

Gnangnon, Sèna Kimm

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# The Quality of Aid for Trade Flows and Economic Complexity

**Author:** Sèna Kimm GNANGNON<sup>1</sup>

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## **Abstract**

The few existing studies on the effect of Aid for Trade (AfT) flows on economic complexity have reached inconclusive outcomes. The present analysis re-examines this issue through the lens of the concept of 'quality of AfT flows' that takes into account not only the amount of AfT flows, but also the predictability and volatility of these capital inflows. A country enjoys a better quality of AfT flows if it receives higher AfT flows in a predictable and less volatile fashions. We investigate the effect of the quality of AfT flows on economic complexity, over a set of 86 countries and the period from 2004 to 2019, and using the within fixed effects estimator and the Method of Moments Quantile Regression with fixed effects approach. The findings suggest that not only does a better quality of AfT flows fosters economic complexity in recipient countries, but its positive effect is larger in less complex economies (including poorest countries) than in relatively more complex economies among recipient countries. These findings reveal that what really matters for the enhancement of economic complexity in developing countries may not be only the amounts of the total AfT flows, but more importantly the predictability and the stability of these resource inflows. Improving the quality of AfT flows by increasing AfT amounts in a predictable and stable fashions would be beneficial to developing countries, and particularly to a greater extent to poorest countries among them.

**Keywords:** Aid for Trade; Predictability of Aid for Trade; Volatility of Aid for Trade; Economic complexity.

**JEL Classification:** O11; O14; F14; F35.

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<sup>1</sup> Economist at the World Trade Organization (WTO). E-mail for correspondence: [kgnangnon@yahoo.fr](mailto:kgnangnon@yahoo.fr)

# 1. Introduction

Producing and exporting diverse and sophisticated products is key for promoting export competitiveness (e.g., Tacchella et al., 2013), fostering economic growth (e.g., Hausmann and Hidalgo, 2009; Poncet and Starosta de Waldemar, 2013; Shahzad et al., 2022), dampening economic growth volatility and cycles (e.g., Maggioni et al., 2016; Miranda-Pinto, 2021), increasing the labor share (e.g., Arif, 2021), generating less unemployment and more employment (e.g., Adam et al., 2021), reducing poverty (e.g., Gnangnon, 2021a), improving the green development efficiency (e.g., Wang et al., 2023) and ultimately promoting economic development (e.g., Caldarelli et al., 2012; Cristelli et al., 2015; Hidalgo et al., 2007; Hidalgo, 2021; Inoua, 2023). In this regard, economic complexity offers many insights for the improvement of the political decision-making (Balland et al., 2022).

An economy is qualified as 'complex' if it produces and exports a diversity of products that have a unique set of capabilities such that they are not easily reproduceable by other countries (i.e., products with a low ubiquity) (e.g., Albeaik et al., 2017a,b; Hartmann et al., 2017; Hausmann and Hidalgo, 2009, 2011; Hausmann et al., 2014; Hidalgo et al., 2007; Hidalgo, 2021). The complexity of a country's productive structure is determined by the country's diversity of the knowledge embedded in the production process, and this country's ability to apply tacit and explicit bundles of innovation across the productive structure.

There is a large recognition among actors of the international trade and development community that the participation of developing countries, and especially the least developed countries<sup>2</sup> (LDCs) in the global trading system is hampered by major constraints, including trade-related infrastructure and capacity constraints (e.g., Hallaert, 2010; Hallaert and Munro, 2009). In view of this situation, the Members of the World Trade Organization (WTO) launched at the Hong Kong Conference of Trade Ministers of the WTO, the Aid for Trade (AfT) Initiative. This Initiative purports to help developing countries and LDCs to build the supply-side capacity and trade-related infrastructure that they need to assist them to implement and benefit from WTO Agreements and more broadly to expand their trade" (WTO, 2005: paragraph 57). The Global Review<sup>3</sup> of AfT organized by the WTO Secretariat every two years, aims to strengthen the monitoring and evaluation of AfT, and hence ensure the effectiveness of AfT flows in recipient countries.

Do AfT flows contribute to improving recipient countries' levels of economic complexity when these capital inflows are predictable and less volatile? The present article aims to address this question by examining the effect of the 'quality of AfT flows' on economic complexity. The concept of "AfT quality" is defined in the present study as reflecting the increase in AfT flows in a predictable and less volatility (i.e., in a stable) manner.

The Organisation for Economic Co-operation and Development (OECD) has defined AfT flows as the portion of the overall official development assistance flows that comprises three main

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<sup>2</sup> LDCs constitute a group of countries designated as such by the United Nations, and considered as the poorest and most vulnerable countries in the world to exogenous economic, financial and environmental shocks. Detailed information on the conditions for the inclusion of country in or the graduation of country from the category of LDCs is provided by the UNOHRLLS (Office of the High Representative for the Least Developed Countries, Landlocked Developing Countries and Small Island Developing States) and is accessible online at: <https://www.un.org/ohrlls/content/least-developed-countries>

<sup>3</sup> The first Global Review of AfT was held in 2007. The latest Global Review of AfT was held in 2022, and focused on the theme "Empowering Connected Sustainable Trade".

categories. The latter are the AfT flows aiming at building economic infrastructure, AfT flows allocated for the strengthening of productive capacities, and AfT flows related to trade policy and regulation (e.g., OECD/WTO, 2011). Details on the sectoral coverage of each AfT category are provided in Appendix 1.

By relying on these categories of AfT flows established by the OECD, many studies have assessed whether AfT flows have achieved their objective of increasing recipient-countries' participation in international trade. Most of these studies have established that AfT flows have been instrumental in promoting recipient-countries' exports<sup>4</sup> measured either in terms of export share of GDP or export upgrading (e.g., Cali and te Velde, 2011; Gngangnon, 2019; Gngangnon and Roberts, 2007; Helble et al., 2012; Kim, 2019; Nathoo et al., 2021; Vijil and Wagner, 2012). At the same time, few studies have examined whether AfT flows have been associated with a greater economic complexity in recipient countries.

The existing few studies on the economic complexity effect of AfT flows have reached mixed conclusions regarding the effect of AfT flows on economic complexity (e.g., Arpaci-Ayhan, 2022; Gngangnon, 2021b; Hai, 2021; Kamguia et al., 2022; Kim, 2019). This lack of a clear-cut direction of the economic complexity effect of AfT flows prompts us to question whether in addition to the total amount of AfT, the predictability of these capital inflows and the low volatility (i.e., increased stability) of these resource inflows matter for fostering economic complexity in recipient countries. In that perspective, we investigate the effect of the quality of AfT flows on economic complexity in recipient countries.

The rationale for this question lies on the fact that aid volatility damages the macroeconomic effectiveness of aid in recipient countries (e.g., Chauvet and Guillaumont, 2009; Hudson, 2015; Lensink and Morrissey, 2000). OECD (2011) and Celasun and Walliser (2008) have argued that the concept of 'aid predictability' is more relevant when studying aid effectiveness issues. The literature on aid predictability have often used interchangeably<sup>5</sup> the concepts of "aid unpredictability" and "aid volatility" (e.g., Celasun and Walliser, 2008). However, in reality, two concepts are clearly distinct (e.g., Andrews and Vera, 2008; Celasun and Walliser, 2008; OECD, 2006, 2011). According to OECD (2006), Aid is considered as "predictable" when partner countries can be confident about the amounts and the timing of aid disbursements. In contrast, aid is deemed as volatile when fluctuations in aid flows are large, relative to the volume involved. Nevertheless, both concepts are linked to the extent, for example, that aid volatility can contribute (at least partly) to the lack of aid predictability, or that the unpredictability of aid can result in a greater aid volatility. In the same spirit, Celasun and Walliser (2008) have argued that aid predictability relates to the deviation of the expected aid disbursements ex-ante from actual aid disbursements during a given time-period, while aid volatility refers to an ex-post description of the variability in aid disbursements over time. In a nutshell, it is likely that in addition to the amounts of AfT, the predictability and less volatility of these amounts are likely to matter for economic complexity.

The empirical exercise on the effect of the quality of AfT flows on economic complexity has been carried out over an unbalanced panel dataset of 86 AfT recipient countries over the period from 2004 to 2019. It has used the within fixed effects estimator as well as the Method of

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<sup>4</sup> Benziane et al. (2022) have provide a literature review on the effects of AfT flows.

<sup>5</sup> In practice, studies on aid predictability tend to use aid volatility measures as a proxy indicator of aid unpredictability (OECD, 2011).

Moments Quantile Regression (MMQR) with fixed effects approach proposed by Machado and Santos Silva (2019). It has established several findings. We first observe that taken separately, total AfT flows, the predictability of these inflows and the volatility of these inflows exert different effects on economic complexity in recipient countries. Total AfT flows reduce economic complexity, including to a greater extent in less complex economies (e.g., LDCs) than in relatively more complex economies. A greater predictability of AfT inflows exerts a larger positive effect on economic complexity in less complex economies than in relatively more complex economies. At the same time, a higher volatility of total AfT flows is more harmful to economic complexity in more complex economies than in relatively less complex economies. Second, and more importantly, we find that the improvement in the quality of AfT flows fosters economic complexity in recipient countries. Less complex economies, including poor countries experience a larger positive effect of a better AfT quality on economic complexity than relatively complex economies do. These findings clearly indicate that improving the quality of AfT flows by increasing AfT amounts in a predictable and stable fashions would be beneficial to developing countries, and notably, to a greater extent, to LDCs among them.

