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Tackling Illicit Financial Flows for Sustainable Development in Africa

Background Paper

Illicit financial flows and sustainable development: Panel-data evidence for Africa

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1. Introduction

As a background paper to the 2020 edition of the Economic Development in Africa Report (EDAR), this technical paper aims to add value by shedding light on the interactions between illicit financial flows (IFFs) and sustainable development in Africa. To do so, the paper offers an empirical investigation of illicit financial flows out of the continent, based on illicit capital flight and a measure of trade underinvoicing as proxies of IFFs. These are in turn confronted with a series of proxies for economic, social and environmental sustainability. The analysis is primarily motivated by the urgency to address financial hemorrhage from the continent in its efforts towards achieving the 2030 Sustainable Development Goals (SDGs). As such, it builds on the limited literature of the impact of capital flight on development in Africa.

The bi-directional relationship between poor institutional quality in mineral resource rich countries in Africa and IFFs permeates the paper's empirical sections. Indeed, drawing on the literature on the role of institutional channels in mediating the detrimental impact of natural resource abundance on economic growth (Sachs and Warner, 1995, 2001; Sala-i-Martin et al., 2004), the paper considers that poor institutional quality is both an enabler and a consequence of IFFs. It then contributes to defining the association between IFFs and productivity growth, a central element of structural transformation.

The analysis is structured as follows. First, it unpacks definitions and measurement issues, from IFFs to sustainable development and measures of labour productivity and investigates the relationship between its core variables of interest. Second, it presents the empirical analysis, including a description of the estimation methods. Third, it offers a further examination of the sectoral dimensions of the relationships between IFFs and productivity changes. The paper concludes with some remarks on the implications of its findings for the relationship between IFFs and sustainable development in Africa.

2. Measurement of illicit financial flows and sustainable development

Definition, scope and estimates of Illicit financial flows

Definitions matter because they frame what is being measured and the associated implications for policy. In line with EDAR 2020, the paper acknowledges the definition endorsed by the Inter-Agency and Expert Group on Sustainable Development Goals Indicators (IAED-SDGs) as the basis for the measurement of progress towards Sustainable Development Goal 16.4. The definition is as follows: *Illicit financial flows are financial flows that are illicit in origin, transfer or use; that reflect an exchange of value (instead of a pure money transaction); and that cross country borders.*

Illicit financial flows cannot be accurately measured. Capital flight is the variable widely used in the empirical literature as a suitable proxy for IFFs. Few exceptions have focused on trade-related measurements of IFFs (Mevel et al., 2013; Ogbonnaya and Ogechuckwu, 2017). In literature, though clearly distinct illicit financial flows and capital flight have been used interchangeably. Ndikumana and Boyce (2019) state that while all capital flight is illicit, not all illicit financial flows are capital flight (i.e. smuggling, money laundering).[4] Drawing on these past practices, the paper makes use of two proxies for IFFs. First, it adopts the balance of payment-based measure of capital flight. In line with the definition from Ndikumana and Boyce (2019: 2), it refers to capital flight as "illicitly transferred financial assets, capital outflows that are not reported to government authorities". Capital flight may be illicit through illegal acquisition, transfer, holding abroad, or some combination of the three. Illicitly acquired capital is money obtained through embezzlement, bribes, extortion, tax evasion, or criminal activities. In this paper we use the Balance of Payments Residual measure of capital flight which quantifies illicit financial flows as unrecorded capital

[4] In the macro-economic literature of the 1990s, capital flight was considered as both, licit and illicit. The definition used in this paper is based on the work from Ndikumana and Boyce (2019, 2018) and Boyce and Ndikumana (2008).

outflows and is measured as the missing residual in the balance of payments, after corrections for underreported external borrowing and the Partner-Country Trade Gap[5]. Data is obtained from Ndikumana and Boyce (2018), published by the Political Economy Research Institute (PERI) at the University of Massachusetts, Amherst.

The paper's second proxy for IFFs, trade-related estimates of illicit financial flows are more closely related to activities in selected value chains and reflect different implications for sustainable development across sectors. We use the Partner-Country Trade gaps where consistent export underinvoicing is indicative of illicit outflows. These are obtained from Schuster and Davis (2020) who deliberately consider export underinvoicing instead of all forms of misinvoicing in order to only capture illicit financial outflows through exports. In addition to total products trade, Schuster and Davis (2020) provide an estimate that focuses on key commodities and their value chains which are of particular importance to Africa (in terms of total exports) and which have been highlighted in the literature to being prone to illicit outflows. These commodities are iron, diamonds, platinum, copper, aluminium, gold and manganese. This paper uses this commodity-specific estimate for insights into value chains and for robustness checks in the econometric analysis. In addition, robustness checks are also provided with the total trade (export and import misinvoicing) obtained from the PERI website.

In both datasets, some countries had to be excluded due to data limitations. The country coverage is reported in Table 8 in Appendix I. First, we miss 24 out of 54 African countries[6] using the Ndikumana and Boyce (2018) data from the PERI website. Those missing countries tend to be the countries with very weak institutions such as Somalia and South Sudan (see Figure 7 in Section 3.2. for state fragility index across African countries). Second, we miss 17 out of 54 African countries[7] using the data from Schuster and Davis (2020). Those are missing due to the lack of data on international trade flows needed to compute the estimates of export underinvoicing. For instance, Chad, Democratic Republic of the Congo, Equatorial Guinea, Liberia, Somalia and South Sudan do not report any statistics in the UN Comtrade.

We treat negative values as missing values in the dataset in order to capture only illicit financial outflows. As this may cause a bias towards IFF-prone countries, a sensitivity analysis is provided for setting negative values to zero. Keeping all observations (including negative estimates), illicit capital flight is available for 54 percent of all observations (2000-2015). In contrast, export underinvoicing from Schuster and Davis (2020) is available for 70 percent of the sample. Dropping the negative values from the dataset, data coverage of capital flight drops to 35 percent and export underinvoicing to 36 percent of observations. As indicated in Schuster and Davis (2020), the larger relative number of negative estimates in the export underinvoicing variable comes from storage of commodities and time lags in shipping exports. This is also why only positive values of export underinvoicing can be an indicator of illicit financial outflows. Missing data for some countries may cause a selection bias which will be addressed throughout the analysis. In addition, though the paper provides insights on IFFs and sustainable development in Africa, strict interpretation of its findings is limited to the countries included in the sample.

Over the period 2013-2015, capital flight amounted to $88.6 billion annually across the sample, 70 percent of which were export underinvoicing. Figure 1 displays estimated capital flight and export underinvoicing in percent of GDP for the years 2000-2015 across the sample of African countries. Among the countries for which data exist, Sierra Leone shows the highest estimate of annual capital outflow with an average of 44 percent over the period 2000 to 2015. In 2013, the highest annual capital flight estimate of 131 percent of GDP was reported for Sierra Leone. Congo, Seychelles and Burundi are also particularly prone to capital flight. The comparison between capital flight and export underinvoicing in Figure 1 suggests large variations, not only in data coverage but also in the magnitude of IFFs. The average prevalence of all capital flight across the sample is roughly 4 percent of GDP. Table 9 in Appendix I provides the descriptive statistics of the indicators of IFFs for the sample of 54 African countries and

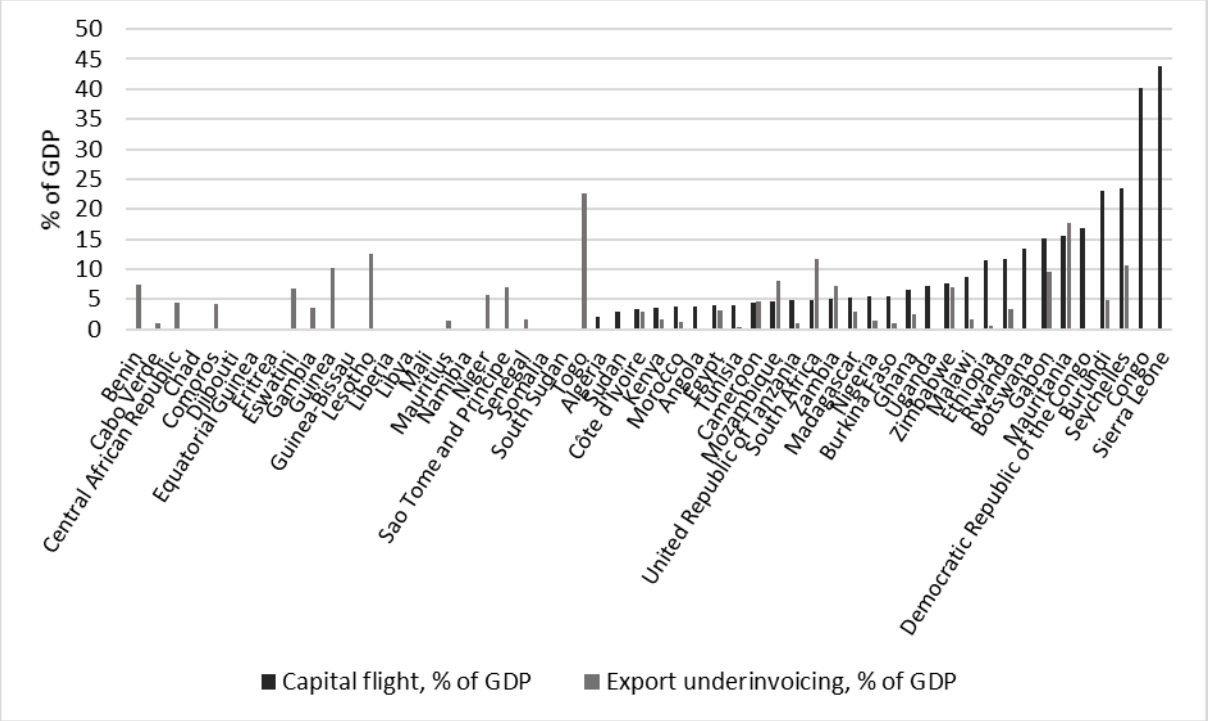
[5] Capital flight as a Balance of Payment residual is computed as the change in debt stock, adjusted for exchange rate fluctuations, debt forgiveness and change in interest arrears, plus Foreign direct investment, plus Portfolio investment, plus other investments, minus the current account deficit and net additions to foreign exchange reserves (Ndikumana and Boyce, 2019).

[6] Those countries are: Benin, Cabo Verde, Central African Republic, Chad, Comoros, Djibouti, Equatorial Guinea, Eritrea, Eswatini, Gambia, Guinea, Guinea-Bissau, Lesotho, Liberia, Libya, Mali, Mauritius, Namibia, Niger, Sao Tome & Principe, Senegal, Somalia, South Sudan and Togo.

[7] Those countries are: Cabo Verde, Cameroon, Chad, Republic of the Congo, Democtatic Republic of the Congo, Djibouti, Equatorial Guinea, Eritrea, Ethiopia, Guinea-Bissau, Liberia, Libya, Mauritius, Sierra Leone, Somalia, South Sudan, Sudan.

from 2000-2015, including all observations (including negative values), and for dropping negative values to yield an average estimate of illicit financial outflows. Trade-related illicit financial outflows, proxied by the export underinvoicing measure, were on average 6.45 percent of GDP ranging from zero to 42 percent of GDP. The high standard deviation of both IFF measures indicates the large differences across countries. For instance, while no estimate from the Balance-of-Payments method is available for Togo, the country reports the highest estimate of export underinvoicing (22.6 percent of GDP), according to Schuster and Davis (2020). While this highlights the sensitivity of estimates of IFFs to the method used and the quality of data, it also limits the comparability of different model specifications (see section 4).

Figure 1: Illicit capital flight and export underinvoicing, in % of GDP, 2000-2015 annual average



Source: Authors' graph based on capital flight data obtained from Ndikumana and Boyce (2018) and export underinvoicing estimates from Schuster and Davis (2020).

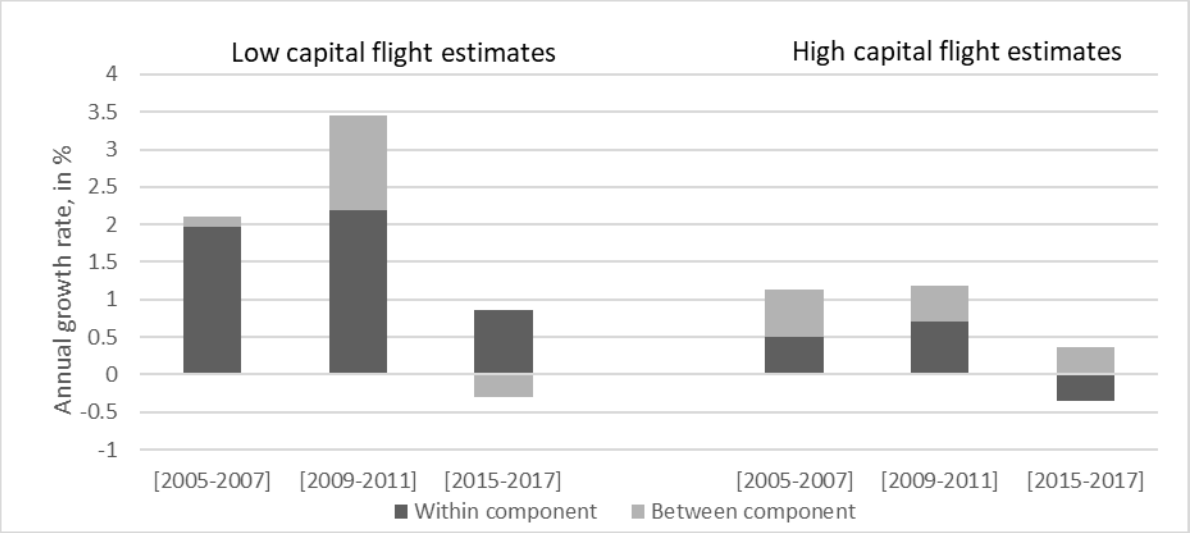
Estimating structural transformation and social and environmentally sustainable development

The concept of economic sustainability is subject to debates that span from the consideration of natural resource stocks, institutional environment to that of the stability of macroeconomic and trade indicators. With the emergence of modern macro-economics, the essence of modern economic growth was described as the sustained increase in productivity and living standards. Ensuing analysis of the features of the process of economic growth uncovered the central role that the structural transformation plays, as the process of reallocation of economic activity across agriculture, manufacturing and services (Chenery, 1960; Kuznet, 1966, 1973). This process ultimately resulted in productivity growth, increased job creation and higher wages.

For this paper, economic sustainability is proxied by indicators of structural transformation. Taking data challenges in production and consumption measures of structural transformation in Africa as given, the analysis refers to the rationale of structural change as a higher share of manufacturing in total value added or employment because of greater opportunities to accumulate capital, exploit economies of scale and stimulate technological change. The paper also considers strong forward and backward linkages with other sectors which can then stimulate positive spill-over effects. On the empirical analysis of structural transformation, in recent literature (McMillan et al., 2014;

Timmer et al., 2015), structural transformation has been decomposed into productivity changes *within*- and *between* economic sectors. Figure 2 displays the calculated annual growth rates of *within*- and *between*-sector productivity growth rates, for the years 2005-2007, 2009-2011, 2015-2017, by group of countries with low versus high estimates of illicit capital flight. The simple comparison suggests that African countries prone to capital flight seem to have experienced lower labour productivity growth, on average by one percentage point over the respective period.

Figure 2: Overall annual labour productivity growth rates, by Within-sector and between sector component



Source: Authors' calculation based on ILO statistics and UNCTAD statistics.

Note: Overall (sum of within and between component) labour productivity growth is defined as: $\Delta Y_t = \sum_{i=n} \theta_{i,t-1} \Delta y_{i,t} + \sum_{i=1} y_{i,t} \Delta \theta_{i,t}$.

The classification of low versus high capital flight as a percentage of GDP is based on the simple average over time as a threshold. Countries with estimates of capital flight above 5 percent are Benin, Burundi, Comoros, Congo, Djibouti, Eswatini, Ethiopia, Gabon, Guinea, Lesotho, Mali, Mauritius, Rwanda, Sao Tome and Principe, Senegal, Seychelles, Sierra Leone, Togo and Uganda. Countries with relatively lower capital flight relative to their GDP are Algeria, Angola, Botswana, Burkina Faso, Capo Verde, Cameroon, Côte d'Ivoire, Democratic Republic of the Congo, Egypt, Ghana, Guinea-Bissau, Kenya, Madagascar, Malawi, Mauritania, Morocco, Mozambique, Namibia, Nigeria, South Africa, Sudan, Tunisia, United Republic of Tanzania, Zambia, Zimbabwe.

