.424358	89.38105	1,131
REER	144.4329	104.4214	24.75845	1954.183	1,320
Domestic credit	16.77035	18.89965	.0077258	142.422	1,205
B. Treated group					
Diversification	.2615684	.0729732	.1579624	.5604497	900
Extensive diversification	7.928856	777.7239	-21141.65	9468.711	898
Intensive diversification	.3048017	.0826109	.1710477	.6024957	900
log (GDP per capita)	7.085316	.8928171	5.119464	9.628238	856
Trade openness	62.13393	26.72338	6.320343	152.5471	770
Investment	20.99109	10.46818	-2.424358	89.38105	731
REER	144.9682	121.7379	24.75845	1954.183	845
Domestic credit	19.77815	22.77803	.0077258	142.422	751
C. Control group					
Diversification	.2180105	.0324505	.1635167	.4716971	540
Extensive diversification	-123.9425	2954.871	-68493.15	397.3813	540
Intensive diversification	.292317	.0852549	.1677752	.6374843	540
log (GDP per capita)	6.573507	.9192948	5.392851	9.572786	456
Trade openness	53.51792	31.22576	20.0568	225.0231	412
Investment	18.25427	8.657378	2.732897	60.15617	400
REER	143.4807	62.86607	71.15722	418.1472	475
Domestic credit	11.79489	7.110437	.4025806	38.88238	454
D. Not-yet-treated group					
Diversification	.2521459	.0679358	.1579624	.5604497	630
Extensive diversification	-2.868665	925.6234	-21141.65	9468.711	629
Intensive diversification	.3015396	.0814164	.1710477	.6024957	630
log (GDP per capita)	7.034461	.9107771	5.119464	9.628238	586
Trade openness	58.45415	26.83092	6.320343	152.5471	500
Investment	20.20998	11.49288	-2.424358	89.38105	464
REER	161.7345	141.0526	24.75845	1954.183	594
Domestic credit	16.0997	16.48749	.0077258	105.5439	494

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