In the rest of the article, Section 2 discusses theoretically how the quality of AfT flows can affect economic complexity in recipient countries. Section 3 presents the measure of the quality of AfT flows. Section 4 lays down the model specification that serves to address the question at the heart of the analysis, and Section 5 presents the econometric approach to estimate this model. Section 6 interprets empirical outcomes, and Section 7 concludes.

## **2. Theoretical discussion on the effect of AfT quality on economic complexity**

This section provides a brief literature review on the effect of AfT flows on economic complexity (sub-section 2.1), and then, discusses the extent to which the quality of total AfT flows can affect economic complexity.

### ***2.1. Effect of AfT flows on economic complexity***

In the present analysis, we argue that the total AfT flows affect economic complexity by enhancing productive capacities and reducing trade costs, including both tariff and nontariff costs. Indeed, many studies<sup>6</sup> have demonstrated empirically that AfT flows contribute to reducing trade costs in recipient countries. Higher trade costs undermine export product upgrading (e.g., Bas and Strauss-Kahn, 2015; Chen and Juvenal, 2022; Mau, 2016; Regolo, 2013), and limit countries' ability to produce and export sophisticated goods (e.g., Hu et al., 2022; Weldemicael, 2014). Therefore, it is likely that AfT flows would promote economic complexity, that is, encourage the export of increasingly complex products in developing countries that endeavour to enhance their productive capacities and reduce trade costs. AfT flows can contribute to achieving these objectives.

The limited number of studies on the effect of AfT flows on economic complexity has not come up with a clear-cut conclusion concerning the direction of this effect, with some of them reporting the absence of such an effect (e.g., Arpacı-Ayhan, 2022; Gnangnon, 2021b; Hai, 2021; Kamguia et al., 2022; Kim, 2019). Kim (2019) has found no significant effect of AfT on export

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<sup>6</sup> These studies include for example, Busse et al. (2012); Cali and te Velde (2011); de Melo and Wagner (2016); Hoekman and Nicita (2010); OECD/WTO (2015); Tadesse et al. (2017); Tadesse et al. (2019) and Tadesse et al. (2021).

sophistication either in the short run or in the long run. Hai (2021) has obtained that total AfT inflows do not enhance export sophistication, but this finding reflects differentiated effect of the components of AfT flows on economic sophistication. AfT for trade policy and regulations tend to foster economic sophistication in low-income countries, while AfT for economic infrastructure exerts a higher positive economic sophistication effect on advanced economies than in relatively less developed economies. Kamguia et al. (2022) have established several findings concerning the effect of the overall development aid (and not only AfT) on economic complexity. They have obtained that the effect of foreign aid on economic complexity depends on recipient countries' level of economic complexity, and the type of aid concerned. In particular, foreign aid reduces economic complexity in countries with lower levels of economic complexity, but increases it in countries with higher levels of economic complexity. Furthermore, foreign aid in the energy (which is part of AfT flows) enhances economic complexity, while development aid in favour of the agricultural sector (which is also part of AfT flows) reduces economic complexity. Finally, AfT flows allocated for the build-up of productive capacity influence negatively export sophistication at the sectoral level. Gnangnon (2021b) has observed empirically that total AfT flows foster economic complexity in countries that improve their productive capacities, with the magnitude of this positive effect being larger for poor countries than for other AfT-recipient countries. Arpacı-Ayhan (2022) have uncovered that while both technical cooperation aid (i.e., which involves the transfer of tacit knowledge) and non-technical cooperation aid (that allows for the build-up of physical capital stock and transfer of tangibles) can affect positively economic complexity, this is not necessarily the case for sectoral aid. In particular, aid for production sectors exerts no significant effect on economic complexity.

Overall, in light of this literature review, we can, at best, expect that total AfT flows would exert no significant effect on economic complexity, while not necessarily ruling out the possibility of a negative effect of total AfT flows on economic complexity in recipient countries (hypothesis 1). But, as discussed above, what may ultimately matter is the quality of AfT flows, and not merely the amounts of total AfT flows that accrue to countries.

## ***2.2. Effect of AfT Quality on economic complexity***

We define the concept of 'quality of AfT' as the one that reflects an increase in AfT flows in a predictable and less volatile manner. Thus, the discussion below about the effect of the quality of AfT flows on economic complexity would entail discussing the possible effect of the amounts of AfT on economic complexity, and the effect of the predictability and the stability (less volatility) of these resource inflows on economic complexity.

The need for making aid more predictable has been recognized and accepted by donor-countries in the Paris Declaration of 2005, and the Accra Agenda for Action of 2008. For example, Paragraph 26<sup>7</sup> of the 2008 Accra Agenda for Action indicates donors' strong willingness to improve aid predictability for recipient countries. Specifically, Paragraph 26b of this Agenda for Action reads as follows "*Beginning now, donors will provide full and timely information on annual commitments and actual disbursements so that developing countries are in a position to accurately record all aid flows in their budget estimates and their accounting systems.*" Paragraph 26c of the same Agenda states that "*Beginning*

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<sup>7</sup> See the document on the Paris Declaration on Aid Effectiveness (2005) and the Accra Agenda for Action (2008) that is accessible online at: <https://www.oecd.org/dac/effectiveness/34428351.pdf>

*now, donors will provide developing countries with regular and timely information on their rolling three-to five-year forward expenditure and/or implementation plans, with at least indicative resource allocations that developing countries can integrate in their medium-term planning and macroeconomic frameworks. Donors will address any constraints to providing such information."* Finally, paragraph 26d of the Accra Agenda for Action provides that "*Developing countries and donors will work together at the international level on ways of further improving the medium-term predictability of aid, including by developing tools to measure it.*"

The predictability of development aid rests on two main conditions, namely the reliability and transparency of aid (OECD, 2011: p62). Aid is considered as reliable "*if recipient countries can rely on donor pledges/commitments being translated into actual flows*". This requires that clear rules (e.g., the pre-conditions for disbursement) govern aid disbursements. The transparency of aid relates to "*the timely availability of information on expected future aid flows, with the appropriate degree of detail*" (OECD, 2011: p62). Thus, aid cannot be reliable if there is a lack of transparency about the expected future aid flows, and expected amounts of aid are obtained in a reliable manner by recipient countries' governments if aid is disbursed in accordance with the rules embedded in the commitment.

There are different configurations concerning the link between aid predictability and aid volatility, depending on whether the actual amounts of aid received are: expected and reliable; expected but unreliable; unexpected but reliable; and unexpected and unreliable (e.g., Andrews and Vera, 2008).

If aid is fully predictable, that is, if it is both expected and accrues to recipient countries in a reliable fashion, then it will facilitate fiscal planning, and allow the recipient governments to achieve the intended objectives of the aid received. While such aid may be volatile, it would not result in any ill-advised or in the adoption of fiscal consolidation measures by the recipient government that would ultimately undermine its effectiveness. This is in particular the case if donor-countries announced in advance the forthcoming ups-and-downs movements of aid such that recipient countries' budgetary authorities foresee this aid inflows volatility. This makes these resource inflows predictable. Aid financing large infrastructure projects is a case in point. Given that such aid requires by its nature that large amounts of money be disbursed, they are typically predictable, even though their disbursements may be volatile (Celasun and Walliser, 2008).

An expected amount of aid received by recipient countries' budgetary authorities in a non-reliable fashion would likely reflect a deviation of aid disbursements from aid commitments. In these circumstances, aid is not fully predictable and can lead to aid volatility, thereby undermining the efficient allocation of budgetary resources in recipient countries, and ultimately reducing aid effectiveness in these countries. Celasun and Walliser (2008) have provided evidence of the adverse effects of the unpredictability of budget aid, i.e., the deviations of budget aid commitments from disbursements. In particular, budget aid shortfalls result in public debt accumulation and falls in investment spending, while budget aid windfalls yet contribute to reducing public debt, but in the meantime, lead to a higher government consumption.

An unexpected amount of aid that accrues to recipient countries' budgetary authorities can be reliable. Such aid is either off budget or will enter into the budgets without being programmed, i.e., it was not forecast by budgetary authorities. This aid is by definition a source of volatility. Thus, an unexpected but reliable aid received by fiscal authorities (such aid being considered as unpredictable) is volatile and can be damaging for recipients' economies.

Finally, aid can be both unexpected and received in an unreliable fashion, therefore leaving fiscal authorities of the recipient-countries with no possibility of predicting it in budgets. This type

of aid, which is highly unpredictable, is also highly volatile and is likely to be ineffective, as it will adversely affect the recipient economies.