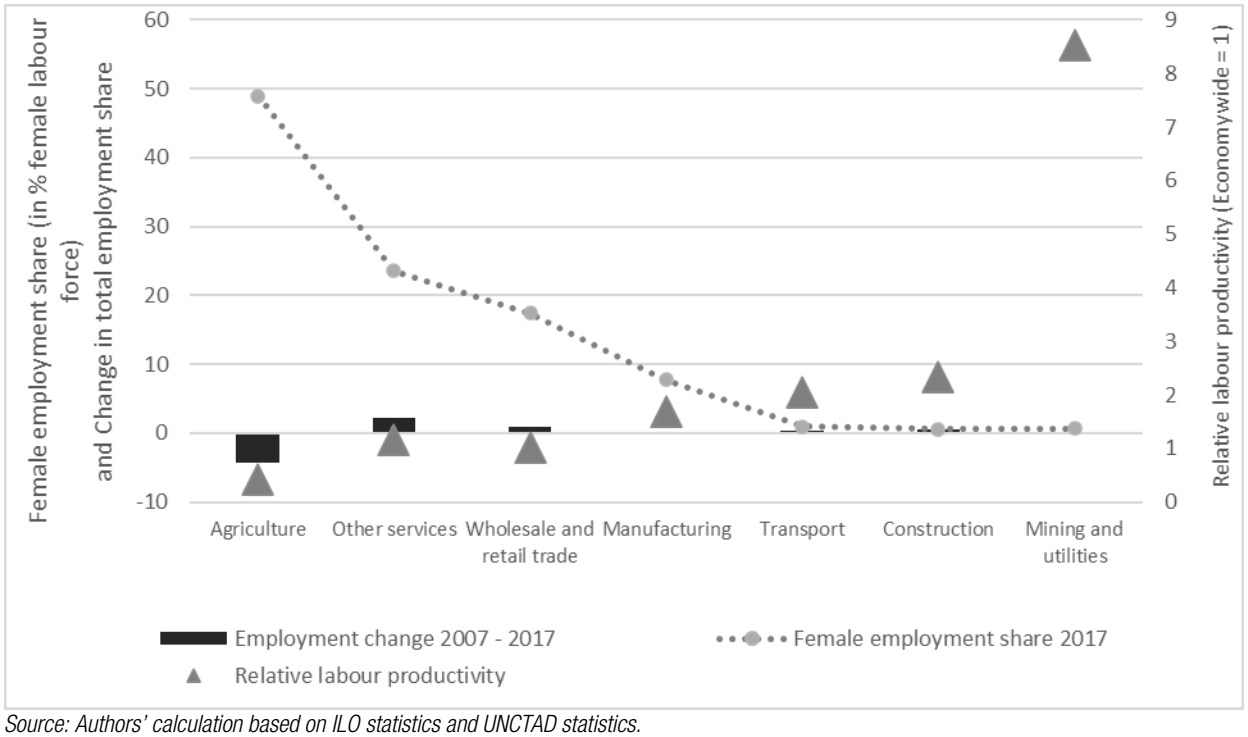
There is evidence that structural transformation in Africa has mainly been driven by *within*-sector productivity growth over the last decades. There has been little reallocation of labour towards the productive sectors, and mostly from agriculture to services. Technological changes in manufacturing have made the sector more capital-intensive than in the past which reduces the scope of poor economies to expand the manufacturing sector and absorb labour (McMillan et al., 2014). The reallocation of labour strongly depends on institutions that facilitate the movement of labour (e.g. labour market flexibilities). Empirical evidence (McMillan et al., 2014; Trenczek, 2016; Martins, 2019; Mühlen and Escobar, 2020) suggests that the main driver behind structural change over time is the quality of institutions rather than the level of investments itself. In contrast, investments play a greater role in explaining *within*-sector productivity increases. Indeed, our empirical investigation of *between*- and *within*-sector growth rates does not find a significantly positive correlation between capital flight and the allocation of labour. Therefore, with regards to the harmful impact of illicit financial flows on economic development, the methodology and findings discussed in this paper focus on the *within*-sector component of structural change.

The empirical strategy situates the analysis of structural transformation within that of other indicators of socially and environmentally sustainable development. With regards to social sustainability for instance, the discussion of sector-specific effects takes into account female employment share by sector and emphasizes how illicit financial flows can have adverse impacts on women. Figure 3 illustrates large gaps in labour productivity between economic sectors in African countries and a relatively higher share of female employment in the sectors with the lowest

productivity levels - agriculture and wholesale and retail trade. Sector-unequal effects of capital flight could reveal insights on rising inequalities and vulnerability of females to financial leakages. In addition to a sectoral differentiation, the analysis also reflects on the effect of education and gender-parity in education on productivity.

With regards to environmental sustainability, the paper begins with the tenet that sustainable development and economic growth are limited by a country's abundance of natural resources and the environmentally sustainable management of resources (Nordhaus, 2014, 1974). This implies that in light of illicit exploitation of resources as a potential channel of illicit financials flows, the outflow of capital may be directly associated with weaker environmental performance. Productivity increases are also linked to an efficient use of resources and environmentally sustainable production processes. As mentioned earlier, the mining sector is prone to illicit financial flows. This in turn is partly due to poor governance and resource management of the extractive industries, and is likely to result in a negative social and environmental impact. However, despite this likelihood, financial modeling of a project's expected revenue insufficiently quantifies negative externalities on other sectors, social and environmental impacts.[8]

Figure 3: Sectoral labour productivity and female employment, 2017



Source: Authors' calculation based on ILO statistics and UNCTAD statistics.

3. Unpacking the relationship between Illicit financial flows and sustainable development

3.1. The channels: A literature review

[8] Current practices often focus on the revenues generated from the extraction of the resource, the extent to which revenues are shared through royalties, taxes and fees, and how these revenues are spent (Woodroffe and Grice, 2019).

Much of the literature on the harmful impact of capital flight has focused on the economic channels of capital accumulation via public and private investments. The determinants of illicit financial flows are first reviewed, followed by a discussion of some of the key channels through which IFFs may affect sustainable development.

Determinants of Illicit financial flows

Capital flight can arise from multiple causes that can be classified into three broad categories. First, past values of capital flight have been shown to be a good predictor of current capital flight, and most papers using a quantitative approach show that it is strongly autocorrelated[9] (e.g. Davies, 2007; Cerra et al., 2008; Ndikumana, 2014). Therefore, any successful attempts to dampen illicit financial flows today is likely to reduce IFFs in the future. Second, the macro policy of a given country can be a powerful lever with which governments can act. Hermes and Lensink (2001) show that higher inflation levels make assets in foreign currency relatively more attractive, which increases the likelihood of assets being shifted abroad. Similarly, Cuddington (1986) shows that the real effective exchange rate has an impact on capital flight, as the overvaluation of domestic currency distorts the relative price of foreign goods. Strong economic growth may also reduce capital outflow, as it sends a positive signal and gives incentives for higher local investment (Boyce and Ndikumana, 2008). Foreign borrowing can also be a means of financing the accumulation of foreign assets for elites, as demonstrated by Fofack (2009). In addition, Ndikumana (2003) shows that external borrowing is the single most important determinant of capital flight. The author argues that between 1970 and 1996, 80 percent of the amount of foreign loans in Africa was leaving the continent in the form of capital flight. This estimate has been later scaled down to 60 percent but is still statistically significant (Ndikumana and Boyce, 2011). Similarly, foreign aid could be channelled into fuelling IFFs if it is not accurately monitored (Cerra et al., 2008). Capital flight can also be explained by the desire to avoid local taxation. Collier et al. (2001) show that an increase in taxation may also discourage local investment, as investors anticipate future financial losses. The last category is more institutional, because conflict, civil war and domestic terrorism have been shown to be drivers of capital flight (Collier et al., 2004; Davies, 2007; Asongu and Amankwah-Amoah, 2018). Corruption control, as well as the government's voice and accountability are the two main factors of political stability affecting capital flight, as demonstrated by Asongu and Nwachukwu (2017). Le and Zak (2006) find that constitutional government changes impact capital flight. Frantz (2018) supports this observation by showing that election years raise capital flight due to rising economic and political uncertainty.

On the policy side, using data from 21 emerging countries, Yalta and Yalta (2012) assert that financial liberalization does not help in tackling capital flight. Hence, liberalization policies may not be a panacea for reducing unrecorded money outflows for African economies. Indeed, some skeptical empirical views on the role of financial liberalization suggest that it seems to increase the risks of financial fragility and stimulate capital flight in Sub-Saharan Africa (Ahmed, 2013) and developed and emerging economies (Yang et al., 2019). Capital flow liberalization is generally less risky if countries have reached certain levels of financial and institutional development[10] (IMF, 2012).

Illicit financial flows and capital accumulation

Illicit financial flows lower the rate of capital accumulation through a reduction of private investment (e.g. Ndikumana, 2014; Fofack and Ndikumana, 2010; Dachraoui and Smida, 2014; Ndiaye, 2014, 2009; Salandy and Henry, 2013; Nkurunziza, 2014) which could have financed new production technologies, machinery and innovative production processes needed to increase labour productivity. A shortage of capital caused by the outflow of capital increases the domestic interest rate which could put additional pressure on high external debt servicing in many African countries. In addition, a potential depreciation of the national currency from capital outflow also increases the costs of investment, lowers productive investment and productivity growth (Ampah and Kiss, 2019).[11] In the

[9] Autocorrelation refers to the similarity between the values of the same variable over successive time intervals.
[10] The specific thresholds for the level of development (macroeconomic stability, financial development, institutional quality and trade openness) vary across studies. For instance, Sedik and Sun (2012) take the median of these factors as the threshold using a sample of 37 emerging countries that have liberalized capital flows during 1995–2010.
[11] This paper does not estimate the relationship between external debt and illicit financial flows but rather draws on existing literature on this topic (Ndikumana et al., 2014; Ampah and Kiss, 2019) to assess its development impact.

same vein, a potentially negative impact on imports due to lower income could increase balance of payments pressures and reduce the rate of capital accumulation.

Using a panel-data approach, Fofack and Ndikumana (2010) estimate the effect of savings on gross domestic investment, public investment, and private investment, controlling for GDP, and use these estimates (assuming that the repatriated IFFs increase domestic savings) to calculate the impact of IFFs on the investment-to-GDP ratio as key driver of economic growth. They show that the average investment-to-GDP ratio increases from 18.5% to 29.6%. However, it should be noted, that only a weak link between investment and savings has been identified mainly because of inefficiencies in the financial system and the large share of public investment that comes from overseas development aid.

Using a sample of 39 countries over the period from 2000 to 2010, Ndikumana (2014) estimates a fixed-effects, iterated reweighted least square method (IRLS) and a system-GMM model on total and private gross fixed capital formation. Using the estimates, the author simulates that by radically stopping all Illicit financial flows African countries might have been able to achieve on average three percent more economic growth. Nkurunziza (2014) also uses the Incremental-Input-Output-Ratio (ICOR) to derive the potential effects of capital flight on poverty. Tackling capital flight and investing it with the same efficiency as actual domestic investment would increase the annual rate of poverty reduction by 1.9 percent (based on a sample of 35 African countries from 1970 to 2010).

The incidence of capital flight is particularly high in West Africa. Ndiaye (2014, 2009) provides empirical evidence of how capital flight is negatively associated with economic growth in the CFA-Franc-Zone. For Nigeria, Ogbonnaya and Ogechuckuw (2017) examine the impact of capital flight on GDP using a time-series approach and find a significantly negative impact on economic growth.

Tax base and government revenue

Illicit financial flows can affect government revenues through lowering the tax base which reduces public expenditure on soft and hard infrastructure, research and development, environmental protection and institutional development (Ndikumana and Boyce, 2011; Mevel et al., 2013). Lower public expenditure results in lower levels of human capital accumulation, a critical element in increasing labour productivity through the acquisition of skills and knowledge. Furthermore, public expenditure reductions have potentially "gender unequal impacts", especially if cuts affect health and education expenditures (Musindarwezo, 2018; Musindarwezo and Jones, 2019).[12] A higher level of female education boosts productivity growth, especially in low productivity sectors with a high share of female employment (Trenczek, 2016).

Mevel et al. (2013) apply a Computable General Equilibrium (CGE) Model to estimate the effect of additional income arising from reclaimed IFFs. They show that real income increases but while imports increase exports decline. In their model, when additional income is constrained for investments in trade facilitation, exports and real income increase, though at a lower rate. If IFFs could be progressively returned to economies, Africa's real income would be boosted by 21.2 percent compared to the baseline scenario.

The channels through which IFFs affect social development are not only captured in the financial expenditure effects but may also come through potential effects on political institutions. Higher government revenues would potentially increase the administrative capacity to address social development, and with that would also increase the elasticity of social outcomes with respect to an increase in social expenditures (see section 3.2).

Institutions

The paper considers that the interaction between the prevalence of IFFs and weak institutions permeates many outcomes related to structural transformation. For example, because high levels of IFFs undermine the quality of economic, political and social institutions (Maton and Daniel, 2012; Moore, 2012; Torvik, 2009) they affect the functioning of labour markets institutions and regulations. This impact alters the mobility of workers and the rapid

[12] Higher public expenditures on health and education potentially reduce the time women spend caring for their families, giving them more time for decent work (Chen and Moussié, 2017).

and efficient reallocation of labour resources. In the same vein, IFFs hinder the development of institutions that would allow the emergence of more technologically advanced new industries thanks to the availability of risk friendly patient capital. This vicious circle would result in lower labour productivity growth and lessen the pace towards structural transformation.

Illicit financial flows through criminal activities, bribes and corruption, are likely to undermine the domestic rule of law and harm institutional quality as they tend to weaken mechanisms of accountability (Ndikumana, 2014). Good governance and strong institutions provide a more conducive environment for investment, increase economic efficiency and therefore, raise productivity (Ndiaye, 2014; Martins, 2019; McMillan et al., 2014). The linkages between capital flight and institutions and how it may determine the harmful impact on development has received little attention in the empirical literature. As one of the few exceptions, Ndiaye (2014) examines the impact of capital flight on economic growth for the CFA-Franc-Zone over the period 1970 to 2010, and notes that the detrimental effects of capital flight decrease with the quality of institutions (measured by constraints on the executive power, obtained from Center for Systemic Peace[13]). Capital flight repatriation is dependent on reducing uncertainties in the macroeconomic and institutional environment and on ensuring political stability (Ndiaye, 2014). In this regard, the theory of state capacity from Besley and Persson (2010) provides useful insights. The authors argue that state effectiveness (or capacity) is central to economic development and relies on two complementary dimensions: legal and fiscal capacity. The legal dimension is related to the availability of infrastructure to enforce contracts or protect property rights whereas fiscal capacity is associated with the infrastructure to raise taxes (income or value added). The authors first show that they are both positively correlated with income per capita and growth, but also negatively correlated with State fragility and violence. They then underline the complementarity between legal and fiscal capacities and argue that growth cannot be achieved when one of the two is missing. The required investment in legal capacity is larger when the factors triggering fiscal capacity are present. These factors include a common interest (e.g. war, ethnic homogeneity), cohesive political institutions (e.g. parliamentary democracies). Also, high wages make taxation more attractive, whereas resource dependency makes the State less likely to rely on taxation. But fiscal capacity cannot be built if the legal capacity is delayed. For instance, substandard property rights and political instability will discourage domestic and foreign investment, and will therefore reduce fiscal capacity. Each investment in one type of State capacity reinforces the other, making it an endogenous relationship, which can be vicious or virtuous (Besley and Persson, 2010).

Environmental sustainability

Illicit financial flows originate largely in the illicit exploitation of environmental resources and are associated with the unsustainable use of finite natural resources which can reduce economic growth (Nordhaus, 2014, 1974). Environmental crimes that violate environmental legislation may harm the environment and human health and as such reduce labour productivity. Environmental damage (such as soil erosion) may cause lower soil productivity which impacts agricultural productivity. Estimates on overall environmental crime, defined as “activities that breach environmental legislation and cause significant harm or risk to the environment, human health or both” range from $110 billion to $281 billion annually, of which illegal mining totals $12 billion to $48 billion (Europol, 2020; INTERPOL et al., 2018). Environmental crime inhibits the ability of countries to achieve environmental goals regarding biodiversity and to achieve sustainable development.

While the impact of extractive industries and natural resource dependency has been widely discussed, the association of illicit financial flows with environmental performance has received little attention. Illicit financial flows are most prevalent in energy-intensive extractive industries. A large-scale extraction of natural resources requires prohibitive amounts of energy which can lead to the depletion of capital stocks and increase climate risks (Biggs et al., 2015). Higher energy production requires water which can impact water quality and availability. Water is an essential input to agricultural production with impacts on food security. Extractive industry activity is not only energy-intensive but can also produce pollution and contaminates soil, groundwater and surface water (Woodroffe and Grice, 2019). Poor environmental performance, especially regarding water quality, negatively impacts agricultural output, human health, and food security.

[13] https://www.systemicpeace.org/polityproject.html

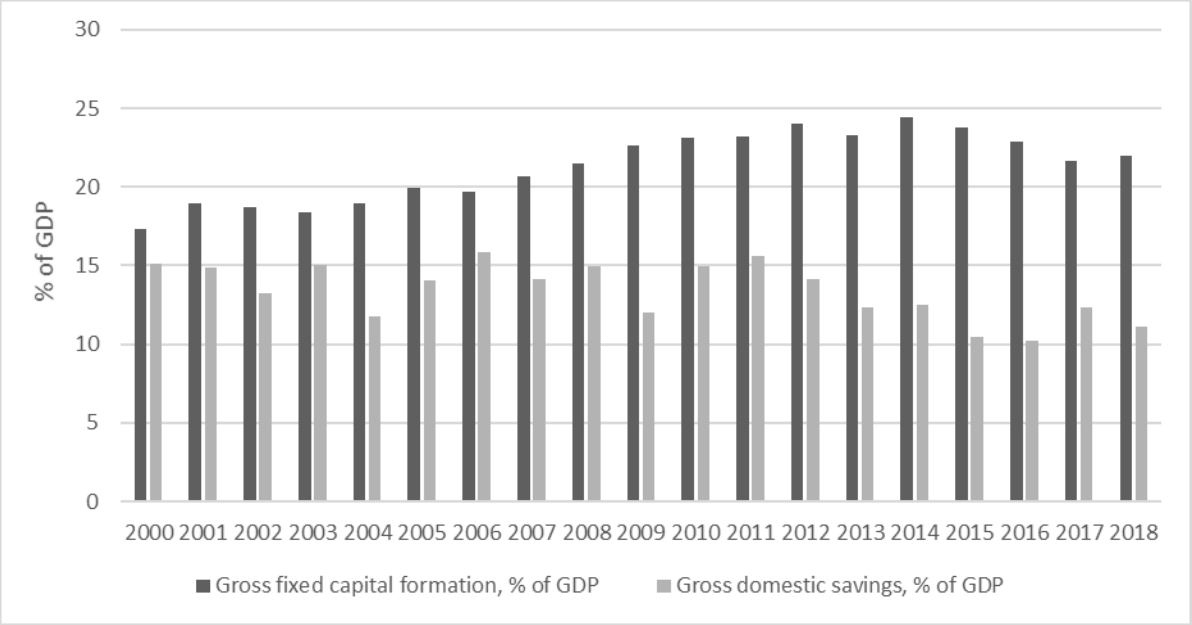
3.2. A descriptive analysis of the channels

Capital accumulation

The investment ratio, measured as gross capital formation as a share of GDP, is slightly smaller in the sample of African countries than the world average in 2018 (22 compared to 25 percent). Between 2000 and 2015, the investment ratio in Africa has increased from 17 percent of GDP to 24.5 percent of GDP in 2014, but slightly fell recently to 22 percent in 2018 (see Figure 4). These investment rates were however not financed entirely by savings which is shown with the imbalance between gross capital formation and gross savings in Figure 4. Gross savings were low at only 11 percent in 2018. The investments in gross fixed capital were mainly driven by foreign capital inflows. However, when large amounts of capital fly out of the country, the overall investment ratio melts away and harms the possibility to boost domestic savings and investments.