A number of studies have pointed out that an increase in aid volatility undermines the ability of the recipient country's government to implement coherent investment programs and fiscal policies (e.g., Agénor, 2020; Arellano et al., 2009; Hudson, 2015; Mosley and Suleiman, 2007), and worsens the soft budget constraints (e.g., Bräutigam and Knack, 2004). As a consequence, it limits governments' future investment activities on the ground that aid disbursements might not be forthcoming from donors (Lensink and Morrissey, 2000). Kodama (2012) has found that aid unpredictability causes typically a waste of one fifth of aid, and in some instances, a waste of up to one third of aid. However, different types of development aid can have different effects on the recipient economies (e.g., Chatterjee et al., 2003; Hudson, 2015; Neanidis and Varvarigos, 2009). Apart from debt and humanitarian aid flows, the most volatile types of aid sectors are industry-related aid, budget aid, and program assistance aid. Fielding and Mavrotas (2005) have found that project aid (i.e., sector-specific aid) (particularly in the more open economies) tend to be quite volatile and is, therefore, likely to undermine recipient countries' long term development prospects. This is because this type of aid aims to promote investment in physical and human capital. Indeed, aid volatility is found to be harmful for economic growth in developing countries, with this adverse effect being particularly significant for project aid, which aims to promote directly or indirectly investment in physical and human capital (e.g., Agénor, 2020; Kathavate and Mallik, 2012; Kodama, 2012; Museru et al., 2014; Neanidis and Varvarigos, 2009).

*Against this background, one can wonder whether the unpredictability and volatility of AfT flows are harmful to economic complexity.*

As noted above, the main categories of official development aid that form AfT flows, as defined by the OECD, include AfT interventions for the build-up economic infrastructure, AfT flows allocated for the strengthening of productive capacities, and AfT flows related to trade policy and regulation. AfT flows allocated for the development of economic infrastructure aim to build hard and soft infrastructure<sup>8</sup>. AfT interventions for productive capacities aim to strengthen the capacity of recipient countries to produce and exports goods and services that meet the world market's demand. Finally, AfT interventions related to trade policy and regulation purport to enhance the capacity of recipient countries' policymakers to effectively participate in trade negotiations, develop trade-related institutions, and elaborate and implement trade policies that comply with WTO rules. It is important to note that AfT flows for trade policy and regulation target the reduction of administrative costs and regulatory trade barriers, in particular by streamlining the time, cost, and number of documents necessary for export and import procedures. Part of this type of AfT inflows is also employed to help less productive firms in recipient countries to be compensated for the losses incurred as a result of the trade regime liberalization.

AfT flows fall into the category of project aid, and are unlikely to be fungible because they target specific projects, such as the build-up of infrastructure and strengthening of productive capacities in recipient-countries (e.g., Bearce et al., 2013). Figure 1 provides the development of the share of each of the three main components of total AfT flows described above, in total AfT flows, over the full sample. The latter is the one that will be used later in the empirical analysis.

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<sup>8</sup> Portugal-Perez and Wilson (2012: p 1296) have considered that hard infrastructure can include highways, railroads, ports, etc., while soft infrastructure includes transparency, customs efficiency, and institutional reforms.



This full sample contains 86 countries covering the period from 2004 to 2019. This Figure shows that while the share of AfT flows for economic infrastructure increased over time, the shares of both AfT flows for productive capacities and AfT flows related to trade policy and regulation exhibited downward trends. Moreover, the graphs in this Figure show the large financial requirements implied by economic infrastructure projects, and productive capacities building projects. Indeed, AfT flows for economic infrastructure accounted for 63.4% of total AfT flows in 2019, from 49.15% in 2004, while the share of AfT flows for productive capacities fell to 35.45% in 2019, from 49.42% in 2004. At the same time, AfT flows related to trade policy and regulation accounted for only 1.2% of total AfT flows in 2019 against 2.25% in 2004.

In general, project aid is disbursed over several years in accordance with specified plans and schedules. These multiyear plans of project aid provide recipient countries' governments with clear expectations in terms of aid amounts to be received from donors both annually and in the medium term. According to Andrews and Vera (2008) in the medium term, the project aid amounts that countries receive can be considered as 'expected' and 'reliable', and hence less subject to strong volatility. Notwithstanding this, in the short term, it is possible that the annual project aid be disbursed in an unreliable fashion, notably if the conditions governing its disbursement are not met. There can be several reasons for the lack of aid predictability, that can potentially result in greater aid volatility. This is the case when specific procedural requirements (e.g., procurement rules for project aid) are not met by recipient countries; when recipient countries face capacity constraints; when fundamental shifts in the recipient country's policy or governance raises doubt about the ability of recipient countries to use effectively aid to achieve the intended objectives<sup>9</sup>; when donors do not follow their administrative procedures and rules, or when they do not coordinate their aid allocation, including in the context of fragmented donor-recipient relationships (e.g., Canavire-Bacarreza et al., 2015; Celasun and Walliser, 2008; Fielding and Mavrotas, 2008).

Against this background, it can be envisaged that in the short term, an unpredictability of AfT interventions (for building economic infrastructure and of AfT interventions for fostering productive capacities) can result in a higher volatility of these resources inflows in recipient countries, jeopardize the recipient country's ability to plan and execute those projects, and ultimately reduce incentives for producing and exporting complex products. This hypothesis applies to both negative<sup>10</sup> AfT unpredictability and positive<sup>11</sup> AfT unpredictability that go hand in hand respectively with negative and positive AfT volatility.

In light of the above discussion, it can be straightforward to expect that negative AfT unpredictability (shortfalls in AfT flows) will be harmful to economic complexity. Likewise, positive AfT unpredictability can be harmful to economic complexity if recipient countries face significant absorptive capacities of the excess of AfT flows disbursements over the AfT flows commitments. A country that faces aid absorptive capacity constraints is the one whose use of additional aid results in a significant inefficiency in public spending, and has adverse effects on the

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<sup>9</sup> Recipient countries that have a weak project implementation systems can experience a higher unpredictability of AfT flows, if donors cut these resource inflows with a view to constraining recipient countries to improve their project implementation systems.

<sup>10</sup> Negative AfT unpredictability refers to shortfalls in AfT flows, i.e., when AfT flows disbursed by donors and received by recipient countries are lower than the amounts of AfT committed by donor-countries.

<sup>11</sup> Positive AfT unpredictability refers to windfalls of AfT flows, i.e., when AfT flows disbursed by donors and received by recipient countries exceed the amounts of AfT committed by donor-countries.

economy (e.g., Bourguignon and Sundberg, 2007; Feeny and De Silva, 2012; Feeny and McGillivray, 2009; Svensson, 2003). For example, Feeny and De Silva (2012) have found that the development aid amounts received by many developing countries tend to exceed the aid amounts that should accrue to these countries given their absorptive capacity. Absorptive capacity problems arise from the Dutch disease concern associated with higher aid flows and aid instability (e.g., Easterly, 2005; Heller, 2005; Rajan and Subramanian, 2011), human and physical capital constraints, policy constraints, weak institutional capacity; deficiencies in the delivery of aid by the international donor community, and social and cultural constraints (e.g., Feeny and De Silva, 2012; Knack, 2001).

The findings in the empirical literature provide a strong support for our hypothesis that the unpredictability of AfT flows accompanied with a higher volatility of these resource inflows will negatively affect economic complexity. For example, Hudson and Mosley (2008a) have observed that an increase in aid volatility results in a greater variability of expenditure, and thus in a proliferation of half-complete projects, as well as in the diminishing projects benefits and the rate of return of these projects. Rajan and Subramanian (2008) have similarly noted that shortfalls in foreign aid allocated for capital projects in poor countries may stall the implementation process of the projects unless funding from other sources is available. The potential negative effect of aid variability on the realization of projects, including trade relating ones will increase trade costs, and discourage firms for innovating and producing sophisticated goods. Arellano et al. (2009) have used two measures of aid volatility<sup>12</sup>, and reported that a permanent flow of aid mainly finances consumption rather than investment, and aid volatility leads to fluctuations of investment. We argue here that investment fluctuations could be detrimental to economic complexity. The authors have specifically found that a one-standard-deviation increase in various measures of aid volatility leads to a fall in manufacturing exports by up to 4 percentage points. This finding clearly indicates aid volatility, and eventually the volatility of AfT flows is likely to hamper economic complexity.

Hudson and Mosley (2008b) have obtained empirical evidence that aid volatility (including both positive and negative aid volatility) reduces investment and the shares of expenditure in gross domestic products (or gross national income). In particular, negative aid volatility reduces the import share. The decline in the import share is likely to hamper the production and export of complex products. In fact, imported goods permit access to various external knowledge flows (e.g., Frenken, et al 2007), can generate incremental innovation (see also Chen et al 2017; Liu and Qiu, 2016) and permit the production of export of sophisticated products, notably if the imported goods are different from countries' own exports (e.g., Kugler and Verhoogen, 2009; Puga and Trefler, 2010). The technology or quality embedded in imported inputs contributes significantly to the production (and export) of sophisticated products (e.g., Fan et al 2015; Feng et al. 2016; Colantone and Crino, 2014; Verhoogen, 2008).

Agénor and Aizenman (2010) have considered aid unpredictability in the sense of aid volatility, and put forth several arguments to explain how the lack of predictability of development aid (notably of project aid) results in permanent costs in terms of output loss, and generates large adverse effects on economic growth and welfare. In countries (e.g., low-income countries) where creating public capital requires time, and where a substantial portion of development aid is used

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<sup>12</sup> Aid volatility was measured by the authors in terms of aid unpredictability (i.e., ratio of commitments to disbursements) and by the ratio of variances of detrended aid to domestic revenue.

to finance infrastructure project, the lack of predictability of such aid (e.g., in the form of aid shortfalls) could paralyse the implementation process of the project, including by bringing it to a halt, especially in the absence of alternative sources of financing. On the other side, in response to this aid volatility, recipient countries' governments may opt for reducing the desired level of investment, which, *ceteris paribus*, means lower funding requirements. In turn, donors may misinterpret these lower requirements as a signal of absorption capacity problems, and subsequently reduce their amounts of announced (committed) aid. This situation would make the initial concerns about lower assistance self-fulfilling, and consequently perpetuate a stagnation equilibrium (including a poverty trap). These arguments clearly support our claim that AfT unpredictability and the related volatility are likely to exert negative effects on economic complexity in recipient countries.

Besides the negative economic complexity effect of the unpredictability and volatility of AfT for economic infrastructure and productive capacities, the unpredictability and volatility of AfT related to trade policy and regulation can also adversely affect economic complexity. For example, Gnanon (2020) has provided empirical evidence that the unpredictability of AfT flows leads recipient countries to adopt restrictive trade policies, and undermines the positive trade policy liberalization effect of AfT flows. In view of the positive economic complexity effect of trade policy liberalization<sup>13</sup>, we can expect that a higher unpredictability and volatility of AfT flows related to trade policy and regulation will negatively associated with economic complexity. Along the same lines, Rodrik (1990) has pointed out that the volatility of revenue inflows, of which a significant portion is constituted of development aid in poor countries, creates an unpredictable policy environment, which discourages domestic and foreign investment. Other studies have also emphasized the adverse possible effects of aid volatility on the business climate, that can deter private investment (e.g., Tressel and Prati 2006; Fatas and Mihov, 2008) and be harmful to the production and export of complex products. Aid volatility can also reduce recipient-countries' export competitiveness through its real exchange rate appreciation effect (i.e., through the so-called 'Dutch disease' effect) (e.g., Tressel and Prati 2006), and ultimately discourage the upgrading of export products, including the production and export of complex goods.

In light of the whole discussion under this section, we expect clearly that AfT flows that accrue to recipient countries in unpredictable and volatile fashions are likely to be detrimental to economic complexity. Against this backdrop, we formulate the following hypotheses.

Hypothesis 2: An increase in the predictability of total AfT flows is likely to promote economic complexity.

Hypothesis 3: A higher volatility of total AfT flows is likely to be harmful to economic complexity.

Hypothesis 4: Total AfT flows are likely to foster economic complexity in the context of greater predictability of these capital inflows.

Hypothesis 5: Total AfT flows can be more effective in promoting economic complexity in the context of lower volatility of these capital inflows.

Hypothesis 6: A higher unpredictability of total AfT flows and a heightened volatility of total AfT flows are likely to be jointly associated with lower economic complexity.

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<sup>13</sup> Trade policy liberalization facilitates the import of intermediate inputs needed in the production process of sophisticated goods (see our discussion on this matter above).

Hypothesis 7: Countries that enjoy higher total AfT flows in a predictable and less volatile fashions are likely to experience an improvement in their levels of economic complexity. In other words, the improvement in the quality of total AfT flows is likely associated with a greater economic complexity.

The empirical analysis will test each of these hypotheses, and notably the main one of interest in the analysis, which is hypothesis 7. But before turning to the empirical analysis, we present our measure of the quality of AfT flows.

### 3. Measuring the Quality of AfT

In light of the discussion laid out in section 2, the indicator of the quality of total AfT flows is a composite index of total AfT flows, AfT predictability, and AfT stability (i.e., low volatility). Therefore, we describe below how we compute the indicators of AfT predictability and AfT volatility, and then explain how the index of the quality of total AfT flows has been constructed.

We follow previous studies on the economic effect development aid unpredictability (e.g., Gnanon, 2014; Levy, 1987) and in particular of the unpredictability of AfT inflows (e.g., Gnanon, 2021c) by measuring the predictability of total AfT flows as the residual of the regression of the indicator of total AfT flows disbursements on the one-year lag of the total AfT flows commitment. As we will see later, the panel dataset constructed, based on available data on all variables used in the baseline model specified below, covers 86 AfT recipient countries over the annual period from 2004 to 2019.

This approach of measuring the predictability of AfT rests on the argument drawn from Levy (1987) that commitments of future AfT flows supplies are outcomes of dialogues and multiple negotiations between donor-countries and recipient-countries. The active participation of recipient-countries' policymakers in these negotiations enables them to estimate the probable level of the regular or permanent AfT inflows that they would receive. They, therefore, expect that the amount of AfT that they would receive (i.e., AfT flows disbursements) would reflect past AfT flows commitments. For this reason, we build on Levy (1987) and measure the anticipated AfT inflows by the predicted values of total AfT flows, obtained from an equation that establishes a stable relationship between current AfT disbursements inflows and past AfT flows commitments (see also Gnanon, 2021c). Both indicators of total AfT flows disbursements and commitments are expressed in constant prices 2019, US Dollar (see Appendix 1). The indicator capturing the anticipated AfT values has been computed for each AfT country of the full sample under analysis. Concretely, this approach involves regressing the indicator of total AfT flows disbursements over the one-year lag values of total AfT flows commitments. It is important to note that we would have included additional lags of the indicator of AfT flows commitments in the regression. However, the inclusion<sup>14</sup> of the two-year lag of AfT commitments as a regressor in the regression did not show a significant coefficient at the 10% level.

Once the indicator of anticipated AfT flows disbursements is calculated for each country, we compute for each country, the indicator of predictability of total AfT flows as the difference between the actual AfT flows disbursements and the anticipated AfT flows disbursements. The

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<sup>14</sup> Moreover, the limited time dimension of the panel dataset (i.e., 2004-2009) reduces significantly the scope of including many lags of total AfT flows commitments in the regression performed for each country.

computed indicator of predictability of total AfT flows is denoted "AfTPRED"- Higher values of this indicator of total AfT predictability reflect a greater predictability of total AfT flows.

We primarily measure the volatility of total AfT disbursements flows (denoted "AfTVOL") as the standard deviation over 3-year rolling windows (that is, from t-2 to t) of the growth rate of total AfT disbursements flows. Once again, to compute this volatility indicator, we use the total AfT flows disbursements expressed in constant prices 2019, US Dollar.

Next, we calculate the index of quality of total AfT flows. As noted above, it reflects a combination of an increase in total AfT flows, a rise in the predictability of total AfT flows, and a low volatility of total AfT flows. To compute this indicator, we have, first, calculated the indicator the inverse of the volatility of total AfT flows (denoted "INVAfTVOL") as follows:  $INVAfTVOL = 1/AfTVOL$ . It is worth emphasizing here that the values of the indicator "AfTVOL" are all higher than zero. Second, we transform the indicators "AfT", "AfTPRED" and "INVAfTVOL" into indices whose values range between 0 and 1. Finally, we calculate the index of quality of AfT as the geometric mean of these three indices.

The index of total AfT flows is computed for a given country  $i$ , in a given year  $t$  as follows:

$$INDEXAfT_{it} = \frac{AfT_{it} - \min(AfT_i)}{\max(AfT_i) - \min(AfT_i)}.$$

The index of the predictability of total AfT flows is calculated for a given country  $i$ , in a given year  $t$  as follows:  $INDEXAfTPRED_{it} = \frac{AfTPRED_{it} - \min(AfTPRED_i)}{\max(AfTPRED_i) - \min(AfTPRED_i)}$ .

The index of the inverse of the volatility of total AfT flows is calculated for a given country  $i$ , in a given year  $t$  as follows:  $INDEXINVAfTVOL_{it} = \frac{INVAfTVOL_{it} - \min(INVAfTVOL_i)}{\max(INVAfTVOL_i) - \min(INVAfTVOL_i)}$ .

Finally, the index of quality of total AfT flows has been calculated as the geometric mean of these three indices "INDEXAfT", "INDEXAfTPRED" and "INDEXINVAfTVOL". As a result,  $AfTQUAL_{it} = [(INDEXAfT_{it}) * (INDEXAfTPRED_{it}) * (INDEXINVAfTVOL_{it})]^{\frac{1}{3}}$ . An increase in the values of the index "AfTQUAL" indicates a better quality of total AfT flows.

It could be interesting to have a first view on the developments of these indicators over the full period. Figures 2 to 4 provide first insights into the relationship between total AfT flows, the predictability, volatility, and quality of these resource inflows, and economic complexity over the full sample.