Based on our findings from a simple regression analysis (see Box 1) on the relationship between gross capital formation and capital flight in African countries between 2000 and 2015, there seems to be a negative relationship between the two but no significant link can be established. Especially when other country-specific characteristics are considered, capital flight cannot explain changes in capital formation. Therefore, the impact of illicit financial outflows on sustainable development may not only occur through investments but also through other channels.

Figure 4: Gross fixed capital formation and Gross domestic savings, in % of GDP, average African countries, 2000-2018



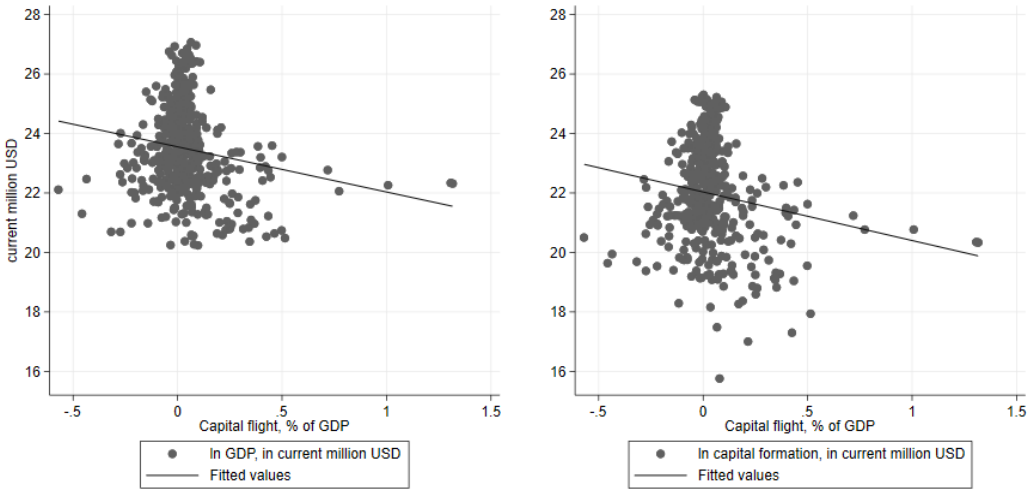
Source: Authors' graph based on UNCTAD statistics.

Box 1: An empirical analysis between GDP, gross capital formation and capital flight

Considering relatively high levels of GDP growth rates and increases in annual capital flight in African countries throughout the last decade, it is difficult to ascertain the relationship between economic growth and capital flight. It may be that with increased investments and economic output, the probability for illicit financial flows increases. Depending on the size and the form of illicit financial flows they might be more harmful for economic development.

Figure 5 shows that there seems to be a negative association between logarithms of GDP and capital flight over the period 2000 to 2015. However, high levels of GDP growth rates in the past have been unable to boost structural transformation. Investments in productive capacity across sectors are crucial to achieve higher productivity levels. The right panel of Figure 5 shows that there is also a negative association between investments, proxied by gross capital formation, and capital flight.

Figure 5: Relationship between Capital flight and current GDP (left) and current Gross Capital Formation (right), 2000-2015



Source: Authors' calculation based on capital flight data obtained from Ndikumana and Boyce (2018) and UNCTAD statistics

To isolate the impact of capital flight on gross fixed capital formation we apply a fixed-effects regression estimator controlling for country-specific and time-specific unobservable characteristics. Other possibilities, beyond the scope of this paper, include using a quantile regression on the level of IFFs to derive additional insights on the dependent relationship between capital flight and investments. Although Figure 5 suggests a rather non-linear relationship, in the simple linear regression capital flight can explain 14 percent of the changes in capital formation. We cannot identify a direct link between the two. Indeed, controlling for country-fixed effects (Table 1, column (3)), the coefficient becomes insignificant and even positive. Much of the variation can be explained by factors that are fixed across countries and hence, captured by the country-fixed effects. Based on these preliminary findings we argue that it is important to apply an integrated approach to examine the harmful effect of illicit financial flows. Productivity is affected by various channels and so illicit financial flows are likely to be harmful through various channels, going beyond the investment channel.

Table 1: Simple regression analysis, Gross capital formation and capital flight

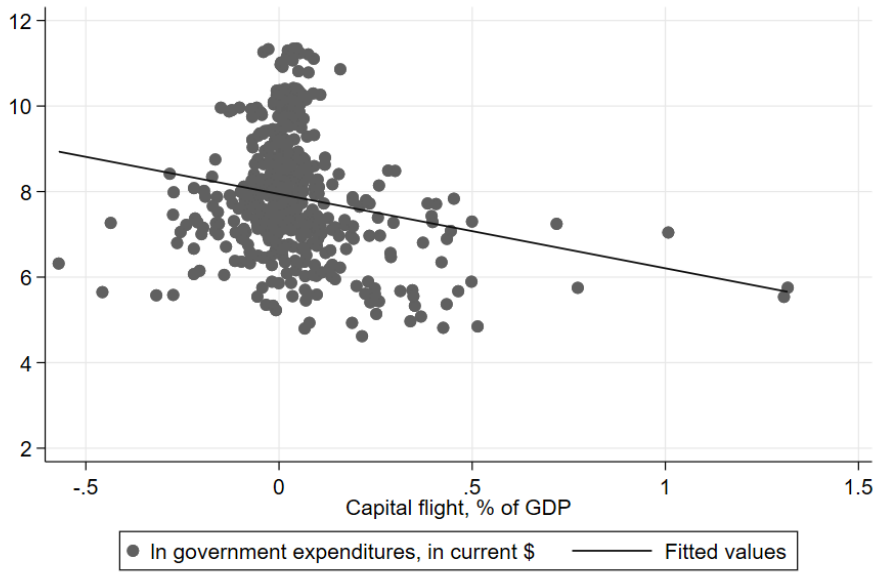
	(1)	(2)	(3)
Dependent variable: ln Capital formation (in $)			
Capital flight, % of GDP	-0.0412***	-0.0401***	0.00217
	(0.00853)	(0.00691)	(0.00242)
Constant	22.52***	20.72***	23.31***
	(0.129)	(0.627)	(0.220)
Observations	281	281	281
Year-fixed effects	No	Yes	Yes
Country-fixed effects	No	No	Yes
R-squared	0.142	0.355	0.971

Public revenues

As already mentioned, the channels through which IFFs impact social development are captured in the financial expenditure effects but may also come through potential negative impacts on political institutions. The impact of IFFs on public revenues, to the best of our knowledge, has still received only marginal attention. And yet, limited public resources cause limited growth in expenditures in health and education which in turn will result in poor performance in reaching the critical SDGs. Total government revenue, as a percent of GDP have been relatively stable over time. African governments raised on average 18 percent (of GDP) tax revenues in 2018 which is small compared to the 33 percent of developed countries (see EDAR 2020). Expenditures on education and health have been relatively stable over time, but to achieve the SDGs more resources, need to be mobilized and spent on both social and productive sectors.

Similarly, as with the analysis of investment, capital flight is negatively associated with government revenue (see Figure 6). Interestingly, countries with negative estimates of capital flight, which would indicate illicit financial inflows, seem to have similarly low levels of government expenditure as those countries with positive capital outflows. This points to institutional leakages (e.g. high levels of corruption) for any kind of unrecorded capital flows. Other reasons for this could be due to data quality and unreliable estimates of capital flight for countries with weak institutional performance. After controlling for time- and country-fixed effects in a simple regression (results are provided in Table 2), higher capital flight seems to be linked to lower government revenue and therefore, limits spending on health and education. However, it should be acknowledged that higher public spending on health and education does not automatically imply higher outcomes (see EDAR, 2020).

Figure 6: Relationship between capital flight (% of GDP) and government expenditures (in million $), 2000-2015



Source: Authors' calculation based on capital flight data obtained from Ndikumana and Boyce (2018) and UNCTAD statistics

Table 2: Simple linear regression of capital flight on government expenditures, 2000-2015

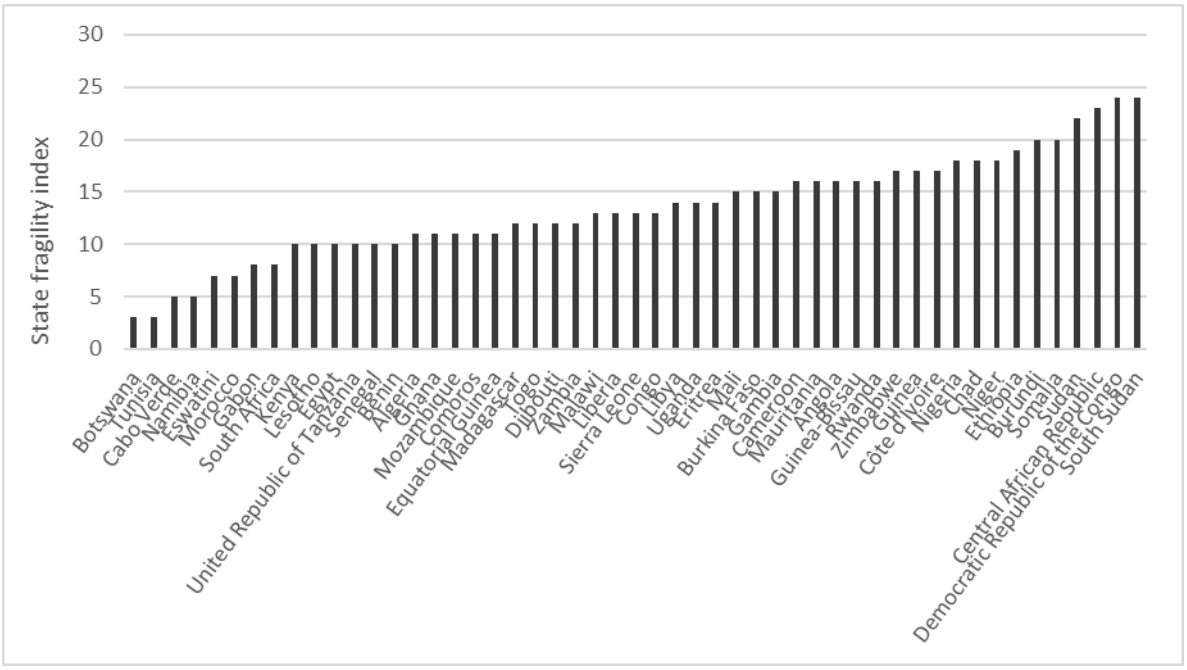
	(1)	(2)	(3)
Dependent variable: ln Government expenditures (in $)			
Capital flight, in % of GDP	-0.0385***	-0.0382***	-0.00256**
	(0.00644)	(0.00592)	(0.00102)
Constant	8.361***	7.288***	9.484***
	(0.103)	(0.441)	(0.155)
Observations	299	299	299
Year-fixed effects	No	Yes	Yes
Country-fixed effects	No	No	Yes
R-squared	0.175	0.262	0.978

Note: Robust standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1

Institutional development

As stated earlier, the bi-directional nature of the interactions between capital flight and institutional quality makes it difficult to firmly assert the impact of poor institutional quality on capital flight. Moreover, a state's capacity to collect data is also linked to institutional quality which raises concerns about selection bias of missing observations. Figure 7 compares the state fragility index across African countries for 2017, emphasizing the strong institutional heterogeneity across countries. The most fragile states are South Sudan, Democratic Republic of the Congo, Central African Republic, Sudan, Somalia, and Burundi. With the exception of Burundi, data is incomplete for all these countries (either capital flight or export underinvoicing, or both is missing).

Figure 7: State fragility index, 2017, African countries

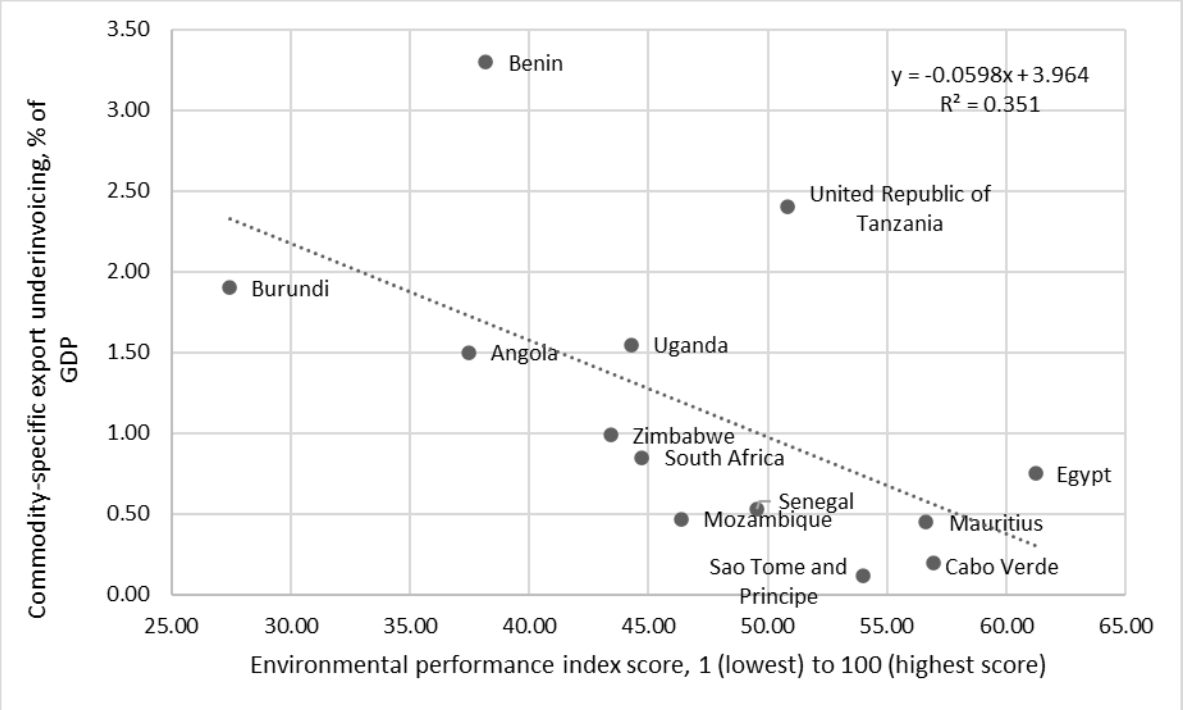


Source: Authors' graph based on data from Center for Systemic Peace.

Environmental sustainability

In order to establish the potential link between environmental sustainability and IFFs, described above, we use information from the Environmental Performance Index (EPI) (Wendling et al., 2018). The EPI combines a number of indicators on environmental health and economic vitality including risk exposure to air pollution and lead poisoning which strongly relate to mining activities.[14] Because of the link to mining activities, the index is compared to the commodity-specific estimates of export underinvoicing (Schuster and Davis, 2020). Indeed, countries where export underinvoicing is less pronounced perform on average better on environmental policies. Figure 8 shows that in 2018, countries with higher values of commodity-specific export underinvoicing may be associated with inferior environmental performance (e.g. in Burundi, Angola, and Benin). In contrast, as indicated from a simple linear regression of export underinvoicing on environmental sustainability (see the black line for the result in Figure 8), countries with relatively higher scores on national environment sustainability commitments and achievements are found in the bottom righthand quadrant of Figure 8 with lower observed commodity-specific export underinvoicing. The relationship between illicit financial flows and environmental sustainability is bi-directionnal. On one hand, inadequate environmental policies and weak enforcement of existing commitments may increase the incidence of illicit resource exploitation and as a channel for capital outflow in extractive industries. On the other hand, the loss of capital undermines public expenditure on biodiversity and climate change mitigation.

Figure 8: Environmental Performance Index and commodity-specific export underinvoicing (as percent of GDP), in 2018



Source: Authors' calculation based on the Environmental Performance Index data.

[14] The construction of the EPI acknowledges the tensions between environmental health (lower environmental risk exposure), which is positively influenced by higher income, and ecosystem vitality (biodiversity and sustainable resource use), which is negatively impacted by industrialization and urbanization, and argues that good governance institutions are a critical factor for the overall performance of sustainability (https://epi.envirocenter.yale.edu/epi-downloads).

4. Empirical approach

4.1. Models and variables

As outlined in section 2 the focus of this analysis is on the potentially direct link between illicit financial flows and productivity levels within sectors. Labour productivity, defined as value added in dollar divided by employment, is constructed for the sectors for which disaggregated data is available from UNCTAD statistics and ILO statistics. Those are: agriculture, mining and quarrying, manufacturing, construction, wholesale and retail trade, transport services and other services.

Two models are estimated. First, equation (1) regresses two estimates of illicit financial outflows - capital flight (in % of GDP) and total-products export underinvoicing (in % of GDP) - on cross-sector labour productivity for country *i* and sector *k,* in time *t.* Increases in the productivity level might not materialize immediately which is why the independent variables all enter with its first lag into the regressions.

$$\ln\left(\frac{\text{value added}}{\text{employment}}\right)_{itk} = \beta_0 + \beta_1\, IFF\ (\%\ of\ GDP)_{it-1} + \beta_2\, Institutions\ indicator_{\ it-1} + \beta_3\, IFF\ (\%\ of\ GDP)_{it-1} \#\ Institutions\ indicator_{\ it-1} + \beta_4 X_{it-1} + \gamma_{kt} + \alpha_{ik} + \mu_{itk} \quad (1)$$

Second, in order to identify sector-specific effects, Equation (1) is re-estimated for each sector *k* (equation (2)).

$$for\ each\ k = 1, \dots N \left\{ \ln\left(\frac{\text{value added}}{\text{employment}}\right)_{it} = \beta_0 + \beta_1\, IFF\ (\%\ of\ GDP)_{it-1} + \beta_2 Institutions\ indicator_{\ it-1} + \beta_3\, IFF\ (\%\ of\ GDP)_{it-1} \#\ Institutions\ indicator_{\ it-1} + \beta_4 X_{it-1} + \alpha_i + \gamma_t + \mu_{it} \right. \quad (2)$$

The two main proxies for Illicit financial flows used in the econometric analysis are capital flight from Ndikumana and Boyce (2018) and export underinvoicing, obtained from Schuster and Davis (2020) (see section 2 for variable description). Additional robustness checks will be discussed using the total trade misinvoicing variable constructed by Ndikumana and Boyce (2018)[15].