Figure 2 displays the development of economic complexity and total AfT flows over the full sample, and Figure 3 presents the development of the indicators of the predictability of total AfT flows, volatility of total AfT flows, and quality of total AfT flows. Figure 4 shows a scatter plot between total AfT flows and economic complexity over the full sample (see the first hand-side graph), and between the quality of total AfT flows and economic complexity over the full sample, and the sub-samples of LDCs and NonLDCs (see other graphs).

We observe from Figure 2 that total AfT flows exhibited an upward trend, from US\$ million 138.7 in 2004 to US\$ million 380 in 2019. At the same time, the average level of economic complexity of developing countries in the full sample fluctuated over the period 2004-2019, although it increased between 2004 and 2019, from the value of -0.5 in 2004 to the value of -0.39 in 2019.

Figure 3 indicates that the predictability of AfT flows improved over time, from the value of -0.39 in 2004 to 0.38 in 2019. However, while the volatility of total AfT flows declined between

2004 and 2006, it significantly increased between 2006 and 2008, reaching its peak in 2008. It, then, remained stable until 2009, and significantly declined between 2009 and 2011. Between 2011 and 2013, AfT volatility remained relatively stable, but slightly declined from 2014 to 2015. It, then moved up again between 2015 and 2018, and slightly fell between 2018 and 2019. On the other side, we observe a tendency of improvement of the quality of total AfT flows over time.

Figure 4 shows a slightly negative correlation pattern between total AfT flows and economic complexity over the full sample. The correlation pattern between the quality of AfT flows and economic complexity over the full sample is not clear-cut. This reflects a slightly negative correlation pattern for the sub-sample of NonLDCs, but a slightly positive one for LDCs. The different correlation patterns between the quality of total AfT flows and economic complexity in LDCs and NonLDCs suggest that the effect of the quality of total AfT flows on economic complexity is likely to vary across countries.

Figures 2 to 4 provide only correlation patterns between AfT indicators and economic complexity, and therefore, do not prejudge the direction of the causal effects of the indicator of AfT quality, including those of AfT inflows, AfT predictability and AfT volatility on economic complexity. Such causal effects (if any at all) would be uncovered only through an appropriate model specification estimated using an appropriate econometric approach.

#### 4. Model specification

We investigate empirically the effect of the quality of total AfT flows (that reflects total AfT, its predictability and volatility) on economic complexity by drawing from the few existing studies on the effect of AfT flows on economic complexity (e.g., Arpaci-Ayhan, 2022; Gnanon, 2021b; Hai, 2021; Kamguia et al., 2022; Kim, 2019), and more generally on studies<sup>15</sup> that have explored the macroeconomic factors underpinning economic complexity.

We start with a baseline model that allows us to first examine the effect of the components of AfT quality on economic complexity. We will then, later, replace these components with the indicator of the quality of AfT in model (1).

We postulate the following baseline model:

$$ECI_{it} = \alpha_0 + \alpha_1 AfT_{it} + \alpha_2 AfTPRED_{it} + \alpha_3 Log(AfTVOL)_{it} + \alpha_4 Log(GDPC)_{it} + \alpha_5 HUM_{it} + \alpha_6 FDEV_{it} + \alpha_7 Log(REER)_{it} + \alpha_8 RENT_{it} + \alpha_9 INST_{it} + \alpha_{10} TERMS_{it} + \alpha_{11} Log(POPD)_{it} + \mu_i + \delta_t + \epsilon_{it} \quad (1)$$

The subscripts  $i$  and  $t$  represent respectively an AfT recipient country, and a given year, in the unbalanced panel dataset of 86 countries over the period from 2004 to 2019. This panel dataset has been built on the basis of available data on variables in the baseline model (1). The coefficients  $\alpha_0$  to  $\alpha_{11}$  will be estimated.  $\mu_i$  stand for countries' time invariant and unobserved specific effects.  $\delta_t$  capture global shocks (i.e., time dummies) that influence together the levels of economic complexity in all countries of the full sample.  $\epsilon_{it}$  is an error-term. Appendix 1 provides the

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<sup>15</sup> These studies include for example, Chu (2020); Gnanon (2021b, 2022); Hausmann et al. (2007); Hausmann and Hidalgo (2014); Lapatinas (2019); Lapatinas and Litina (2019); Laverde-Rojas and Correa (2019); Nguyen et al. (2020); Nguyen and Su (2021a; 2021b); Saadi (2020); Sweet and Maggio (2015) and Trung (2021).

description and source of the variables introduced in model (1). The standard descriptive statistics of these variables are presented in Appendix 2. Appendix 3 contains the lists of the 86 countries of the full sample, and of LDCs.

The dependent variable "ECI" is the indicator of economic complexity. As indicated above, it captures the diversity and sophistication of a country's export product structure, and hence, combines the diversity and ubiquity of a country's export structure. It has been estimated using data connecting countries to their export products, and applying the methodology described in Hausmann and Hidalgo (2009). Higher values of this indicator show an improvement in the degree of economic complexity.

The variable "AfT" is the total AfT flows disbursements expressed in constant prices 2019, US Dollar. The variables "AfTPRED" and "AfTVOL" are respectively our indicator of predictability of total AfT flows, and volatility of total AfT flows (see above). It is worth noting that we have applied the natural logarithm to the variable "AfTVOL" in order to reduce its skewed distribution. Later in the analysis, the variables "AfT", "AfTPRED" and "AfTVOL" will be replaced by the indicator of AfT quality.

The variable "GDPC" is the real per capita income (constant prices 2015, US\$), and acts as a proxy for countries' level of development. We expect an improvement in the real per capita income to be positively associated with economic complexity (e.g., Lapatinas and Litina, 2019; Sweet and Maggio, 2015).

The indicators "REER" and "POPD" are respectively the real effective exchange rate, and the population density. Higher values of the indicator "REER" reflect an appreciation of the real exchange rate. We have applied the natural logarithm to both variables to reduce their respective skewed distributions. We expect the depreciation of the real exchange rate to be associated with an improvement in the level of economic complexity. This is because a competitive and stable real exchange rate is critical for fostering production and export diversification (e.g., Guzman et al., 2018; Freund and Pierola, 2012; Noura et al., 2011). The population density represents countries' geographic potential and size of the labour force. It has been introduced in model (1) due to its potential for influencing countries' economic complexity paths (e.g., Gnangnon, 2022; Lapatinas, 2009).

The variables "HUM", "FDEV" and "RENT" are respectively indicators of the level of human capital accumulated in a country (see Feenstra et al., 2015), financial development and the share of total natural resources rents in GDP (an indicator of countries' dependence on natural resources). Finally, the variables "INST" and "TERMS" are respectively the measure of the institutional and governance quality, and of the terms of trade. The accumulation of human capital is expected to be positively associated with economic complexity (e.g., Ajide, 2022; Hausmann et al. 2007; Lapatinas and Litina, 2019). The development of domestic financial markets can also promote economic complexity (e.g., Ajide, 2022; Nguyen and Su, 2021a, 2021b). The improvement in the quality of institutions and governance contribute to fostering economic complexity through enhancing incentives to innovate (e.g., Lapatinas and Litina, 2019; Trung, 2021). The dependence in natural resources can serve as a strong basis for productive structure diversification and industrialization (e.g., Gutiérrez, 2022; Page 2015) or be a hindrance for the production and export of complex products (e.g., Ajide, 2022; Gnangnon, 2022) given its potential for reducing the prospects for industrialization (e.g., Orihuela, 2021; Sharma and Pal, 2021). This implies that the theoretical direction of the effect of the natural resources dependence on economic

complexity is a priori undetermined. Lastly, improvements in terms of trade can affect positively or negatively economic complexity depending on whether the revenues (or part of these) generated by higher commodity export prices are used to diversify export products towards sophisticated goods, or not (e.g., Gnanon, 2022).

## 5. Econometric approach

We employ two estimators, which are the within fixed effects (FEDK) estimator, and the Method of Moments Quantile Regression (MMQR) with fixed effects approach (also known as "Quantile via Moments"), developed by Machado and Santos Silva (2019). The FEDK estimator is used along with the technique developed by Driscoll and Kraay (1998) to correct estimates' standard errors for the heteroscedasticity, autocorrelation and contemporaneous correlation in the error term.

Using the FEDK estimator allows uncovering the effect of a given right-hand side regressor on the dependent variable at the mean of the conditional distribution of the dependent variable. Moreover, while the use of the FEDK estimator provides a first insight into the relationship between AfT flows, AfT predictability and AfT volatility on economic complexity, it has the drawback of not helping address possible endogeneity concerns (notably reverse causality problems) that can plague model (1) or its different variants estimated. An example of such an endogeneity problem is that while AfT, its predictability and stability are expected to affect the ability of recipient countries to develop and export complex products, it is also conceivable that donors could endeavour to make AfT more predictable and stable, including in collaboration with recipient countries, if they intended to help these countries, in particular poorest among them, improve their economic complexity and better integrate into the global trading system. Similarly, it is possible that the relatively low levels of economic complexity in developing countries prompt these countries' governments that wish to enhance their integration into the global trade markets through fostering economic complexity, to implement policies aiming at improving human capital, developing the domestic financial markets (to facilitate access by exporting firms to credit), making the real exchange rate more favourable to export product diversification, and improving their institutional and governance quality. As also noted above, economic complexity influences countries' real per capita income. All these lead us to suspect that a number of regressors in model (1) may be endogenous. These regressors are the indicators of the quality of total AfT flows, total AfT flows, AfT flows predictability, AfT flows volatility, the real per capita income, human capital, the real exchange rate, financial development, the dependence on natural resources, and the quality of institutions and governance. The variables representing the population density and terms of trade are likely to be exogenous in the present analysis.