Based on preliminary findings on the importance of institutions in economic development and the two-way relationship with illicit financial flows, this interdependency needs to be addressed in the econometric model. Motivated by the interplay between illicit financial flows, institutional quality and economic development, the extent of the harmful effects of illicit financial flows will to some extent, likely depend on the quality of institutions.

On one hand, the legal and regulatory framework of a given economy provides certainties for investment, and on the other hand, a system of institutions set rules, norms and organization "within which individuals accumulate skills, and firms accumulate capital and produce output" (Hall and Jones, 1999; North, 1994; Vitola and Senfelde,

[15] In contrast to the estimate of export underinvoicing, total trade misinvoicing accounts for positive and negative mirror trade gaps in exports and imports. The measure of export underinvoicing seems more accurate for a measure of capital outflows (Schuster and Davis, 2020).

2015). Therefore, a stable and transparent institutional environment increases the efficiency of economic transactions through a reduction in transaction costs. Illicit capital outflows affect socio-economic development dependent on the overall level of transaction efficiency.

The choice of institutional variables is guided by how they have been addressed in the literature on illicit financial flows (e.g. Ndiaye, 2014; Ndikumana, 2014). The estimation separately includes distinct indicators for the quality of institutions ($Institutions\ indicator_{it-1}$); those are:

1) Limited state capacity to ensure security and political stability is proxied by the state fragility index constructed by the Center for Systemic Peace[16] – high uncertainties through political instability increase the marginal impact of each unit of lost capital;
2) An indicator on the perception of control of corruption is obtained from the World Governance Indicators – a high level of corruption increases the costs of information and risks, and reduces the efficiency of capital spending;
3) Using as an indicator for financial sector institutions, the index on financial sector quality, obtained from the World Bank's Country Policy and Institutional Assessment (CPIA) Sub-Index 7[17], proxies financial stability and access to financial resources, going beyond the measure of credit to the private sector – the loss of an additional unit of capital is supposed to be less harmful with a higher spectrum of alternative financial resources; and
4) An institutional indicator of policies for environmental sustainability over time is obtained from CPIA Sub-Index 12[18] - higher quality of environmental sustainability policies is more likely to ensure sustainable resource extraction and illicit financial flows may be less harmful for achieving higher productivity because of the lower environmentally harmful effect of IFFs.[19] The index can also be interpreted as an indicator for the sustainable use of finite natural resources which can reduce economic growth and productivity (Nordhaus, 2014, 1974).

For the interaction with the indicators for the quality of institutions, we expect a negative interaction effect which means that the higher the quality of institutions is, the smaller is the effect of IFF on economic development (decreasing effect of IFFs with higher institutions). In the specifications including the interaction term, all variables (except the dummy variables) are centered mean predictors to make interpretation easier[20]. Centering at its mean also reduces the multicollinearity problem that may arise as a result of including predictors plus their product terms in a regression.

X_{it-1} refers to a set of control variables. Alongside the institutional quality indicators described above, additional observed variables that potentially explain productivity levels are controlled for. The choice of variables is guided by the literature. Initial conditions of structural transformation are proxied by value added in the mining and utilities sector (as a percentage of total value added) in equation (1) and by the sector employment share (as a percentage of total employment) in equation (2). Macroeconomic conditions include gross capital formation (as a percentage of GDP), inflation rate (in % change), obtained from UNCTAD statistics; net enrolment in primary schooling as a proxy for human capital (obtained from UNESCO statistics). Data availability does not allow us to include indicators of higher educational attainment levels. The analysis also aimed to include an indicator for gender gaps in education, following Klasen (2002), Klasen and Lamanna (2009), and Trenszek (2016). However, the simple ratios of female to male primary enrolment rates (for which data availability would be sufficient) are not able to capture the real gender

[16] "A country's fragility is closely associated with its state capacity to manage conflict, make and implement public policy, and deliver essential services, and its systemic resilience in maintaining system coherence, cohesion, and quality of life, responding effectively to challenges and crises" (https://www.systemicpeace.org/inscrdata.html).
[17] The index on financial sector rating includes financial stability (vulnerability to shocks), efficiency and strength of financial sector (competition, interest rates, capitalization, concentration of liquidity) and access to financial services (savings, credits, payments, insurance) (https://databank.worldbank.org/reports.aspx?source=country-policy-and-institutional-assessment). The index is based on qualitative and quantitative information drawn from a number of different sources.
[18] Policy and institutions for environmental sustainability, measured by the CPIA Sub-Index 12, assess the extent to which environmental policies foster the protection and sustainable use of natural resources and the management of pollution (https://databank.worldbank.org/reports.aspx?source=country-policy-and-institutional-assessment).
[19] Additional proxies of good environmental policies have been used as well but the CPIA Sub-Index 12 is the most appropriate indicator for quality of environmental policies. For instance, the existence of a climate law A descriptive analysis shows the correlation of the variables and justifies the introduction of interaction terms to our econometric models.
[20] Centering predictors around their mean (so that the mean of the new predictor is 0) is also one way of reducing the multicollinearity problems that may arise as a result of including predictors plus their product terms in a regression, and the coefficient of the interaction will not be affected.

gaps over the past decade which are mainly observed in higher education and quality of education while observing an upward trend of primary schooling. To control for climate change, the number of natural disasters is included in the regression[21]. Data is obtained from Emergency Events Database (EM-DAT), Centre for Research on the Epidemiology of Disasters (CRED). Each natural disaster destroys infrastructure, kills people and is likely to reduce productivity. Time-sector dummies (γ_{kt}) account for technology changes and other unobservable factors that affect productivity levels over time across countries, and country-sector dummies (α_{ik}) control for time-invariant unobservable variables such as cultural differences and geography.

The final choice of control variables is partly guided by the Akaike Information Criterion. We run diagnostic tests to identify multicollinearity between the variable of interest and control variables and include variables step-by-step. This procedure, for instance, led to the exclusion of some additional variables (e.g. rule of law, voice and accountability, gender parity in education). Variables definition, sources and expected coefficient signs are provided in Table 3.

Table 3: Variable description and data source

Variable	Description	Data source	Expected sign
IFFs	a) Capital flight as percentage of current GDP; b) Total trade export underinvoicing (extraregional) as percentage of current GDP	Ndikumana and Boyce (2018); Schuster and Davis (2020)	-
Institutional quality and interaction terms			
State fragility index	The index measures State performance with regard to effectiveness and legitimacy in addressing shocks and crises: 1=low level of fragility; 25=high level of fragility	Centre for Systemic Peace	-
Interaction of IFFs*State fragility index			
Control of corruption	The indicators are based on variables showing the perception of corruption: -2.5=high corruption; 2.5=low corruption	World Bank world governance indicators	+
Interaction of IFFs*control of corruption			
Financial sector rating in CPIA subindex No. 7	The subindex assesses financial stability and access to financial resources: 1=low financial sector rating; 6=high financial sector rating	World Bank	+
Interaction of IFFs*financial sector rating			
Environmental sustainability rating in CPIA subindex No. 12	The subindex assesses policy and institutions for environmental sustainability: 1=low environmental sustainability rating; 6=high environmental sustainability rating	World Bank	+
Interaction of IFFs*financial sector rating			
Control variables			
Mineral resource dependency	Share of value added in the mining and utilities sectors as percentage of total value added	UNCTAD statistics	-

[21] The paper does not provide a discussion of the link between climate change and the occurrence of natural disasters, but refers to the literature on the nexus (e.g. https://www.gfdl.noaa.gov/global-warming-and-hurricanes/.)

Sector employment share	Number of employed per sector, as a percentage of total employment	UNCTAD statistics	-
Gross capital formation	Gross capital formation as percentage of GDP	World Bank world development indicators	+
Inflation	Change in annual consumer price index (percentage)	World Bank world development indicators	-
Primary enrolment rate	Net enrolment rate in primary education	UNESCO	+
Natural disasters	Number of occurrences each year	Emergency events database	-

Note: Descriptive statistics of the variables is provided in Table 9 and Table 10 in the appendix.

4.2. Estimation procedure and econometric challenges

The dataset covers observations on labour productivity from 2000 to 2016 and measures on IFFs from 2000 to 2015. The period of 2000 to 2015/16 is chosen in order to allow some comparison between the two variables of IFFs – capital flight and export underinvoicing. The number of countries included in the regression depends on the data coverage of the IFF estimate (see Table 8 in the appendix) and the control variables (see Table 10). The estimation procedure is explained as follows.

Reverse causality

The main econometric challenge in identifying the impact of illicit financial flows on productivity is endogeneity, caused by omitted variables and reverse causality. The impact of illicit financial flows on productivity is affected by reverse causality, as increasing labour productivity is hypothesized to provide greater returns to investments in the local economy and would potentially disincentivise illicit outflow of capital. If reverse causality is not addressed, Ordinary Least Squares (OLS) estimates may produce biased and inconsistent estimates. Both, equations (1) and (2) are estimated using standard fixed effects estimator, controlling for unobserved heterogeneity, autocorrelation, and correlation across panels (Driscoll-Kraay standard errors). While endogeneity caused by omitted variable bias can be partly captured by the set of fixed-effects (α_{ik} and γ_{kt} in equation (1), α_i and γ_t in equation (2)) endogeneity due to reverse causality is still an issue. The inclusion of fixed effects may reduce the impact of cofounding factors and unobserved characteristics but will not solve reverse causality. However we can mitigate this problem using lagged independent variables as labour productivity is less likely to affect past values of IFFs. Additional robustness checks with higher lag order are discussed in section 6.

The best way to address endogeneity would be to use an Instrumental Variable (IV) approach. However, an IV would only be feasible under the restrictions of having a valid instrument. In order to be valid, a potential instrument needs to satisfy the relevance condition (it must be strongly correlated with our measure of IFFs) and the exclusion restriction (it must not affect labour productivity other than through our measure of IFFs). If these conditions are not met, invalid instruments may even cause a larger bias than in the fixed-effects model. While the baseline regressions rely on a static model, and a partially dynamic model through the inclusion of lagged independent variables, this approach may be too simplistic. To address this shortcoming, we also estimate a dynamic panel model by including the first lag of the dependent variable. The dynamic model is only discussed as a robustness check in Section 6 as this procedure introduces additional problems. The correlation between the lagged dependent variable and the error term (Nickell, 1981) introduces a bias. Arellano and Bond (1991) propose a solution using a Generalized Methods of Moments (GMM) model and the application of a first differencing model using the lags of the independent variables as instruments. In addition, Blundell and Bond (1998) and Bond et al. (2001) show with simulations that first-differencing in a GMM framework can also lead to biased and inconsistent estimates if the number of observations is insufficiently large, and if the explanatory variables are persistent over time. They suggest using a dynamic version of this model called a system GMM, that is based on an assumption of stationarity for

persistent time series. Studies that use this type of model include Asongu and Nwachukwu (2017) and Yalta and Yalta (2012). However, GMM does not solve the problem of invalid instruments as Bun and Windmeijer (2010) argue that the issues raised by Bond et al. (2001) are still present when the concentration parameters (unobserved heterogeneity and idiosyncratic errors) in persistent time series are similar in the covariance stationarity model. [22]

Selection bias

Another recurring problem in evidence-based research for African countries is the lack of available data over an extensive timeline. Data quality is also critical and should encompass four principles: the information needs to be accurate, timely, disaggregated and widely available. Least developed countries, composed mostly of African countries, produce the least information, as they lack the institutions and infrastructure needed to build the capacity to report such metrics. The literature is limited by this scarcity of information, and so is our research. If all African countries are not represented in the dataset, it can lead to significant bias and sampling issues when performing regression analysis. Many countries for which no data is available are small and highly fragile states. Among the 10 most fragile states from Figure 7, with no data on capital flight available includes: South Sudan, Central African Republic, Somalia, Niger, Chad; and those with insufficient data on export underinvoicing include: the Democratic Republic of the Congo, South Sudan, Sudan, Somalia, Ethiopia and Chad. Hence, our estimates are likely to be biased due to the omission of countries with weak institutions, which affects their capacity to produce quality data on socio-economic and trade statistics.

Empirically, there is no easy way to adequately control for the selection bias. Approaches such as the Heckman selection model require a valid selection variable[23] which appears to be highly difficult. Instead, we discuss several robustness checks, for instance, how setting negative values of IFF estimates to zero may influence the results.

5. Results

5.1. Cross-sector productivity

The regression results are interpreted in terms of their significance levels rather than the size of the coefficient estimates. Although the coefficient estimates are similar across different specifications, they are still subject to a potential bias in the estimation which is discussed further. The estimates give an idea of what curbing IFFs could mean for increasing productivity in Africa.

Capital flight

Table 4 presents the results from the fixed-effects regression as specified in equation (1) for capital flight (as a percentage of GDP). Each column shows the results obtained with and without different interaction terms. The coefficient estimate of capital flight is significantly negative in each specification, except for when the interaction with state fragility is controlled. The interaction with state fragility itself is also significant, meaning that a country's vulnerability to political and economic distress indeed influences the marginal impact of each unit of lost capital. This can be related to an overall more business-friendly environment. The endogeneity problem is addressed in a robustness check but seems less of a concern than the selection bias. Many countries for which data on capital

[22] The existence of interaction terms of two continuous variables in our model makes it even more difficult to find valid instruments (indicated by the Sargan test and the high sensitivity of our results to the lag of instruments). We have confidence that the Nickell bias which may exist due to the inclusion of the lagged dependent variable is small in our model because of the sufficiently large number of time periods. With that, system-GMM approach is also biased when N is small compared to T. In the case of weak instruments, the obtained bias might be even higher than in the FE estimation.

[23] The selection variable in the Heckman procedure is the variable that determines the selection equation but not the outcome equation of an dependent variable, meaning that this variable may not influence the value or variation of an dependent variable but only whether the dependent variable is observed (0/1).

flight or quality trade data is not available are countries with lower capacity to manage political distress and experience lower productivity levels. Higher state fragility has a significantly negative influence on a country's labour productivity.

In economic terms, the estimates suggest that a one-percentage point reduction of capital flight (as a percentage of GDP) increases productivity by up to 0.0025 percent (Table 4, column (4)). With average capital flight at 11 percent of GDP (negative values deleted) over the period 2000 to 2015 (see Table 9 in Appendix I for descriptive statistics), this would mean that annual labour productivity levels could be 0.0275 percent higher every year. Although this number seems low, it should be noted that productivity increases have been very low in Africa, with recent increases since 2010 of below one percent per year.

If tackling Illicit financial flows is accompanied or fostered through an improvement in institutional quality the positive multiplier effect on productivity would be larger. Higher control of corruption and higher quality of financial institutions providing access to financial resources, which are both a means of fighting illicit financial flows, are associated with higher productivity levels. The direct impact of capital flight is not affected by the inclusion of these institutional variables or the control variables[24].

Regarding control variables, gross fixed capital formation (as a percentage of GDP) positively affects productivity levels through productive investments. In addition, the number of natural disasters, including all types of natural disasters[25], strongly impacts productivity levels across African countries. Primary education enrolment is however not significant in most specifications. Although this variable yields the best data coverage over time and across countries, enrolment in primary education itself is unable to capture the quality of human capital essential to boost labour productivity. With regards to capital flight, government revenue is reduced through tax avoidance; and expenditures on education and health are lower in countries with high estimates of capital flight (see section 3). However, due to poor access to health and education facilities the efficiency of public spending to improve outcomes in health and education is low (Kharas and McArthur, 2019; Kapsoli and Grigoli, 2013; Gaspar et al., 2019).

Trade-related Illicit financial flows

For comparative purposes, we look at trade-related IFFs. As identified in Schuster and Davis (2020) and UNECA (2015) most of the IFFs stem from the extractive industries in Africa. The results for export underinvoicing as a (first) proxy for trade-related IFFs are presented in Table 5. Export underinvoicing boasts a significantly negative association with productivity. For the larger sample including the variables state fragility and control of corruption, as well as their interaction terms, the marginal impact of the loss of capital due to export underinvoicing is equally harmful for productive capacity as capital flight (Table 5, columns (1)-(4)). The impact is however not significant for the smaller sample including the variables from the CPIA index. Higher adjusted R^2 in the specifications shown in columns (1) to (4) (0.53-0.56) compared to the columns (5) to (8) (0.26-0.27) suggest that the results in columns (1) to (4) are more reliable and suffer less from a potential selection bias due to loss of data for a number of countries.[26]

In contrast to the measure of capital flight, the interaction of export underinvoicing with control of corruption is significant (Table 5, column (4)), indicating that the harmful impact of trade-related Illicit financial flows is more strongly channeled through high levels of corruption. Export misinvoicing of goods crossing the border involves practices of corruption more than other sources of illicit financial flows which can be transferred through, for instance, banks. As a robustness check, the total trade misinvoicing estimate, obtained from Ndikumana and Boyce

[24] Results for each separate specification, including control variables each at a time, are available upon request.
[25] The EM-DAT database provides data for biological, meteorological, hydrological, geophysical, and climatological disasters. We use the sum of occurrence.
[26] Despite the lack of data for the CPIA Index for many countries, the proxies are still preferred to other indicators of financial quality or environmental policies. For instance, the credit-to-private sector rating as a measure of financial depth is unable to explain inclusive access to financial resources, and therefore cannot be associated with productivity increases.

(2018), yields the same finding (see Table 11 in the appendix), i.e. fighting corruption effectively, reduces the harmful marginal impact of trade-related Illicit financial flows on productivity.

Regarding control variables, we observe slight differences across the results. For instance, for the sample for which export underinvoicing is positive, higher net primary education also increases productivity levels within countries. This may be related to the sample of countries for which data on export underinvoicing is available. On average, these countries have a lower educational attainment level than countries for which data on capital flight is available. The difference in the results also relates to the countries' economic structure. For the countries where export underinvoicing is positive and which are hence included in the regressions, the share of mining value added is positively associated with productivity levels since these countries depend heavily on extractive industries as a main source of income. The sensitivity of the results to the country coverage and how the seemingly random selection of countries influences our findings is discussed in section 6.

Table 4: Fixed-effects regression estimates, capital flight (outflows), 2000-2016

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	No Interaction	Interaction with State fragility	No interaction	Interaction with Control of corruption	No interaction	Interaction with Financial sector rating	No interaction	Interaction with Environmental sustainability
Dependent variable: ln cross sector labour productivity								
L. Capital flight (CF) (% of GDP)	-0.00164***	-0.00099	-0.00202***	-0.00247**	-0.00224***	-0.00216**	-0.00212**	-0.00174*
	(0.000540)	(0.000736)	(0.000571)	(0.000901)	(0.000594)	(0.000706)	-0.000688	(0.000932)
L. State fragility	-0.0202**	-0.0193**						
	(0.00937)	(0.00899)						
L.State fragility*CF		-0.000528**						
		(0.000202)						
L. Control of corruption			0.157***	0.164***				
			(0.0325)	(0.0333)				
L. Control of corruption*CF				0.00233				
				(0.00203)				
L. Financial sector rating					0.152*	0.153*		
					(0.0765)	(0.0768)		
L. Financial sector rating*CF						-0.000624		
						(0.00165)		
L. Environmental sustainability							-0.0204	-0.00686
							(0.0286)	(0.0362)
L. Environmental sustainability*CF								-0.00237*
								(0.00125)
L. Share of mining value added (% of total)	-0.000739	-0.00104	-1.78e-05	0.000188	0.00271	0.00253	0.000324	-0.00163
	(0.00139)	(0.00144)	(0.00167)	(0.00166)	(0.00349)	(0.00384)	(0.00313)	(0.00414)
L. Gross fixed capital formation (% of GDP)	0.00267*	0.00300**	0.00239**	0.00233*	0.00403**	0.00400*	0.00328*	0.00272
	(0.00141)	(0.00138)	(0.00109)	(0.00109)	(0.00179)	(0.00183)	(0.00177)	(0.00206)
L. Inflation	-0.00223	-0.00275	-0.00103	-0.00128	-0.00450	-0.00449	-0.00576	-0.00566
	(0.00264)	(0.00245)	(0.00355)	(0.00331)	(0.00349)	(0.00346)	(0.00334)	(0.00323)
L. Primary education	0.00198	0.000443	0.00275*	0.00233	0.000651	0.000867	0.00104	0.00187
	(0.00145)	(0.00156)	(0.00145)	(0.00146)	(0.00107)	(0.00123)	(0.000919)	(0.00127)
L. Natural disasters	-0.0137*	-0.0135**	-0.0120*	-0.0121*	-0.00803	-0.00793	-0.00886	-0.00867
	(0.00701)	(0.00632)	(0.00635)	(0.00607)	(0.00922)	(0.00906)	(0.00981)	(0.00964)
Observations	1,393	1,393	1,344	1,344	784	784	784	784
Number of groups	168	168	168	168	126	126	126	126
Adjusted R-squared	0.626	0.630	0.585	0.587	0.378	0.378	0.367	0.370

Note: Driscoll-Kraay standard errors in parentheses, country-sector and sector-year fixed effects always included. *** p<0.01, ** p<0.05, * p<0.1

Table 5: Fixed-effects regression estimates, Export underinvoicing, 2000-2016

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	No Interaction	Interaction with State fragility	No interaction	Interaction with Control of corruption	No interaction	Interaction with Financial sector rating	No interaction	Interaction with Environmental sustainability
Dependent variable: ln cross sector labour productivity								
L. Export underinvoicing (EU) (% of GDP)	-0.00187*	-0.00215*	-0.00119	-0.00285**	0.000786	-0.000994	0.000621	0.000500
	(0.00104)	(0.00104)	(0.000990)	(0.00123)	(0.00157)	(0.000983)	(0.00146)	(0.00196)
L. State fragility	-0.0172***	-0.0171***						
	(0.00535)	(0.00528)						
L. State fragility*EU		-0.000309						
		(0.000559)						
L. Control of corruption			0.144***	0.110**				
			(0.0395)	(0.0481)				
L. Control of corruption*EU				-0.0134**				
				(0.00506)				
L. Financial sector rating					0.0446	0.0395		
					(0.0690)	(0.0596)		
L. Financial sector rating*EU						-0.0101**		
						(0.00410)		
L. Environmental sustainability							0.0232	0.0359
							(0.0355)	(0.0386)
L. Environmental sustainability*EU								-0.00447
								(0.00249)
L. Share of mining value added (% of total)	0.0162***	0.0164***	0.0177***	0.0159***	0.00986**	0.0107**	0.00959**	0.0103**
	(0.00380)	(0.00381)	(0.00346)	(0.00301)	(0.00388)	(0.00399)	(0.00417)	(0.00363)
L. Gross fixed capital formation (% of GDP)	0.00126	0.00106	0.00199	0.000890	0.00505**	0.00530**	0.00527**	0.00513**
	(0.00221)	(0.00237)	(0.00201)	(0.00228)	(0.00176)	(0.00202)	(0.00204)	(0.00210)
L. Inflation	0.00134	0.00146	0.00300*	0.00289	-0.00117	-0.000376	-0.000290	-0.000381
	(0.00154)	(0.00147)	(0.00167)	(0.00185)	(0.00176)	(0.00151)	(0.00156)	(0.00168)
L. Primary education	0.00785***	0.00814***	0.00805***	0.00849***	0.00694***	0.00689***	0.00628***	0.00668***
	(0.00148)	(0.00150)	(0.00173)	(0.00188)	(0.00194)	(0.00175)	(0.00183)	(0.00187)
L. Natural disasters	-0.0153	-0.0156	-0.00666	-0.00512	0.00647	0.00572	0.00560	0.00429
	(0.0112)	(0.0114)	(0.00764)	(0.00694)	(0.0100)	(0.00993)	(0.00867)	(0.00871)
Observations	1,631	1,631	1,519	1,519	798	798	798	798
Number of groups	203	203	203	203	140	140	140	140
Adjusted R-squared	0.581	0.581	0.552	0.558	0.252	0.261	0.251	0.258

Note: Driscoll-Kraay standard errors in parentheses, Country-sector and sector-year fixed effects always included. *** p<0.01, ** p<0.05, * p<0.1

5.2. Heterogeneity across sectors

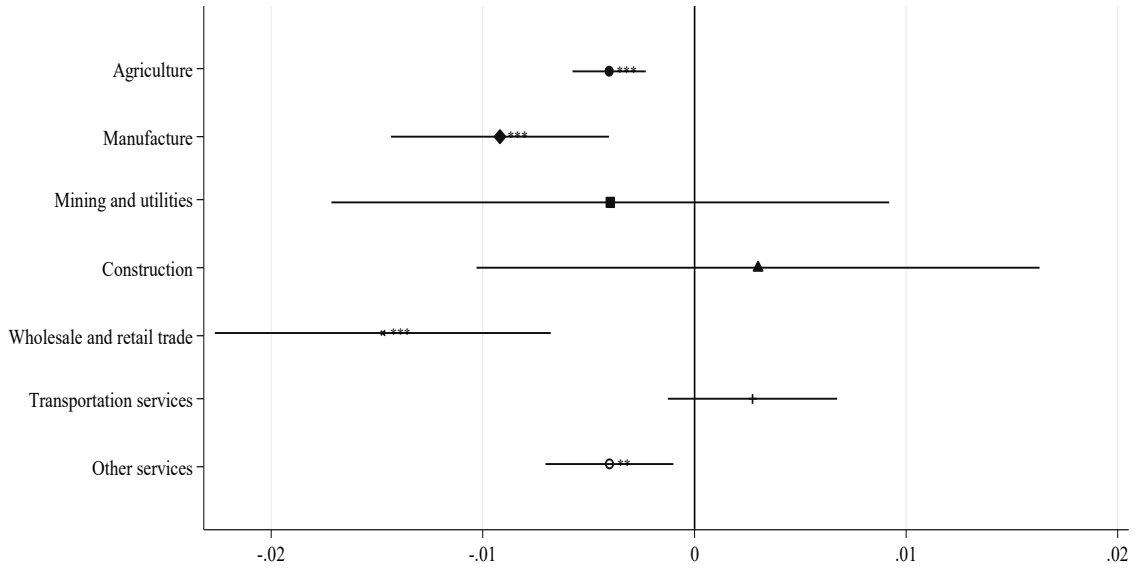
In what follows, the discussion of heterogenous effects of illicit financial flows on productivity across sectors contributes to the understanding of how illicit financial flows may increase inequalities. The low-productivity sectors (e.g. agriculture) may be differently affected by illicit financial flows than high productivity sectors (e.g. mining and utilities). Notably, trade-related capital outflows which can be traced back to economic sectors may be closely associated with adverse economic impacts, hence further contributing to income disparities.

Our results obtained from the by-sector regressions on labour productivity (equation 2) indicate that sectors are differently affected by illicit financial flows. However, it is trade-related IFFs rather than capital flight that seems to be strongly associated with lower within-sector productivity. We carefully argue that adverse sector-specific effects may be channeled from IFF-prone sectors to locally or economically close sectors. In other words, negative externalities from poor management of resources and illicit financial flows are mostly captured through trade-related IFFs. Therefore, the following discussion will focus on the results obtained from using export underinvoicing.

The heterogeneity of sector effects is displayed in Figure 9 by the estimated coefficient results of export underinvoicing associated with sector labour productivity. The estimates refer to the specification including control of corruption and its interaction with export underinvoicing.

The strongest negative harmful effect of IFFs, in terms of significance level and size of the coefficient estimate, is observed for the sectors with the lowest productivity levels, i.e. Agriculture, Wholesale and retail services, and Manufacturing. The following discussion sheds light on the potential linkages behind these findings, and offers additional perspectives on structural transformation, including value added in manufacturing and the service sector.

Figure 9 : Sector-specific results for Export underinvoicing, Interaction with corruption



Note: Authors' calculation. The graph shows the coefficient estimates for each sector k, obtained from a Fixed-effects estimation of equation (2). ***, **, * refer to 1, 5 and 10 percent significance levels respectively.

Agriculture

Africa's relatively low level of agriculture productivity is a major obstacle to poverty reduction, food security and gender equality (Nin-Pratt, 2015). Furthermore, female farmers tend to have lower productivity levels than male farmers due to lesser access to finance and agricultural inputs (UN Women, 2019). Access to land and access to capital are among the main reasons that prevent farmers to graduating from subsistence and to higher productivity farming.

It is hypothesised that the negative externalities from illicit financial flows are most likely transmitted through unsustainable extraction of resources. The extractive industries are the most prone to illicit financial flows. It follows that we use the commodity-specific estimate of export underinvoicing, obtained from Schuster and Davis (2020), to have a more accurate measure of Illicit financial flows in the extractive industries. Results are reported in Table 12 in the appendix, for using both, all products (Table 12, columns (1)-(4)) and commodity-specific (columns (5)-(8)) export underinvoicing. Although we would expect a larger negative effect of commodity-specific export underinvoicing on agriculture productivity, the coefficient estimate is not significant. Rather, the share of mining value added becomes significantly negative. This finding suggests that the higher the share of mining and utilities in total value added, the lower the estimate on agriculture productivity. Poor management and environmentally unsustainable use of natural resources negatively impacts agriculture productivity (Aragón and Rud, 2016). Mis-managed extractive industries in combination with low environmental standards can have a negative impact on water resources, air pollution and soil productivity (Aragón and Rud, 2016).[27] The index on environmental sustainability and its interaction with export underinvoicing is significant at the 1-percent level. Higher ratings of policies and institutions for environmental sustainability are not only positive for agriculture productivity but they also reduce the vulnerability of the agriculture sector to negative externalities from export underinvoicing.

In contrast to the results obtained for the cross-sector specification, reported in Table 5, the index on control of corruption and financial sector rating seems to play a less important role for explaining productivity levels in the agriculture sector. Nevertheless, lack of investment and financial resources potentially reduces the availability of funds for agricultural activities. Securing finance to raise productivity or innovate has been a major impediment on growth for smallholder farmers (McMillan et al., 2017).

Negative externalities due to the activities of extractive industries which may impact agricultural productivity can arise from competition over land use, changes in land prices and expropriation (UNECA and African Union, 2011; Kotsadam and Tolonen, 2016; Ouoba, 2018). Furthermore, the significant coefficient estimate of export underinvoicing in interaction with levels of state fragility may be linked to a deterioration in peace and security from poor management of natural resources (Berman et al., 2017).

Manufacturing

The potential of developing a competitive manufacturing sector differs across African countries but the positive spillover effects of manufacturing activities to the primary and tertiary sector cannot be neglected in the existence of strong backward and forward linkages. Development of the manufacturing sector would make countries less dependent on mining commodities and agriculture output which is also more vulnerable to externalities, such as climate change and commodity prices. Instead of productivity in the manufacturing sector, the share of manufacturing value added in total value added has traditionally been used as an indicator for structural transformation. To acknowledge the importance of a prospering manufacturing sector for many African countries in order to provide decent job opportunities, we provide empirical evidence on how export underinvoicing can be negatively associated with lower manufacturing value added. Table 6 displays the regression results for manufacturing value added (columns (1) to (4)) and manufacturing productivity (columns (5) to (8)). The coefficient estimates of export underinvoicing are very similar in terms of size of the coefficient across model specification but slightly more significant in the models using manufacturing productivity as the indicator of sustainable development.

[27] Using household level data from Ghana, Aragón and Rud (2016) estimate that large-scale gold mining has reduced agriculture productivity by 40 percent in areas which are closer to the mine. The effect is mainly driven by high pollution rather than the availability of inputs.

Hence, trade-related IFFs can be negatively associated with manufacturing productivity; the coefficient estimates are larger than those obtained for the cross-sector specification, reported in Table 5.

Regarding institutional variables, higher control of corruption and a high rating of the financial sector are associated with higher productivity in manufacturing as they reduce inefficiencies and provide financial resources for investments in productive capacity. In contrast, the estimates are not significant for value added in manufacturing. Moreover, primary education is positively and the number of natural disasters per year is negatively correlated with manufacturing productivity. Curbing IFFs can be invested in education, infrastructure to increase access to education facilities, and in building resilience from natural disasters.

Services

The services sector can play a vital role in structural transformation of many African countries. The sector-specific results indicate that there is a statistically significant negative relationship between productivity in the wholesale and retail service sector and export underinvoicing. The sector has the second lowest productivity across sectors and the second highest share of female employment. Hence, females are particularly vulnerable to the outflow of capital.

As an additional measure of structural transformation, value added in services is regressed on export underinvoicing. The results are provided in Table 13 in the appendix. We find a significantly negative coefficient estimate of export underinvoicing for the sample of 29 countries (Table 13, columns (1) and (2)). This finding cannot be confirmed for the broader capital flight measure. It seems that the macroeconomic measure of illicit financial flows is unable to explain sector-specific effects and that rather trade-related illicit financial flows are negatively associated with reduced sector productivity through negative externalities and the vulnerability of low-productivity sectors to illicit financial outflows.

Table 6: Fixed-effects regression estimates, Manufacturing (ln value added and productivity), 2000-2016

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	ln Manufacturing value added				ln Manufacturing labour productivity			
	Interaction with State fragility	Interaction with Control of corruption	Interaction with Financial sector rating	Interaction with Environmental sustainability	Interaction with State fragility	Interaction with Control of corruption	Interaction with Financial sector rating	Interaction with Environmental sustainability
L. Export underinvoicing (EU) (% of GDP)	-0.0074***	-0.00774***	-0.000590	-0.00222	-0.00755***	-0.0086***	-0.00334*	-0.00395**
	(0.00208)	(0.00194)	(0.00174)	(0.00134)	(0.00221)	(0.00228)	(0.00162)	(0.00144)
L. State fragility	-0.00108				-0.000534			
	(0.00881)				(0.00696)			
L. State fragility*EU	0.0020***				0.00145***			
	(0.00066)				(0.000439)			
L. Control of corruption		0.155				0.111*		
		(0.0947)				(0.0593)		
L. Control of corruption*EU		-0.00447				-0.00584		
		(0.00480)				(0.00503)		
L. Financial sector rating			-0.00501				0.0890*	
			(0.0676)				(0.0418)	
L. Financial sector rating*EU			0.00235				-0.00428	
			(0.00593)				(0.00531)	
L. Environmental sustainability				0.00787				0.0298
				(0.0762)				(0.0388)
L. Environmental sustainability*EU				-0.0139***				-0.0157***
				(0.00245)				(0.00323)
L. Share sector employment (% of total)					-0.0630***	-0.0583***	-0.0752	-0.0765*
					(0.0102)	(0.00811)	(0.0508)	(0.0402)
L. Share of mining value added (% of total)	0.0107**	0.0157***	0.00762	0.00926**	0.0124**	0.0156***	0.00799	0.00843*
	(0.00450)	(0.00447)	(0.00583)	(0.00363)	(0.00520)	(0.00485)	(0.00689)	(0.00447)
L. Gross fixed capital formation (% of GDP)	-0.00155	0.000329	0.00327	0.00222	-0.00388	-0.00195	0.00257	0.00141
	(0.00344)	(0.00194)	(0.00241)	(0.00265)	(0.00409)	(0.00273)	(0.00309)	(0.00300)
L. Inflation	-0.000972	-0.00146	-0.00489*	-0.00559*	0.000199	0.00212	-0.000907	-0.000775
	(0.00217)	(0.00191)	(0.00218)	(0.00268)	(0.00100)	(0.00163)	(0.00136)	(0.00135)
L. Primary education	0.0094***	0.0128***	0.00271	0.00502	0.0104***	0.0128***	0.00813	0.0102
	(0.00186)	(0.00231)	(0.00385)	(0.00505)	(0.00138)	(0.00161)	(0.00516)	(0.00586)
L. Natural disasters	-0.0261**	-0.0153**	-0.0248**	-0.0306***	-0.0199	-0.00794	-0.0144*	-0.0220**
	(0.0103)	(0.00618)	(0.00918)	(0.00843)	(0.0115)	(0.00532)	(0.00684)	(0.00910)
Observations	217	206	103	103	217	201	103	103
Number of groups	29	30	20	20	29	29	20	20
Adjusted R-squared	0.799	0.787	0.608	0.643	0.698	0.691	0.357	0.415

Note: Driscoll-Kraay standard errors in parentheses, Country and year fixed effects always included. *** p<0.01, ** p<0.05, * p<0.1

6. Robustness checks

The relatively robust finding of a significantly negative impact of different proxies of illicit financial flows on various dimensions of structural transformation may still be subject to some bias despite the rigorous empirical approach. In what follows, this section discusses several robustness checks and provides further evidence for the harmful effect of illicit financial flows on sustainable development. First, the results may be sensitive to the set of fixed effects and the number of lags introduced in the regressions. Second, a dynamic model may be more accurate to explain the harmful impact of illicit financial flows on structural transformation. Despite econometric challenges, the results obtained from the dynamic model deserve further consideration. Third, the potential sample selection bias and the choice of countries require some attention. The section also addresses how countries may be affected by external policies that aim to improve financial transparency, such as the Dodd-Frank-Act.