To address these endogeneity concerns while also uncovering the effect of these regressors on economic complexity across various quantiles of the conditional distribution of the dependent variable (and not only at the mean, i.e., at the 50<sup>th</sup> quantile of this distribution), we use the panel quantile regression approach, especially the Method of Moments Quantile Regression (MMQR) with fixed effects approach (also known as "Quantile via Moments") developed by Machado and Santos Silva (2019). The MMQR approach has similar features to other panel quantile approaches (e.g., Canay, 2011; Koenker, 2004), such as helping overcome the problem of heteroscedasticity and that of outliers. However, it has many advantages over standard panel quantiles approaches.



First, unlike standard panel quantile approaches based on the ordinary least squares fixed effects where countries' fixed effects represent location (intercept) shifters (e.g., Heckman et al., 1997), the MMQR approach allows for the effects of countries' time-invariant characteristics to vary across different quantiles of the conditional distribution of the dependent variable (here, economic complexity). Second, the MMQR approach relies on the method of moments that permits to address endogeneity concerns, i.e., to deal appropriately with the endogenous regressors in the model.

We obtain the conditional quantiles for economic complexity by using the following panel quantile function:

$Q_{IPR_{it}}(\tau/X_{it}) = [(\mu_i + \delta_i q(\tau)) + X_{it}\beta + Z_{it}\gamma q(\tau)]$  (2), where the scalar parameter  $\mu_i(\tau) = \mu_i + \delta_i q(\tau)$  indicates the quantile- $\tau$  fixed effects for individual country  $i$ , or the distributional effect at  $\tau$ . It captures the time-invariant effect of individual country characteristics that potentially vary depending on the location of a country in the conditional distribution of economic complexity. Thus, while individual time-invariant (i.e., fixed) effects represent location (intercept) shifts in the ordinary least squares fixed effects approach, in the MMQR approach, these countries' fixed unobserved characteristics have different effects on the conditional distribution economic complexity, i.e., they have heterogenous impacts across different quantiles of the conditional distribution of economic complexity.

From equation (2), the conditional quantile function of the level of economic complexity  $q(\tau)$  (i.e., the  $\tau$ -th quantile) based on the MMQR approach, is uncovered from the optimization of the following function:

$\min_q \sum_i \sum_t \theta_\tau(\hat{R}_{it} - (\hat{R}_{it} + Z'_{it} \hat{\gamma})q)$  (3), where the check function  $\theta_\tau(A) = (\tau - 1)AI\{A \leq 0\} + \tau AI\{A > 0\}$  is the standard quantile loss function.

In the empirical exercise, we utilize the MMQR<sup>16</sup> approach of Machado and Santos Silva (2019) to estimate the effect of the quality of AfT flows (including AfT flows, their predictability and stability) on economic complexity across the conditional distribution of the indicator of economic complexity, and notably for 10 quantiles that are Q10<sup>th</sup> (i.e., the 10<sup>th</sup> quantile), Q20<sup>th</sup>, Q30<sup>th</sup>, Q40<sup>th</sup>, Q50<sup>th</sup>, Q60<sup>th</sup>, Q70<sup>th</sup>, Q80<sup>th</sup> and Q90<sup>th</sup> (i.e., the 90<sup>th</sup> quantile).

The empirical exercise proceeds as follows. We start by exploring the effect of AfT flows, AfT flows predictability and AfT flows volatility on economic complexity by using the FEDK estimator to estimate model (1) as it stands. This estimation is carried out over the full sample, and the sub-samples of LDCs, and Non-LDCs (i.e., countries that are not LDCs in the full sample). The results of this estimation are reported in Table 1. These results allow testing hypotheses 1 to 3.

To test hypotheses 4 to 6, we estimate several variants of model (1). In particular, hypothesis 4 is tested by estimating a variant of model (1) that includes the interaction variable between the indicator of AfT predictability and the variable measuring total AfT flows. The results of the estimation of this model specification are provided in column [1] of Table 2. Estimates reported in column [2] of the same Table allow testing hypothesis 5, and are uncovered by estimating

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<sup>16</sup> A routine (mmqreg) in the Stata software was developed by Rios-Avila (2020) to estimate quantile regressions via the Quantile via Moments approach of Machado and Santos Silva (2019).

another variant of model (1) that contains the interaction variable between the indicator of the volatility of total AfT flows and the variable measuring total AfT flows. Outcomes displayed in column [3] of Table 2 allow testing hypothesis 6, and are obtained by estimating a specification of model (1) that contains the interaction variable between the predictability of total AfT flows and the volatility of these inflows.

We test our main hypothesis in the analysis, that is, hypothesis 7, by estimating a specification of model (1) in which we replace the indicators of total AfT flows, AfT predictability and AfT volatility by the variable measuring the quality of total AfT flows. This specification of model (1) is estimated over the full sample, and the sub-samples of LDCs and NonLDCs. The results of these estimations are presented in Table 3.

Finally, we use equation (2) and the MMQR approach to replicate the estimations of specifications of model (1) whose results have been reported in Tables 1 and 3. In other words, the MMQR approach is used to test hypotheses 1, 2 and 7, that is, to investigate the effect of total AfT flows, AfT predictability, AfT volatility, and ultimately AfT quality on economic complexity. Table 4's estimates enable to test hypotheses 1 to 3, while the outcomes in Table 5 help test hypothesis 7, that is, the effect of AfT quality on economic complexity.

In the remaining part of the article, we use the expression "AfT flows" to mean "Total AfT flows".

## 6. Empirical outcomes

Outcomes presented in the three columns of Table 1 show that at the 1% level, AfT flows exert a negative effect on economic complexity, over the full sample as well as for the two sub-samples of LDCs and NonLDCs. It, however, appears that AfT flows have resulted in a higher negative effect on economic complexity in LDCs than in NonLDCs. This may be explained by the fact that LDCs face higher trade costs than NonLDCs. If we were to interpret these outcomes (even though the FEDK-based outcomes are not the preferred results in the analysis), we would note that a one-per cent increase in the AfT flows leads to a decrease in the level of economic complexity by 0.0008-point in LDCs and 0.0005-point in NonLDCs. In other words, doubling AfT flows (i.e., an increase in AfT flows by 100 per cent) leads to a fall in the index of economic complexity by 0.08-point in LDCs and 0.05-point in NonLDCs. To recall, in the full sample, the values of the indicator of economic complexity range between -2.196 and 1.371 (see Appendix 2). These outcomes support hypothesis 1, and are to some extent consistent with the findings in the existing literature, and notably the work by Kamguia et al. (2022) who have obtained, *inter alia*, that the effect of foreign aid on economic complexity depends on recipient countries' level of economic complexity.

On the other side, we find that across the three columns of the Table, at the 1% level, a greater predictability of AfT flows is associated with a higher level of economic complexity, with the effect being of almost the same magnitude in LDCs and NonLDCs. These findings lend credence to hypothesis 2. A one-point increase in the value of the index of AfT predictability is associated with a 0.06-point increase in the level of economic complexity. It, therefore, appears that the positive effect of the predictability of AfT flows on economic complexity is larger than the negative effect of the amount of AfT flows on economic complexity. These findings underline

the strong role played by the predictability of AfT flows in fostering economic complexity in AfT recipient countries.

On another note, the volatility of AfT flows appears to exert a negative and significant effect (at the 1% level) on economic complexity over the full sample. At the same time, the volatility of AfT flows exerts no significant effect (at the 5% level) on economic complexity in LDCs (as the effect is yet negative but significant only at the 10% level), but affects negatively and significantly economic complexity in NonLDCs at the 1% level. As for the magnitude of the effect of AfT volatility on economic complexity, we observe that a significant increase in the volatility of AfT flows, for example when the magnitude of such volatility doubles (i.e., increase by 100 per cent), the value of the index of economic complexity declines by 0.017 point in NonLDCs (at the 1% level) and 0.016 point in LDCs (but only at the 10% level). These outcomes tend to support hypothesis 3.

Concerning the effect of control variables on economic complexity, we find that at the 5% level over the full sample, greater economic complexity is positively driven by an improvement in the real per capita income, a greater financial development, and a lower dependence on natural resources. It also appears that an improvement in the institutional and governance quality exerts a negative and significant effect on economic complexity. This surprising outcome may be attributed to the possibility that the effect of the institutional and governance quality on economic complexity depends on countries' development level. In the present paper, we do not delve into this issue as it goes beyond the scope of the paper. Human capital, the real exchange rate, the population density and the terms of trade exert no significant effect (at the 10% level) on economic complexity over the full sample. In LDCs, at the 5% level, the bad performance in terms of economic complexity is driven essentially by their high dependence on natural resources (the effect population density is significant only at the 10% level). For NonLDCs, at the 5% level, results are similar to those obtained over the full sample, with few exceptions, notably that terms of trade improvements result in a lower economic complexity. This may suggest that these countries do not use the revenues extracted from the improvements in terms of trade to diversify their export product baskets toward complex products.