Set of fixed effects and lag structure

The modeling of fixed effects may influence coefficient estimates. In contrast to the main baseline regressions of equation (1) where country-sector and sector-year fixed effects are introduced, robustness checks with country-sector and year-fixed effects, as well as country-sector, year- and sector-fixed effects are conducted. The findings are highly robust to the choice of fixed effects.[28]

In order to address potential reverse causality, the main specification assumes a one-year lagged effect of the explanatory variables on labour productivity. The number of lags however must be carefully evaluated. The results are reported in Table 14 in the appendix for "no lag" (columns (1)-(4)), a lag of two-years (columns (5) – (8)) and a five-years lag (columns (9)-(12)). We find that the negative link between capital flight and labour productivity can only be established within a lag of one year. In contrast to our main findings discussed in Section 5, the variables gross fixed capital formation and primary education level increase in size and significance level with a higher number of lags. Although the robustness of a direct link of illicit financial flows on labour productivity cannot be confirmed throughout the specifications, illicit financial flows may still influence productivity indirectly through an impact on private investments and public expenditures on education (see section 2 for a discussion of the channels).

Dynamic model

As stated in section 3, the static model with lagged independent variables may insufficiently explain the dynamic long-run impact of illicit financial flows on labour productivity. Although a dynamic model causes additional econometric challenges, it is considered as an important robustness check. The specification of the dynamic model follows the respective literature on capital flight. A standard dynamic model with the first lag of the dependent variable but no lags of the independent variables is introduced (see Equation (3)). While such variation in contrast to equation (1) limits the direct comparison of the results it allows us to justify our findings compared to those in the literature (i.e. Ndikumana, 2014; Dachraoui and Smida, 2014; Ndiaye, 2014).[29]

$$
\begin{aligned}
ln\left(\frac{\text{value added}}{\text{employment}}\right)_{ikt} &= \beta_0 + \beta_1 \ln value\ added/emplyoment_{ikt-1} + \beta_2 IFF\ (\%\ of\ GDP)_{it} \\
&+ \beta_3 Institutions\ indicator_{it} \\
&+ \beta_4\ IFF\ (\%\ of\ GDP)_{it} \# \ Institutions\ indicator_{it} + \beta_5 X_{it} + \gamma_{kt} + \alpha_{ik} + \mu_{itk}
\end{aligned} \tag{3}
$$

The dynamic model is estimated using a fixed effects estimator controlling for unobserved heterogeneity, autocorrelation and correlation across panels. The results for capital flight are presented in Table 7 and for export underinvoicing in Table 15 in the appendix.

[28] Results are available upon request.

[29] Other specifications of the dynamic model such as introducing the one-year lagged dependent and one-year lagged independent variables at the same time were also tested but suffer from multicollinearity.

Compared to the main specification reported in Table 4 the results largely confirm the findings: As expected, the lagged dependent variable is significant and positive indicating that productivity in previous periods well determine future productivity levels. Capital flight remains negative and significant, with slightly smaller coefficient estimates, ranging from -0.0013* to -0.00186*** (compared to -0.00099 to -0.00247** in Table 4). Moreover, lower state fragility and higher control of corruption significantly increase productivity growth. The interaction between capital flight and institutional variables does not appear to be statistically significant. Other coefficient estimates are much in line with the main findings. Only primary education now plays a more important role in explaining the long-run impact on labour productivity.

The results from the static and the dynamic model are generally in line with the findings on capital flight and economic development from the literature. For instance, Ndikumana (2014) yield a coefficient estimate of -0.082** (Fixed-effects estimator) and -0.064*** (system-GMM) on domestic investments for a sample of 39 African countries; and Ndiaye (2014) an estimate of -0.0326 to -0.136** on economic growth for the CFA-Franc-Zone. While the dynamic model should be favored to explain the long-run impact on labour productivity growth, it suffers from perfect multicollinearity and endogeneity of the lagged dependent variable (see section 4.2. for limitations of the system-GMM estimator). Roodman (2009) argues that the Nickell bias stemming from the correlation of the lagged dependent variable and the error term will become less significant the larger the T-dimension in panels. With this, the FE estimator appears to be comparatively more efficient for our dataset than the system-GMM estimator. In addition, most specifications fail to pass the Sargan test of overidentification for valid instruments which is why we refrain from an interpretation of the results obtained with the system-GMM estimator.[30]

[30] The coefficient estimates for capital flight become insignificant but remain negative. The results are available upon request.

Table 7: Dynamic model – Fixed effected regression estimates, 2000-2015

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	No Interaction	Interaction with State fragility	No interaction	Interaction with Control of corruption	No interaction	Interaction with Financial sector rating	No interaction	Interaction with Environmental sustainability
Dependent variable: ln cross sector labour productivity								
L. ln labour productivity	0.663***	0.663***	0.663***	0.663***	0.570***	0.570***	0.570***	0.569***
	(0.0532)	(0.0532)	(0.0589)	(0.0587)	(0.0589)	(0.0598)	(0.0697)	(0.0696)
Capital flight (% of GDP)	-0.00132*	-0.00130*	-0.00151*	-0.00160*	-0.00170**	-0.00186***	-0.0016**	-0.00159**
	(0.000710)	(0.000696)	(0.00075)	(0.000791)	(0.00056)	(0.000499)	(0.00052)	(0.000608)
State fragility	-0.0150**	-0.0150**						
	(0.00550)	(0.00549)						
State fragility*Capital flight		-1.89e-05						
		(6.30e-05)						
Control of corruption			0.103***	0.104***				
			(0.0335)	(0.0339)				
Control of corruption*Capital flight				0.000441				
				(0.000533)				
Financial sector rating					0.166***	0.164***		
					(0.0483)	(0.0483)		
Financial sector rating*Capital flight						0.00135		
						(0.00146)		
Environmental sustainability							-0.0381	-0.0360*
							(0.0224)	(0.0196)
Environmental sustainability*Capital flight								-0.000355
								(0.000834)
Share of mining value added (% of total)	0.00398*	0.00397*	0.00427*	0.00432*	0.0101***	0.0105***	0.00785**	0.00755*
	(0.00204)	(0.00206)	(0.00233)	(0.00233)	(0.00265)	(0.00285)	(0.00321)	(0.00362)
Gross fixed capital formation (% of GDP)	0.00150	0.00151	0.000855	0.000846	0.00210	0.00216	0.00134	0.00125
	(0.00114)	(0.00114)	(0.00111)	(0.00111)	(0.00117)	(0.00125)	(0.00122)	(0.00126)
Inflation	-0.00448**	-0.00449**	-0.00436*	-0.00439*	-0.00500	-0.00503	-0.00643*	-0.00642*
	(0.00195)	(0.00194)	(0.00234)	(0.00236)	(0.00299)	(0.00301)	(0.00338)	(0.00338)
Primary education	0.00164**	0.00159**	0.00219**	0.00210**	-0.000724	-0.00120	-0.000283	-0.000158
	(0.000593)	(0.000592)	(0.00091)	(0.000855)	(0.00122)	(0.00171)	(0.00162)	(0.00159)
Natural disasters	-0.00883*	-0.00883*	-0.00890*	-0.00891*	-0.00990*	-0.0101*	-0.0104*	-0.0104*
	(0.00412)	(0.00413)	(0.00459)	(0.00462)	(0.00535)	(0.00555)	(0.00535)	(0.00537)
Observations	1,365	1,365	1,316	1,316	784	784	784	784
Number of groups	168	168	168	168	126	126	126	126
Adjusted R-squared	0.826	0.826	0.803	0.803	0.678	0.679	0.668	0.668

Note: Driscoll-Kraay standard errors in parentheses, Country-sector and sector-year fixed effects always included. *** p<0.01, ** p<0.05, * p<0.1

Sample selection bias

The bias caused by the non-random availability of data is always of concern for empirical research, and especially for a sample of African countries, where the quality of data is poor and a function of the economic and institutional capacity to collect and analyze data (see section 3).

Deleting countries with no data and/or negative estimates of illicit financial flows from the analysis could cause a bias of the coefficient estimates. The fact that observations on trade flows are missing raises questions on the likelihood of illicit trade and illicit financial flows. It could be argued that it is likely that the countries which are missing in the sample, are the ones with an actually high incidence of illicit financial flows. The significant coefficient estimates of the interaction between capital flight and state fragility somehow supports the assertion that the most fragile states tend to have higher amounts of capital flight and with that, lower productivity.

It should also be acknowledged that we are unable to fully consider nor control for selection bias. While econometric tools are limited, we apply different model specifications to yield insights on the sensitivity of the results to different sub-samples:

(1) In the main specification, negative values of capital flight and export underinvoicing were deleted in order to explicitly capture illicit financial outflows. Especially with respect to export underinvoicing, this procedure is the most appropriate since negative values of export underinvoicing may well relate to storage and logistics, causing inconclusive results on the incidence of IFFs. As a robustness check, negative values of capital flight and export underinvoicing are set to zero. Results are provided in Table 16 (for capital flight) and Table 17 (for export underinvoicing) in the appendix. Compared to Table 4, capital flight is no longer significant. The increase of observations from 1,393 to 2,233 comes at the cost of within-country changes of IFFs. The loss of variance in the capital flight variable may well explain the missing impact on labour productivity; the adjusted R-squared is also significantly lower than in the main specifications. A similar result can be observed when negative values of export underinvoicing are set to zero (Table 17). With regards to the control variables, the institutional variables and the interaction between export underinvoicing with control of corruption as well as with financial sector rating, remain significant. The coefficient estimates of control of corruption and financial sector rating increases in size and significance level what can be related to the overall increase of observations from to 1,519 to 3,213 (Table 17, column (2); and from 798 to 1,848 in column (3)).

(2) IFFs are more prominent in countries which are dependent on exports of raw commodities. Therefore, we would expect that the negative impact of capital flight on productivity would be higher in resource-dependent countries[31], simply due to the scale effect. However, the results, provided in Table 18 in the appendix, do not confirm this; a separation of the sample into resource and non-resource dependent countries reduces the number of observations and yields inconclusive results. The coefficient estimates of capital flight and of the institutional variables are no longer significant[32]. A similar result is found for export underinvoicing.[33]

(3) The harmful effect of IFFs on productivity may also differ across the continent's sub regions. As displayed in Figure 10, the incidence of capital flight (light grey bar) and export underinvoicing (dark grey bar) varies widely across African regions. The highest estimate of capital flight, in percent of GDP, is observed for Western Africa (median 10.3%). In contrast, export underinvoicing is more severe in Southern Africa, while North Africa is the least affected region from IFFs. In order to compare the potentially harmful effects of capital flight on productivity, the regressions are run on sub-samples, i.e. for each African region.

[31] Resource-dependency refers to commodity exports of energy products and minerals, ores and metals (UNCTAD, 2019). Resource-dependent countries are: Algeria, Angola, Botswana, Burkina Faso, Burundi, Cameroon, Chad, Congo, Democratic Republic of the Congo, Equatorial Guinea, Eritrea, Gabon, Ghana, Guinea, Libya, Mali, Mauritania, Mozambique, Namibia, Niger, Nigeria, Sudan, Liberia, Rwanda, Sierra Leone, Togo, United Republic of Tanzania, Zambia; Non-resource-dependent countries are: Benin, Cabo Verde, Central African Republic, Comoros, Côte d'Ivoire, Djibouti, Egypt, Eswatini, Ethiopia, Gambia, Guinea-Bissau, Kenya, Lesotho, Madagascar, Malawi, Mauritius, Morocco, Sao Tome and Principe, Senegal, Seychelles, Sierra Leone, Somalia, South Africa, Tunisia, Uganda, Zimbabwe

[32] An exception are state fragility and financial sector rating which are significant in the sample of non-resource dependent countries.

[33] Results are available upon request.

Empirically, the variance of capital flight or export underinvoicing cannot explain the variation of productivity across regional sub-samples, except for countries in East Africa. Although this emphasizes the sensitivity of our findings to the choice of countries investigated, we refrain from an overinterpretation of the results due to a severe reduction of observations for each region. It is only in the regions of Eastern and Western Africa, that the number of observations is high enough for a statistically satisfying model fit.

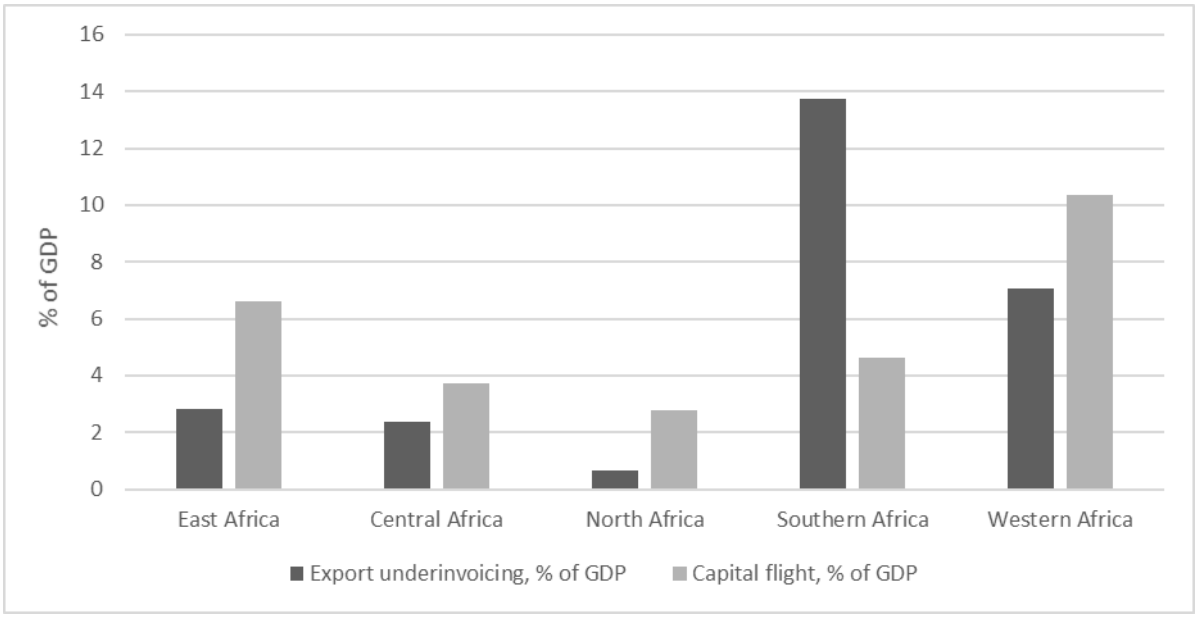
(4) Additional robustness checks have been suggested with respect to South Africa. Trade data on specific commodities, especially gold, are not reported thoroughly which causes some outliers in the data.[34] We exclude South Africa from our regressions but can confirm the significantly negative relationship between export underinvoicing and productivity (-0.0019 to -0.0033***).

(5) Financial transparency and regulation are a global multilateral challenge. For example, in order to increase financial stability in conflict vulnerable states, section 1502 of the Dodd-Frank Act (2010) includes provisions that require companies in the United States to produce a compliance report on the use of conflict minerals, tin, tungsten, tantalum and gold, from the Democratic Republic of Congo (the country of focus) or any neighbouring countries (Dizolele, 2017). However, companies often face difficulties to comply with the act. Both Parker and Vadheim (2017) and Stoop et al. (2018) question whether these regulations achieved their goals. It is difficult to ascertain the extent to which economic diversification and increased overall income via potential shifts of economic activities towards productive sectors might yield durable benefits. The significant coefficient estimate of the financial sector rating variable across model specifications provides some evidence on the importance of strong financial sectors in boosting productivity in African countries. In order to generate insights on how financial sector regulation could influence the harmful impact of capital flight we add a dummy that equals 1 after the Dodd-Frank-Act was enacted in 2010 for the countries affected: Angola, Burundi, Central African Republic, Congo, Democratic Republic of the Congo, Rwanda, South Sudan, United Republic of Tanzania, Uganda, Zambia. Neither the dummy for the Dodd-Frank Act nor the interaction with capital flight are significantly associated with productivity (see Table 19 in the appendix). This preliminary finding supports the view on the challenges in identifying the right policies and regulatory frameworks aimed at ensuring financial transparency and boosting structural transformation.

In summary, the sensitivity of the results to the measurement of IFFs and to the sample of countries included confirms the need for thorough robustness checks when attempting to conduct causality analysis. However, the relatively poor quality of data across many themes of relevance to the analysis of sustainable development in Africa, especially in trade data, increases difficulties in successfully conducting robustness tests. This caveat limits the opportunity to derive evidence-based reliable policy recommendations.

[34] Schuster and Davis (2020) observe large outliers and trade misinvoicing for the case of gold and South Africa. Gold from South Africa, for historic reasons, had no trading partner country assigned before 2011 and reporting remains special.

Figure 10: Capital flight and export underinvoicing, % of GDP, median per region, 2013 - 2015



Source: Authors' calculation based on data obtained from Ndikumana and Boyce (2018) and Schuster and Davis (2020).
Note: Average values of capital flight as a percentage of GDP in 2013–2015 are 3.0 (Northern Africa: Algeria, Egypt, Libya, Morocco, Sudan, Tunisia), 5.9 (Southern Africa: Botswana, Eswatini, Lesotho, Namibia, South Africa), 9.2 (Eastern Africa: Burundi, Comoros, Djibouti, Eritrea, Ethiopia, Kenya, Madagascar, Malawi, Mauritius, Mozambique, Rwanda, Seychelles, Somalia, South Sudan, Uganda, United Republic of Tanzania, Zambia, Zimbabwe), 12.9 (Central Africa: Angola, Cameroon, Central African Republic, Chad, Congo, Democratic Republic of the Congo, Equatorial Guinea, Gabon, Sao Tome and Principe) and 34.9 (Western Africa: Benin, Burkina Faso, Cabo Verde, Cote d'Ivoire, Gambia, Ghana, Guinea, Guinea-Bissau, Liberia, Mali, Mauritania, Niger, Nigeria, Senegal, Sierra Leone, Togo). Average values of export underinvoicing as a percentage of GDP in 2013-2015 0.73 (Northern Africa), 12.5 (Southern Africa), 3.4 (Eastern Africa), 2.1 (Middle Africa) and 12.6 (Western Africa).