As noted in section 2, the potential negative effect of AfT flows on economic complexity may reflect the fact the economic complexity effect of AfT flows may depend on the predictability of these resources inflows, and eventually on the volatility of these inflows. This is what we consider by analysing results in Table 2 that allow testing hypotheses 4 to 6.

We note from column [1] of Table 2 that the coefficient of the interaction variable "[Log(AfT)]\*[AfTPRED]" is positive and significant at the 1% level, while the coefficient of the variable "[Log(AfT)]" is negative and significant at the 1% level. These results would suggest that AfT flows promote economic complexity when these resource inflows exhibit a high degree of predictability, notably when their level of predictability exceeds 7.255 ( $= 0.0674/0.00929$ ). Given that the values of the maximum value of the indicator of "AfTPRED" in the full sample is 2.524 (see Appendix 2) and hence is far lower than 7.255, we conclude that AfT flows are always negatively associated with economic complexity, regardless of the level of the predictability of these capital inflows, and the greater the predictability of these resource inflows, the lower is the magnitude of the negative effect of AfT flows on economic complexity. This finding does not fully support hypothesis 4, but at least underline the role played by a greater AfT predictability in dampening the negative effect of AfT flows on economic complexity. It implies that the

predictability of AfT flows reduces the negative effect of AfT flows on economic complexity. Given the close link between AfT predictability and AfT volatility, one can question whether there is not a missing element (i.e., AfT volatility) in the investigation of the effect of AfT flows on economic complexity. We capture the importance of this missing element by testing hypothesis 7 (see results in column [4] of Table 2). But before interpreting the outcomes that allow testing this hypothesis, we first consider results that permit to test hypotheses 5 and 6 (see respectively results in columns [2] and [3]).

We observe from column [2] of Table 2 that the coefficient of the variable "[Log(AfT)]" is negative and significant at the 1% level, but the interaction term related to the interaction variable "[Log(AfT)]\*[AfTVOL]" is not significant at the conventional significance levels. It, therefore, ensues that on average over the full sample, the negative effect of AfT flows does not depend on the level of volatility of these inflows. At the same time, we obtain from results reported in column [3] of the Table that the coefficient of the variable "[AfTPRED]\*[Log(AfTVOL)]" is negative and significant at the 1% level, and the coefficients of the variables ("AfTPRED") and ["Log(AfTVOL)"] are all significant at 1% level, but respectively positive and negative. We conclude that the predictability of AfT flows fosters economic complexity only when these resource inflows exhibit low volatility, especially for values of the volatility of AfT flows higher than 67.03 [= exponential(0.0656/0.0156)]. It appears, however, from Appendix 2 that the maximum value of the variable "AfTVOL" in the full sample is 51.647, which is lower than the number "67.03" found above. On the basis of these outcomes, we will conclude that regardless of the degree of volatility of AfT flows, the predictability of these resource inflows is always negatively associated with economic complexity, but the lower the volatility of AfT flows, the lower the magnitude of the negative effect of AfT predictability on economic complexity.

We infer from findings across columns [1] to [3] of Table 2 that what likely matters is not the separate effects of AfT flows, the predictability of AfT flows, and the volatility of AfT flows on economic complexity in recipient countries, but rather their combined effect on economic complexity in these countries, including through what we referred to as "Quality of AfT flows". This leads us to consider the estimation's outcomes reported in Table 3. Incidentally, outcomes concerning control variables in Table 2 align, to a large extent, with those in Table 1.

We observe from Table 3 that an improvement in the quality of AfT flows leads to a greater economic complexity in recipient countries. This effect appears to be positive and significant at the 1% level for countries in the full sample, and for those in the sub-sample of NonLDCs, but it is significant only at the 10% level for LDCs. Clearly, these outcomes lend support to hypothesis 7. In terms of magnitude of the effects, we obtain that an improvement in the quality of AfT flows by 1-point leads to an increase in the level of economic complexity by 0.073-point over the full sample, by 0.088-point for LDCs, and by 0.057-point for NonLDCs. Results of control variables in Table 3 are consistent with those in Table 1.

Turning to estimates presented in Table 4, we note that the location parameter associated with the variable "Log(AfT)" is negative and significant at the 1% level (see column [1]), while at the same time, the scale parameter related to the same variable is yet positive, but not significant at the 10% level. Taken together, these two parameters suggest that while the effect of AfT flows on economic complexity is negative and significant at the 1% level across all quantiles of the distribution of economic complexity, the scale of this effect decreases as we move from lower to higher quantiles. In other words, countries in upper quantiles, i.e., countries that experience a

relatively higher level of economic complexity experience a lower negative effect of AfT flows on economic complexity than countries located in lower quantiles, including less complex economies (e.g., poor countries, including LDCs). These findings align with the outcomes of some previous studies, and more importantly with outcomes reported in columns [2] and [3] of Table 1. Moreover, the magnitude of the effect of AfT flows on economic complexity for countries situated in the 50<sup>th</sup> quantile (that amounts to -0.0693) is close to the conditional mean effect of AfT flows on economic complexity in column [1] of Table 1 (the coefficient of the AfT indicator was -0.073). These outcomes lend credence to hypothesis 7.

The location parameter related to the variable capturing the predictability of AfT flows is positive and significant at the 1% level, while the scale parameter associated with the same variable is negative but not significant at the conventional significance levels. These outcomes indicate that at the 1% level, the predictability of AfT flows fosters economic complexity in all quantiles of the distribution of the indicator of economic complexity, but the magnitude (i.e., scale) of this effect is larger for countries situated in lower quantiles than for countries located in upper countries. In other words, less complex economies (e.g., countries situated for example in the 10<sup>th</sup> quantile, such as LDCs) experience a greater positive effect of the predictability of AfT flows on economic complexity than countries located in the 20<sup>th</sup> to 90<sup>th</sup> quantiles. These outcomes clearly support hypothesis 2.

The volatility of AfT exerts a negative and significant effect (at least at the 5% level) on economic complexity across all quantiles of the distribution of the economic complexity indicator. However, the magnitude of this negative effect becomes larger as we move from lower quantiles to upper quantiles. This suggests that countries located in the upper quantiles (i.e., those with relatively high levels of economic complexity) face a larger effect of the volatility of AfT flows on economic complexity than countries situated in lower quantiles. These findings are exemplified by the negative and significant (at the 1% level) location parameter associated with the variable measuring the volatility of AfT flows, and the negative but not significant scale parameter related to the same variable. All these outcomes support hypothesis 3.

Regarding estimates of control variables in Table 4, an improvement in the real per capita income and a greater financial development tend to exert a larger positive and significant effect on economic complexity in countries situated in lower quantiles than in countries located in the upper quantiles of the distribution of the indicator of economic complexity. The real exchange rate appreciation exerts a significant (yet positive) effect on economic complexity only for countries situated in the 80<sup>th</sup> and 90<sup>th</sup> quantiles. The improvement in human development and the increase in the population density exert no significant effect (at the 10% level) on economic complexity across quantiles of the distribution of economic complexity. The institutional and governance quality does not affect economic complexity in countries lower quantiles (in particular from the 10<sup>th</sup> to 40<sup>th</sup> quantiles), but exerts a negative and significant effect on economic complexity for countries in other quantiles. At least at the 10% level, the terms of trade improvement reduces economic complexity in less complex economies (countries residing in the 10<sup>th</sup> to the 40<sup>th</sup> quantiles), while exerting no significant effect on economic complexity in relatively complex economies (those in the upper quantiles, from the 50<sup>th</sup> to 90<sup>th</sup> quantiles). Finally, the endowment in natural resources is negatively and significantly associated with economic complexity, with this negative effect being larger in less complex economies (i.e., those in lower quantiles) than in relatively more complex ones (i.e., upper quantiles). In particular, we find no significant effect of

the dependence on natural resources on economic complexity in countries that enjoy the highest degree of economic complexity, i.e., those locating in the 90<sup>th</sup> quantile of the distribution of the indicator of economic complexity.

Next, we consider estimates in Table 5, which are results based on the MMQR approach, to test hypothesis 7 concerning the effect of the quality of AfT on economic complexity. At the outset, we note that estimates relating to control variables in this Table are consistent with those in Table 4.

Turning now to the estimates of our variable of interest, namely the quality of AfT, we observe that the location parameter and the scale parameter associated with this variable (see column [1]) are respectively positive and significant at the 1% level, and negative but not significant at the 10% level. These results suggest that while the effect of the quality of AfT flows is positive and significant (at least at the 5% level) across all quantiles of the distribution of economic complexity, the scale of this effect decreases as we move from lower quantiles to upper quantiles. Putting it differently, the improvement in the quality of AfT flows exerts a larger positive and significant effect on economic complexity in countries situated in lower quantiles (e.g., countries in the 10<sup>th</sup> quantile, including LDCs) than in countries residing in upper quantiles. Hence, the improvement in the quality of AfT flows exerts a larger positive effect on economic complexity in less complex economies (that include poorest countries) than in relatively more complex economies. These findings clearly support hypothesis 7.