7. Conclusion

This paper asserts that IFFs may be associated with worse outcomes in labour productivity and that weak institutions make African countries more vulnerable to the illicit outflow of capital. The empirical findings on the interaction between IFFs and institutional quality suggest that the harmful impact of trade-related Illicit financial flows is clearly channeled through high levels of corruption. Furthermore, low-productivity sectors are the most vulnerable to the lack of financial resources to increase productivity. In other words, IFFs tend to cause low productivity traps that would ultimately result in locking many African countries into a low-income trap. These preliminary findings call for a more in-depth examination of potential leakages from financial flows within the value chains and how this may affect upstream and downstream sectors.

The paper also contributes to a better understanding of the relationship between IFFs and sustainable development in Africa. It offers an account of some of the mechanisms through which IFFs affect economic, social and environmental sustainability. However, further interpretation of the results of our analysis should be done with the following caveats in mind.

First, the empirical models were devised within the limitations of standard economic tools in addressing the relationship between IFFs and sustainable development. Such limitations include very few published articles and limited insights from the theoretical literature. Second, among the multiple dimensions of productivity growth that characterize structural change, the seemingly limited size of the labour productivity impact of reducing IFFs in Africa should be seen within a wider context of the complex web of trajectories within African economies. From a fast growing services sector in some countries (UNCTAD, 2015a) to the perennial attempt to develop the agricultural sector (UNCTAD, 2015b) whilst also giving due attention to the manufacturing sector (UNCTAD, 2011), the diversity of development across the continent makes it difficult to qualify these results with certainty. The advent of Industry 4.0, characterized by frontier technologies such as artificial intelligence, robotics and smart manufacturing, may further disrupt industrialization pathways. And third, caution is a must due to persistent data limitations.

The paper sets the ground for many avenues for further research. Indeed, although it is often argued that IFFs are partly due to poor governance and weak institutional quality in Africa (Ajayi and Ndikumana, 2014; Stephenson et al., 2011), it is lesser understood about how these interact with loopholes and shortcomings in governance systems at the international level for IFFs to result in the observed developmentally detrimental outcomes for African countries. Moreover, the academic interest in IFFs related issues after years of capital controls relaxation across Africa has largely focused on the potential benefits from the positive impact of capital inflows on growth and employment (Kose et al., 2009; Ranciere et al., 2006). However, there is little discussion about the specifics of financial liberalization across African countries and how some contexts might make such liberalisation conducive to IFFs.

And finally, as with the other analytical pillars of EDAR 2020, the challenges highlighted in this paper underline the urgency of allocating greater resources to strengthening trade and development data infrastructure in African countries as the initial foundation for informed policy making. Considering their scale in the world and in Africa, IFFs affect the integrity of economic and financial variables which in turn, challenge the data that lie at the heart of standard economic analysis.

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Appendix I - Descriptive statistics and additional results

Table 8: Country coverage by used indicator of IFF

Country name	Ndikumana and Boyce (2018)	Schuster and Davis (2020)		Ndikumana and Boyce (2018)	Schuster and Davis (2020)
Algeria	x	x	**cont.**		
Angola	x	x	Liberia		
Benin		x	Libya		
Botswana	x	x	Madagascar	x	x
Burkina Faso	x	x	Malawi	x	x
Burundi	x	x	Mali		x
Cabo Verde			Mauritania	x	x
Cameroon	x		Mauritius		
Central African Republic		x	Morocco	x	x
Chad			Mozambique	x	x
Comoros		x	Namibia		x
Congo	x		Niger		x
Côte d'Ivoire	x	x	Nigeria	x	x
Democratic Republic of the Congo	x		Sao Tome & Principe		x
Djibouti			Senegal		x
Egypt	x	x	Seychelles	x	x
Equatorial Guinea			Sierra Leone	x	
Eritrea			Somalia		
Eswatini		x	South Africa	x	x
Ethiopia	x		South Sudan		
Gabon	x	x	Sudan	x	
Gambia		x	Togo		x
Ghana	x	x	Tunisia	x	x
Guinea		x	Uganda	x	x
Guinea-Bissau			United Republic of Tanzania	x	x
Kenya	x	x	Zambia	x	x
Lesotho		x	Zimbabwe	x	x

Table 9: Descriptive statistics of used measures of illicit financial flows, Sample 2000-2015, African countries

	Data source	Observations		Average	Std. Dev.	Min	Max
		Total	% of sample				
All observations							
Capital flight, % of GDP	Ndikumana and Boyce (2018)	474	54.86	4.02	16.89	-57.04	131.68
Export underinvoicing, % of GDP	Schuster and Davis (2020)	604	69.91	-0.09	10.51	-65.18	42.17
Commodity-specific export underinvoicing, % of GDP	Schuster and Davis (2020)	565	65.39	0.33	6.36	-43.72	43.66
Total trade misinvoicing, % of GDP	Ndikumana and Boyce (2018)	474	54.86	2.15	13.91	-42.02	139.37
Negative estimates treated as missing observations							
Capital flight, % of GDP	Ndikumana and Boyce (2018)	299	34.61	10.97	16.58	0.03	131.68
Export underinvoicing, % of GDP	Schuster and Davis (2020)	312	36.11	6.45	7.23	0.01	42.17
Commodity-specific export underinvoicing, % of GDP	Schuster and Davis (2020)	362	41.90	2.72	5.07	0.00	43.66
Total trade misinvoicing, % of GDP	Ndikumana and Boyce (2018)	240	27.78	9.03	15.75	0.01	139.37

Note: The country coverage in both datasets is reported in Table 8.

Table 10: Descriptive statistics of control variables, 2000 – 2015, 54 African countries

Variable	Obs	Mean	Std. Dev.	Min	Max
Share of value added in the mining and utilities sectors, % of total value added	960	11.62994	14.79006	0.004724	70.54685
State fragility index	924	14.38853	5.197666	0	25
Control of corruption	909	-0.63634	0.609068	-1.86871	1.216737
Financial sector rating in CPIA subindex No. 7	545	2.921101	0.555069	1	4
Environmental sustainability rating in CPIA subindex No. 12	545	3.078899	0.56573	1	4
Gross capital formation, % of GDP	892	21.37462	9.068946	0	60.01827
Inflation, % change	902	8.951112	28.64766	-30.8562	513.9068
Primary enrolment rate, % of net	572	76.6926	17.44478	26.82781	99.09904
Natural disasters, count number	1,026	1.615984	1.830553	0	12

Table 11: Fixed-effects regression estimates, Total trade misinvoicing from Ndikumana and Boyce (2018), 2000-2016

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	No Interaction	Interaction with State fragility	No interaction	Interaction with Control of corruption	No interaction	Interaction with Financial sector rating	No interaction	Interaction with Environmental sustainability
Dependent variable: ln cross sector labour productivity								
L. Total trade misinvoicing (TTM) (% of GDP)	-0.000883	-0.00128	-0.000966	-0.00158	-0.00099**	-0.000955*	-0.00106**	-0.000647
	(0.000876)	(0.00101)	(0.000972)	(0.000935)	(0.000362)	(0.000432)	(0.000389)	(0.000804)
L. State fragility	-0.0237***	-0.0245***						
	(0.00583)	(0.00656)						
L. State fragility*TTM		0.000495*						
		(0.000255)						
L. Control of corruption			0.157***	0.173***				
			(0.0297)	(0.0263)				
L. Control of corruption* TTM				-0.00380***				
				(0.00110)				
L. Financial sector rating					0.163***	0.165**		
					(0.0487)	(0.0531)		
L. Financial sector rating* TTM						-0.00111		
						(0.00298)		
L. Environmental sustainability							0.0140	0.0248
							(0.0311)	(0.0341)
L. Environmental sustainability* TTM								-0.00224**
								(0.000757)
L. Share of mining value added (% of total)	-0.000997	-0.000757	-8.66e-05	-0.000917	0.00960**	0.00944***	0.00617**	0.00424
	(0.00285)	(0.00260)	(0.00238)	(0.00242)	(0.00318)	(0.00297)	(0.00275)	(0.00290)
L. Gross fixed capital formation (% of GDP)	0.000584	0.000253	0.00113	0.00111	0.00562***	0.00559***	0.00433**	0.00400**
	(0.00198)	(0.00191)	(0.00216)	(0.00207)	(0.00144)	(0.00146)	(0.00157)	(0.00160)
L. Inflation	-0.00492*	-0.00482*	-0.00445	-0.00433	-0.00349	-0.00350	-0.00544	-0.00546
	(0.00246)	(0.00247)	(0.00292)	(0.00271)	(0.00303)	(0.00300)	(0.00367)	(0.00356)
L. Primary education	0.000871	0.00119	0.00245	0.00266	0.000987	0.00135	0.00101	0.00167
	(0.00208)	(0.00218)	(0.00184)	(0.00182)	(0.00110)	(0.00175)	(0.00119)	(0.00156)
L. Natural disasters	0.00486	0.00587	0.00378	0.00422	0.00403	0.00431	0.00195	0.00289
	(0.00511)	(0.00541)	(0.00409)	(0.00412)	(0.00769)	(0.00710)	(0.00822)	(0.00785)
Observations	1,071	1,071	1,022	1,022	651	651	651	651
Number of groups	154	154	154	154	119	119	119	119
Adjusted R-squared	0.659	0.660	0.634	0.637	0.408	0.408	0.393	0.397

Note: Driscoll-Kraay standard errors in parentheses, Country-sector and sector-year fixed effects always included. *** p<0.01, ** p<0.05, * p<0.1

Table 12: Fixed-effects regression estimates, Agriculture productivity, Export underinvoicing (total and commodity-specific), 2000-2016

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Interaction with State fragility	Interaction with Control of corruption	Interaction with Financial sector rating	Interaction with Environmental sustainability	Interaction with State fragility	Interaction with Control of corruption	Interaction with Financial sector rating	Interaction with Environmental sustainability
Dependent variable: ln Agriculture labour productivity								
	Total export underinvoicing				Commodity-specific underinvoicing			
L. Export underinvoicing (EU) (% of GDP)	-0.00284*	-0.00430***	-0.000769	-0.000498	-0.000696	-0.00115	-0.000727	0.00236
	(0.00154)	(0.00106)	(0.00195)	(0.00192)	(0.00121)	(0.00132)	(0.00236)	(0.00194)
L. State fragility	-0.0407**				-0.00768			
	(0.0173)				(0.00747)			
L. State fragility* EU	9.12e-05				0.00121			
	(0.000891)				(0.00109)			
L. Control of corruption		0.00170				-0.00488		
		(0.0916)				(0.0542)		
L. Control of corruption* EU		-0.0138*				-0.0114*		
		(0.00725)				(0.00621)		
L. Financial sector rating			0.00411				-0.0565	
			(0.0706)				(0.0495)	
L. Financial sector rating* EU			-0.0129**				-0.00602	
			(0.00426)				(0.00369)	
L. Environmental sustainability				0.155***				0.0458
				(0.0378)				(0.0407)
L. Environmental sustainability* EU				-0.00756***				0.00781**
				(0.00223)				(0.00261)
L. Share of mining value added (% of total)	0.000325	-0.00280	0.00430	0.00521	-0.00710**	-0.00594**	-0.00713**	-0.00747**
	(0.00265)	(0.00292)	(0.00445)	(0.00454)	(0.00239)	(0.00231)	(0.00265)	(0.00249)
L. Sector employment share (% of total)	-0.0343***	-0.0358***	-0.0387***	-0.0450***	-0.0315***	-0.0304***	-0.0340***	-0.0352***
	(0.00635)	(0.00417)	(0.00811)	(0.00624)	(0.00143)	(0.00133)	(0.00188)	(0.00185)
L. Gross fixed capital formation (% of GDP)	-0.00183	-0.00338	0.00765**	0.00707**	-0.000149	-0.000262	0.00541**	0.00637***
	(0.00316)	(0.00354)	(0.00283)	(0.00262)	(0.00338)	(0.00272)	(0.00182)	(0.00161)
L. Inflation	0.00228	0.00364	-0.0108***	-0.00915**	0.000843	0.000544	-0.00115	-0.000686
	(0.00310)	(0.00472)	(0.00330)	(0.00322)	(0.00181)	(0.00190)	(0.00272)	(0.00297)
L. Primary education	0.00781***	0.00847**	0.00156	-0.000276	0.00928***	0.00849***	0.00160	-0.000361
	(0.00255)	(0.00314)	(0.00471)	(0.00464)	(0.00226)	(0.00204)	(0.00365)	(0.00332)
L. Natural disasters	-0.0167	-0.0112	-0.00607	-0.0100	-0.00825	-0.00563	-0.00986	-0.00954
	(0.0134)	(0.0139)	(0.0201)	(0.0161)	(0.00768)	(0.00746)	(0.00678)	(0.00561)
Observations	217	201	103	103	253	242	155	155
Number of groups	29	29	20	20	32	32	24	24
Adjusted R-squared	0.718	0.669	0.528	0.570	0.799	0.783	0.677	0.685

Note: Driscoll-Kraay standard errors in parentheses, Country and year fixed effects always included. *** p<0.01, ** p<0.05, * p<0.1

Table 13: Fixed-effects regression estimates - Services value added, Total export underinvoicing, 2000-2016

	(1)	(2)	(3)	(4)
	Interaction with State fragility	Interaction with Control of corruption	Interaction with Financial sector rating	Interaction with Environmental sustainability
Dependent variable: ln Services value added				
L. Export underinvoicing (EU) (% of GDP)	-0.00428***	-0.00423**	-5.69e-05	0.000305
	(0.00136)	(0.00148)	(0.00151)	(0.00192)
L. State fragility	-0.0251**			
	(0.00977)			
L. State fragility* EU	0.000383			
	(0.000621)			
L. Control of corruption		0.0750		
		(0.0557)		
L. Control of corruption* EU		-0.00998**		
		(0.00335)		
L. Financial sector rating			-0.133***	
			(0.0220)	
L. Financial sector rating* EU			-0.00217	
			(0.00333)	
L. Environmental sustainability				-0.0525
				(0.0339)
L. Environmental sustainability* EU				-0.00288
				(0.00178)
L. Share of mining value added (% of total)	0.0137***	0.0150***	0.00791	0.00880*
	(0.00248)	(0.00283)	(0.00636)	(0.00467)
L. Gross fixed capital formation (% of GDP)	-0.000847	-0.000795	0.00506**	0.00422
	(0.00237)	(0.000983)	(0.00217)	(0.00233)
L. Inflation	-0.00114	-0.000408	-0.00550**	-0.00825**
	(0.00210)	(0.00205)	(0.00228)	(0.00261)
L. Primary education	0.00893***	0.0107***	-0.00104	0.000677
	(0.00229)	(0.00276)	(0.00180)	(0.00164)
L. Natural disasters	-0.0197	-0.00841	-0.00622	-0.00445
	(0.0116)	(0.00676)	(0.00751)	(0.00835)
Observations	217	206	103	103
Number of groups	29	30	20	20
Adjusted R-squared	0.875	0.866	0.838	0.830

Note: Driscoll-Kraay standard errors in parentheses, Country and year fixed effects always included. *** p<0.01, ** p<0.05, * p<0.1

Table 14: Robustness check - Lag structure, Fixed-effects regression results, 2000-2016

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
	No Interaction	Interaction with State fragility	No interaction	Interaction with Control of corruption	No Interaction	Interaction with State fragility	No interaction	Interaction with Control of corruption	No Interaction	Interaction with State fragility	No interaction	Interaction with Control of corruption
Dependent variable: ln cross sector labour productivity												
	No lag				2 (year) lag				5 (year) lag			
Capital flight (CF) (% of GDP)	-0.00117	-0.00108	-0.00123	-0.00106	0.000168	0.000512	-0.00059	-0.00099	0.000256	-0.0002	8.36E-05	-5.87E-05
	-0.00109	-0.0011	-0.00132	-0.00135	-0.0011	-0.00138	-0.00114	-0.00109	-0.00062	-0.00069	-0.0007	-0.00062
State fragility	-0.0173*	-0.0172*			-0.0170*	-0.0164*			-0.00986	-0.01		
	-0.00891	-0.00895			-0.00927	-0.00906			-0.013	-0.0131		
State fragility* CF		-7.38E-05				-0.00029				0.000193		
		-0.0002				-0.0002				-0.00018		
Control of corruption			0.112*	0.110*			0.155**	0.159***			0.114**	0.123**
			-0.0541	-0.0531			-0.0534	-0.0508			-0.0486	-0.0528
Control of corruption* CF				-0.00087				0.00214				0.00085
				-0.00106				-0.00143				-0.00089
Share of mining value added (% of total)	-0.00095	-0.00099	-0.00058	-0.00065	-0.00113	-0.00133	0.000419	0.000524	-0.00335	-0.00316	-0.00254	-0.00242
	-0.00332	-0.00335	-0.0038	-0.00381	-0.0018	-0.00191	-0.00176	-0.00162	-0.00485	-0.00493	-0.00479	-0.00463
Gross fixed capital formation (% of GDP)	-0.00123	-0.00118	-0.00154	-0.00152	0.0052***	0.0054***	0.0049***	0.0048***	-0.00091	-0.00093	-0.00082	-0.00078
	-0.00133	-0.00134	-0.00089	-0.0009	-0.00162	-0.00156	-0.00135	-0.00134	-0.00447	-0.0044	-0.00414	-0.00415
Inflation	-0.0077**	-0.0078**	-0.00733*	-0.00723*	0.000243	-7.08E-05	0.00161	0.00133	0.00501*	0.00514*	0.00618	0.00609
	-0.00333	-0.00334	-0.00399	-0.00401	-0.00295	-0.00283	-0.00402	-0.00376	-0.00246	-0.0025	-0.0035	-0.00355
Primary education	0.00304	0.00283	0.00377*	0.00393*	0.00124	0.000358	0.00153	0.00116	0.00373**	0.00424**	0.0041***	0.0041***
	-0.00194	-0.00218	-0.00213	-0.0022	-0.00157	-0.00152	-0.0018	-0.00169	-0.00127	-0.00137	-0.00123	-0.00128
Natural disasters	-0.0198***	-0.0198***	-0.0183***	-0.0183***	-0.00893*	-0.00882*	-0.00918	-0.00925*	-0.0169	-0.017	-0.0173	-0.0173
	-0.00573	-0.00569	-0.00583	-0.00585	-0.00493	-0.00451	-0.00553	-0.0051	-0.0108	-0.0105	-0.0113	-0.0113
Observations	1,393	1,393	1,344	1,344	1,288	1,288	1,239	1,239	924	924	875	875
Number of groups	168	168	168	168	168	168	168	168	161	161	161	161
Adjusted R-squared	0.661	0.661	0.632	0.632	0.619	0.62	0.591	0.592	0.413	0.414	0.369	0.369

Note: Driscoll-Kraay standard errors in parentheses, Country-sector and sector-year fixed effects always included. *** p<0.01, ** p<0.05, * p<0.1

Table 15: Robustness check - Dynamic model with export underinvoicing, 2000-2016

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	No Interaction	Interaction with State fragility	No interaction	Interaction with Control of corruption	No interaction	Interaction with Financial sector rating	No interaction	Interaction with Environmental sustainability
Dependent variable: ln cross sector labour productivity								
L. ln labour productivity	0.839***	0.842***	0.772***	0.768***	0.756***	0.752***	0.752***	0.749***
	(0.0427)	(0.0422)	(0.0237)	(0.0235)	(0.0330)	(0.0327)	(0.0348)	(0.0349)
Export underinvoicing (EU) (% of GDP)	-0.00267***	-0.00191**	-0.00278***	-0.00371***	-0.00122	-0.00208*	-0.00162	-0.00180
	(0.000844)	(0.000833)	(0.000862)	(0.00114)	(0.00114)	(0.000982)	(0.00102)	(0.00101)
State fragility	-0.00108	-0.00119						
	(0.00450)	(0.00487)						
State fragility*EU		0.000762**						
		(0.000281)						
Control of corruption			0.0757***	0.0518				
			(0.0251)	(0.0295)				
Control of corruption*EU				-0.00971**				
				(0.00376)				
Financial sector rating					-0.0125	-0.0147		
					(0.0403)	(0.0373)		
Financial sector rating*EU						-0.00480		
						(0.00285)		
Environmental sustainability							0.0306	0.0434
							(0.0223)	(0.0250)
Environmental sustainability*EU								-0.00218*
								(0.00114)
Share of mining value added (% of total)	0.00411	0.00367	0.00544**	0.00416	0.00478**	0.00504***	0.00498**	0.00556**
	(0.00259)	(0.00259)	(0.00214)	(0.00247)	(0.00179)	(0.00153)	(0.00210)	(0.00185)
Gross fixed capital formation (% of GDP)	0.00158	0.00204	0.00188	0.00114	0.00329*	0.00345*	0.00307	0.00312
	(0.00120)	(0.00124)	(0.00115)	(0.00110)	(0.00163)	(0.00173)	(0.00180)	(0.00182)
Inflation	-0.000153	-0.000489	0.000182	-6.64e-05	0.000957	0.00137	0.00137	0.00139
	(0.00128)	(0.00133)	(0.00115)	(0.00111)	(0.00171)	(0.00153)	(0.00146)	(0.00159)
Primary education	0.00300***	0.00227**	0.00323***	0.00362***	0.00207	0.00199	0.00149	0.00127
	(0.000813)	(0.000985)	(0.00100)	(0.00102)	(0.00173)	(0.00181)	(0.00172)	(0.00175)
Natural disasters	-0.00500	-0.00414	-0.00166	-0.000994	0.00283	0.00269	0.00204	0.00121
	(0.00626)	(0.00645)	(0.00524)	(0.00497)	(0.00856)	(0.00845)	(0.00727)	(0.00732)
Observations	1,666	1,666	1,554	1,554	889	889	889	889
Number of groups	203	203	203	203	147	147	147	147
Adjusted R-squared	0.872	0.873	0.842	0.846	0.713	0.714	0.714	0.715

Note: Driscoll-Kraay standard errors in parentheses, Country-sector and sector-year fixed effects always included. *** p<0.01, ** p<0.05, * p<0.1

Table 16: Robustness check - Negative capital flight values set to zero, 2000-2016

	(1)	(2)	(3)	(4)
	Interaction with State fragility	Interaction with Control of corruption	Interaction with Financial sector rating	Interaction with Environmental sustainability
Dependent variable: ln cross sector labour productivity				
L. capital flight (CF) (% of GDP)	0.000136	-0.000502	-0.000393	0.000194
	(0.000560)	(0.000746)	(0.000684)	(0.00109)
L. Share of mining value added (% of total)	0.00108	0.00179	0.00359	-0.00160
	(0.00148)	(0.00254)	(0.00254)	(0.00262)
L. State fragility	-0.0139			
	(0.00917)			
L. State fragility*CF	-0.000490**			
	(0.000219)			
L. Control of corruption		0.284***		
		(0.0604)		
L. Control of corruption*CF		0.000389		
		(0.00244)		
L. Financial sector rating			0.236***	
			(0.0453)	
L. Financial sector rating*CF			-0.00428**	
			(0.00140)	
L. Environmental sustainability				0.100**
				(0.0344)
L. Environmental sustainability*CF				-0.00444***
				(0.000805)
L. Gross fixed capital formation (% of GDP)	0.00310***	0.00264***	0.00535***	0.00396***
	(0.000986)	(0.000783)	(0.00103)	(0.000871)
L. Inflation	-0.00250	-0.00120	-0.00302	-0.00428
	(0.00198)	(0.00212)	(0.00288)	(0.00324)
L. Primary education	0.00214	0.00447	0.00629	0.00660*
	(0.00265)	(0.00289)	(0.00354)	(0.00350)
L. Natural disasters	-0.0140*	-0.0116	0.00143	-0.00235
	(0.00705)	(0.00724)	(0.00430)	(0.00553)
Observations	2,233	2,128	1,204	1,204
Number of groups	175	175	133	133
Adjusted R-squared	0.550	0.527	0.267	0.253

Note: Driscoll-Kraay standard errors in parentheses, Country-sector and sector-year fixed effects always included. *** p<0.01, ** p<0.05, * p<0.1

Table 17: Robustness check - Negative export underinvoicing values set to zero, 2000-2016

	(1)	(2)	(3)	(4)
	Interaction with State fragility	Interaction with Control of corruption	Interaction with Financial sector rating	Interaction with Environmental sustainability
Dependent variable: ln cross sector labour productivity				
L. Export underinvoicing (EU) (% of GDP)	-0.00215	-0.00264	-0.00112	0.000460
	(0.00182)	(0.00175)	(0.00157)	(0.00203)
L. Share of mining value added (% of total)	0.00120	0.000430	0.00699*	0.00602
	(0.00242)	(0.00261)	(0.00381)	(0.00404)
L. State fragility	-0.0106			
	(0.00733)			
L. State fragility*EU	0.000511			
	(0.000339)			
L. Control of corruption		0.234***		
		(0.0438)		
L. Control of corruption*EU		-0.0145***		
		(0.00349)		
L. Financial sector rating			0.164***	
			(0.0269)	
L. Financial sector rating*EU			-0.00961***	
			(0.00214)	
L. Environmental sustainability				0.0309
				(0.0178)
L. Environmental sustainability*EU				-0.00466***
				(0.00123)
L. Gross fixed capital formation (% of GDP)	0.00394**	0.00257	0.00682***	0.00666***
	(0.00177)	(0.00176)	(0.00135)	(0.00142)
L. Inflation	-0.00151	-0.000551	-0.00240	-0.00280
	(0.00104)	(0.00102)	(0.00145)	(0.00171)
L. Primary education	0.00537**	0.00628***	0.0110**	0.0101**
	(0.00199)	(0.00188)	(0.00432)	(0.00439)
L. Natural disasters	-0.0142*	-0.0129	-0.000867	-0.00353
	(0.00802)	(0.00750)	(0.00349)	(0.00351)
Observations	3,360	3,213	1,848	1,848
Number of groups	252	252	189	189
Adjusted R-squared	0.497	0.477	0.240	0.227

Note: Driscoll-Kraay standard errors in parentheses, Country-sector and sector-year fixed effects always included. *** p<0.01, ** p<0.05, * p<0.1

Table 18: Robustness check - Resource-dependency, Fixed-effects regression, 2000-2016

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Interaction with State fragility	Interaction with Control of corruption	Interaction with Financial sector rating	Interaction with Environmental sustainability	Interaction with State fragility	Interaction with Control of corruption	Interaction with Financial sector rating	Interaction with Environmental sustainability
Dependent variable: ln cross sector labour productivity								
	Resource-dependent countries				**Non-Resource-dependent countries**			
L. capital flight (CF) (% of GDP)	-0.000563	-0.00191	-0.00130	-0.00122	-0.00191	-0.00460	-0.0108	-0.00261
	(0.00129)	(0.00152)	(0.00139)	(0.00119)	(0.00288)	(0.00280)	(0.00720)	(0.00705)
L. State fragility	-0.00101				-0.0471***			
	(0.0126)				(0.0159)			
L. State fragility*CF	-0.000734**				-0.000793			
	(0.000275)				(0.000880)			
L. Control of corruption		0.0193				0.221		
		(0.0717)				(0.172)		
L. Control of corruption*CF		0.00337				0.00874		
		(0.00238)				(0.00538)		
L. Financial sector rating			-0.131				0.535***	
			(0.0922)				(0.168)	
L. Financial sector rating*CF			0.00197				0.0277	
			(0.00150)				(0.0224)	
L. Environmental sustainability				-0.0456				0.0462
				(0.0530)				(0.101)
L. Environmental sustainability*CF				-0.00209*				-0.0103
				(0.00109)				(0.0172)
L. Share of mining value added (% of total)	0.000230	0.00107	-0.00476	-0.00357	-0.0137	0.0147	-0.0301*	0.00521
	(0.00123)	(0.00208)	(0.00268)	(0.00317)	(0.0178)	(0.0201)	(0.0165)	(0.0360)
L. Gross fixed capital formation (% of GDP)	-0.00300	-0.00451	-0.00791**	-0.00731**	0.00680***	0.00623***	0.00917***	0.00883***
	(0.00216)	(0.00270)	(0.00268)	(0.00260)	(0.00212)	(0.00190)	(0.00125)	(0.00207)
L. Inflation	-0.000266	-0.00141	-0.00766*	-0.00672**	-0.00634***	-0.00435*	-0.00320**	-0.00524***
	(0.00450)	(0.00465)	(0.00381)	(0.00288)	(0.00176)	(0.00208)	(0.00108)	(0.00131)
L. Primary education	-0.00330*	-0.00126	0.000368	0.00162	0.00827*	0.00937**	-0.00192	0.00540
	(0.00175)	(0.00159)	(0.00198)	(0.00185)	(0.00463)	(0.00412)	(0.00654)	(0.00585)
L. Natural disasters	-0.0105	-0.0134	0.000865	0.00408	-0.00779	-0.00614**	-0.0192	-0.00141
	(0.00672)	(0.00894)	(0.00620)	(0.00763)	(0.00468)	(0.00283)	(0.0180)	(0.00969)
Observations	763	742	511	511	630	602	273	273
Number of groups	98	98	84	84	70	70	42	42
Adjusted R-squared	0.662	0.620	0.427	0.425	0.717	0.671	0.731	0.681

Note*:* Driscoll-Kraay standard errors in parentheses, Country-sector and sector-year fixed effects always included. *** p<0.01, ** p<0.05, * p<0.1; Resource-dependent countries: Algeria, Angola, Botswana, Burkina Faso, Burundi, Cameroon, Chad, Congo, Democratic Republic of the Congo, Equatorial Guinea, Eritrea, Gabon, Ghana, Guinea, Libya, Mali, Mauritania, Mozambique, Namibia, Niger, Nigeria, Sudan, Liberia, Rwanda, Sierra Leone, Togo, United Republic of Tanzania, Zambia; Non-resource-dependent countries: Benin, Cabo Verde, Central African Republic, Comoros, Côte d'Ivoire, Djibouti, Egypt, Eswatini, Ethiopia, Gambia, Guinea-Bissau, Kenya, Lesotho, Madagascar, Malawi, Mauritius, Morocco, Sao Tome and Principe, Senegal, Seychelles, Sierra Leone, Somalia, South Africa, Tunisia, Uganda, Zimbabwe

Table 19: Robustness check – Dodd-Frank Dummy, 2000-2016

	(1)	(2)	(3)	(4)
	Capital flight, % of GDP		Export underinvoicing, % of GDP	
Dependent variable: ln cross sector labour productivity				
L. Capital flight (CF) (% of GDP)	-0.00144**	-0.00135**		
	(0.000536)	(0.000525)		
L. Dodd-Frank Dummy	0.0608	0.0652	-0.00187	-0.0285
	(0.0923)	(0.0874)	(0.0444)	(0.0874)
L. Dodd-Frank Dummy*CF		-0.00226		
		(0.00287)		
L. Export underinvoicing (EU) (% of GDP)			-0.00278**	-0.00272**
			(0.00113)	(0.00107)
L. Dodd-Frank Dummy*EU				-0.00944
				(0.0181)
L. Share of mining value added (% of total)	-7.18e-05	9.73e-05	0.0169***	0.0168***
	(0.00167)	(0.00167)	(0.00242)	(0.00237)
L. Gross fixed capital formation (% of GDP)	0.00309*	0.00317*	0.00282	0.00277
	(0.00151)	(0.00156)	(0.00271)	(0.00273)
L. Inflation	-0.00207	-0.00207	0.00129	0.00135
	(0.00284)	(0.00283)	(0.00135)	(0.00131)
L. Primary education	0.000860	0.00111	0.00982***	0.0100***
	(0.00284)	(0.00290)	(0.00191)	(0.00201)
L. Natural disasters	-0.0127*	-0.0126*	-0.0149	-0.0153
	(0.00696)	(0.00704)	(0.0114)	(0.0115)
Observations	1,393	1,393	1,757	1,757
Number of groups	168	168	203	203
Adjusted R-squared	0.623	0.624	0.554	0.555

Note: Driscoll-Kraay standard errors in parentheses, Country-sector and sector-year fixed effects always included. *** p<0.01, ** p<0.05, * p<0.1

Appendix II – Literature review table

Table 20: Overview of selected literature

Authors, Year	Sample (Countries and period)	Welfare indicator	Measure of IFF	Estimation method	Finding
Trade-misinvoicing					
Ogbonnaya and Ogechuckuw (2017)	Nigeria, 1980-2015	Economic growth	GFI estimates of Illicit financial flows (= trade misinvoicing)	Co-integration tests (unit-root ADF)	Significant impact on economic growth
Mevel et al. (2013)	31 countries including 14 African countries and 20 sectors. Convergence period 2013 to 2017	Trade and real income	Trade misinvoicing	Computable General Equilibrium	Illicit financial flows highly concentrated in a few countries and sectors; CGE results indicate that claimed back Illicit financial flows conditional on trade facilitation investment boost GDP
Capital flight					
Ndikumana (2014)	Panel of 39 African countries, from 1970-2010	Domestic investment and bank credit	Capital flight (% of GDP)	IRLS, Fixed effects, system GMM	39 countries studied over the period from 2000 to 2010 might have been able to achieve on average 3 percent more economic growth (with radical stop to all Illicit financial flows).
Nkurunziza (2014)	35 African countries from 1970-2010	Incremental Capital-Output Ratio	Capital flight	Use ICOR and capital stock to derive potential effects of capital flight on income per	Investing capital flight with the same efficiency as actual domestic investment would increase annual rate of poverty reduction by 1.9 percent

				capita and poverty	
AfDB et al. (2012)	All African countries	GDP per capita and poverty	Capital flight	Mean comparison (no regressions)	Capital flight affects human development and deepens inequality
Fofack and Ndikumana (2010)	Sub-Saharan countries (panel of 40 countries) from 2000-2004	Total domestic investment, private investment, public investment	Capital flight	Dynamic model using system-GMM estimator	Investing flight capital domestically (underlying actual return to investment ratio) poverty would have reduced by 4-6 percentage points per year
Dachraoui and Smida (2014)	Panel of 19 African countries from 1984 - 2010	Investment (public + private) /GDP	Capital flight / GDP	Dynamic model using system-GMM estimator	Illicit financial flows to private investment (-), no discernable effect on public investment. Not tested: Illicit financial flows repatriation to human capital (+) through investment in education.
Ndiaye (2009)	Franc Zone countries(1), 1970-2010	Growth rate of real GDP, investment	Real capital flight (from the WB and Morgan Guaranty) over GDP	System GMM	Illicit financial flows have a significantly negative effect (-0,0408*) on investment/GDP but the estimated effect is stronger for Asian and MENA countries.
Ndiaye (2014)	Franc Zone countries(1), 1970-2010	Growth rate of real GDP	Ratio of real capital flight to GDP (World Bank method and Morgan Guaranty method)	System-GMM estimator	Capital flight significantly reduces economic growth in the FZ; The results also reveal that domestic investment, credit to the private sector, the quality of institutions, and domestic savings play an important role in explaining the influence of capital flight on economic growth in the FZ
Salandy and Henry (2013)	Trinidad and Tobago over 1971-2008	Domestic investment	Real capital flight	Vector Error Correction Model, and system GMM	Capital flight crowds out investment and worsens capital formation.

Janský and Palanský (2018)	100 countries between 2009-2015 (IMF CDIS)	Rate of return of FDI to derive tax revenue losses using actual 2016 inward FDI stock and corporate tax rates	Corporate profit shifting (strategic transfer pricing) using country-level FDI statistics	Fixed Effects panel regression model	Capital flight affects government budget balance by lowering tax base (caused by reduced economic activity); external debt and borrowing from abroad increases

Note: [1]Franc Zone countries include: Benin, Burkina Faso, Cameroon, Central African Republic, Chad, Comoros, Côte d'Ivoire, Equatorial Guinea, Gabon, Guinea-Bissau, Mali, Niger, Senegal, Togo