## 7. Conclusion

The existing literature on the relationship between AfT flows and economic complexity has reached a clear-cut conclusion on the direction of effect of these capital inflows on economic complexity in recipient countries. The present article aims to complement the existing works on the matter by taking up the issue from the perspective of what it refers to as 'quality of AfT'. It argues that what matters for economic complexity in recipient countries is not only the amounts of AfT that accrue to recipient countries, but also the level of predictability and degree of volatility of these capital inflows. The concept of 'quality of AfT' is defined as the one that combines not only the amounts of total AfT that a recipient country receives, but also the predictability and stability of these resource inflows. Thus, for a given recipient country, a better quality of total AfT flows reflects an increase in these capital inflows in a predictable and less volatile fashions.

We investigate the effect of the quality of AfT flows on economic complexity, using a panel dataset of 86 countries over the period from 2004 to 2019. The analysis has employed the within fixed effects estimator and the Method of Moments Quantile Regression with fixed effects approach.

Results suggest that total AfT flows reduce economic complexity, and notably exert a larger negative effect on economic complexity in less complex economies (e.g., LDCs) than in relatively more complex economies. Meanwhile, a greater predictability of total AfT flows fosters economic complexity, with the magnitude of this positive effect being larger in less complex economies, including poorest countries, than in relatively more complex economies. Concurrently, the volatility of total AfT flows reduces economic complexity, including to a greater extent in more complex economies than in relatively less complex economies. Interestingly and more importantly, we find that the improvement in the quality of AfT flows promotes economic complexity, with

less complex economies (e.g., LDCs) enjoying a larger positive effect of AfT quality on economic complexity than relatively complex economies do.

The literature has shown that the unpredictability and volatility of aid projects are likely to undermine the development perspectives of recipient countries. The reasons for an unpredictability and volatility of AfT flows lie in both the donor-countries and recipient countries' sides. The findings of the present analysis show that what really matters for the enhancement of economic complexity in developing countries is not only the amounts of total AfT that these countries receive, but more importantly the predictability and the stability of these resource inflows. Donor-countries took the commitments at international gatherings (and regularly renewed these commitments) not only to increase development aid, but also to make this aid more predictable. They also commit to work closely with recipient countries to reach this objective. Meeting these commitments by making AfT flows (the portion of development aid dedicated to the enhancement of countries' participation in international trade) more predictable and less volatile would be of high benefits to recipient countries, including in terms of producing and exporting increasingly complex products.

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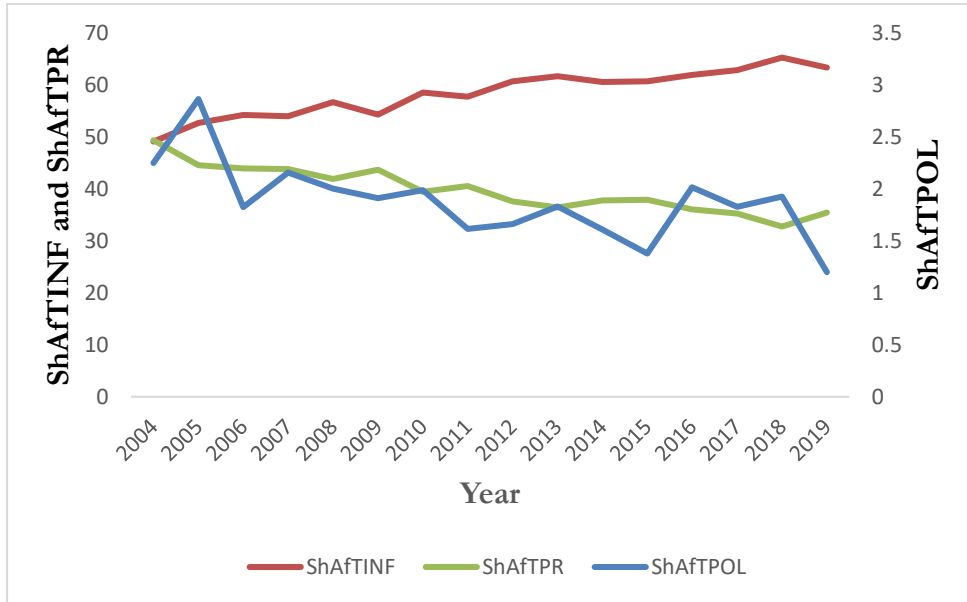
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## FIGURES

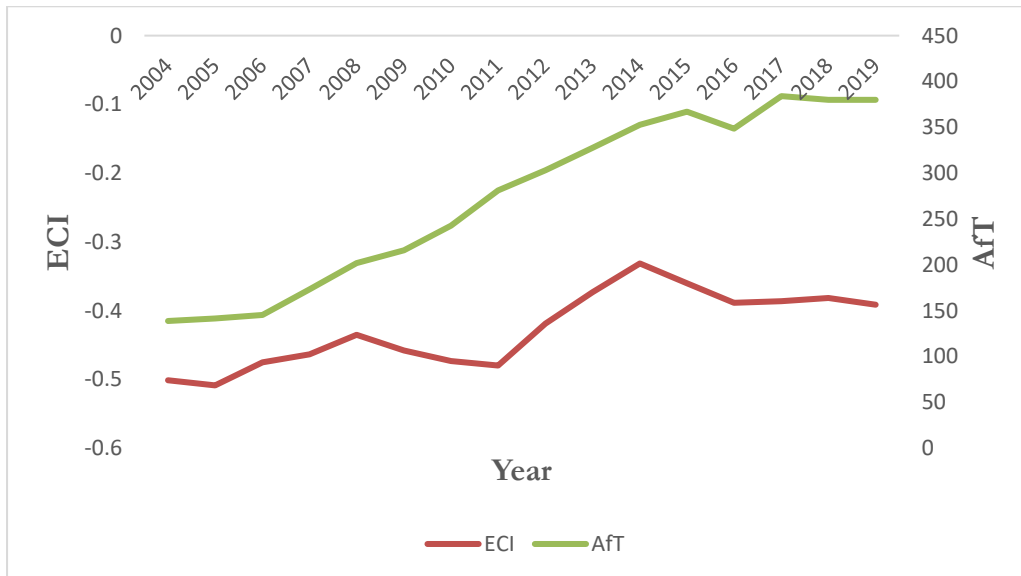
**Figure 1:** Development of the components of total AfT flows\_Over the full sample



Source: Author

Note: The variable "ShAfTINF", "ShAfTPR" and "ShAfTPOL" are respectively the share (in percentage) of AfT flows for economic infrastructure in total AfT flows, the share (in percentage) of AfT flows for productive capacities in total AfT flows, and the share (in percentage) of AfT flows related to trade policy and regulation in total AfT flows,

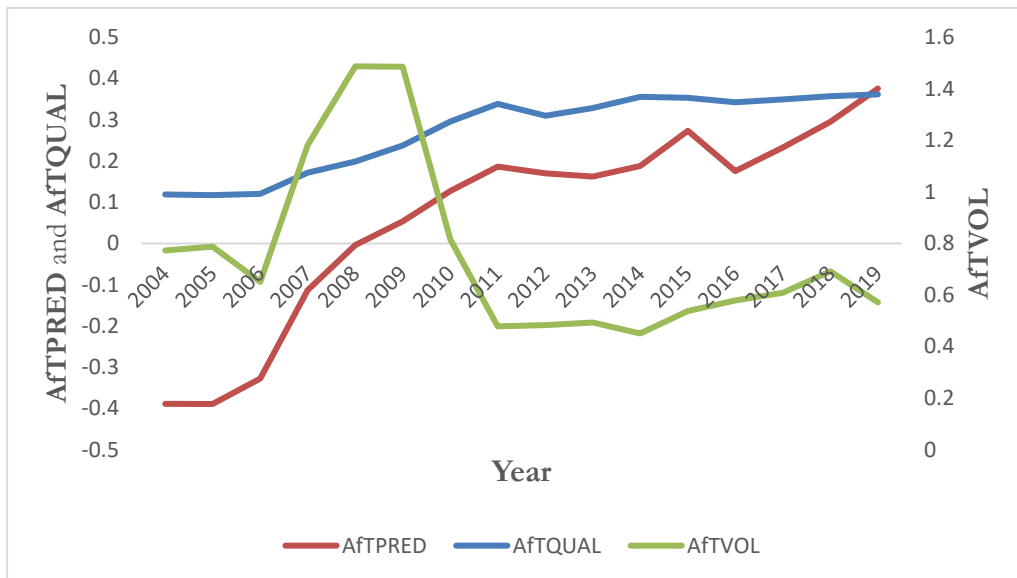
**Figure 2:** Development of Economic complexity and total AfT flows \_Over the full sample



Source: Author

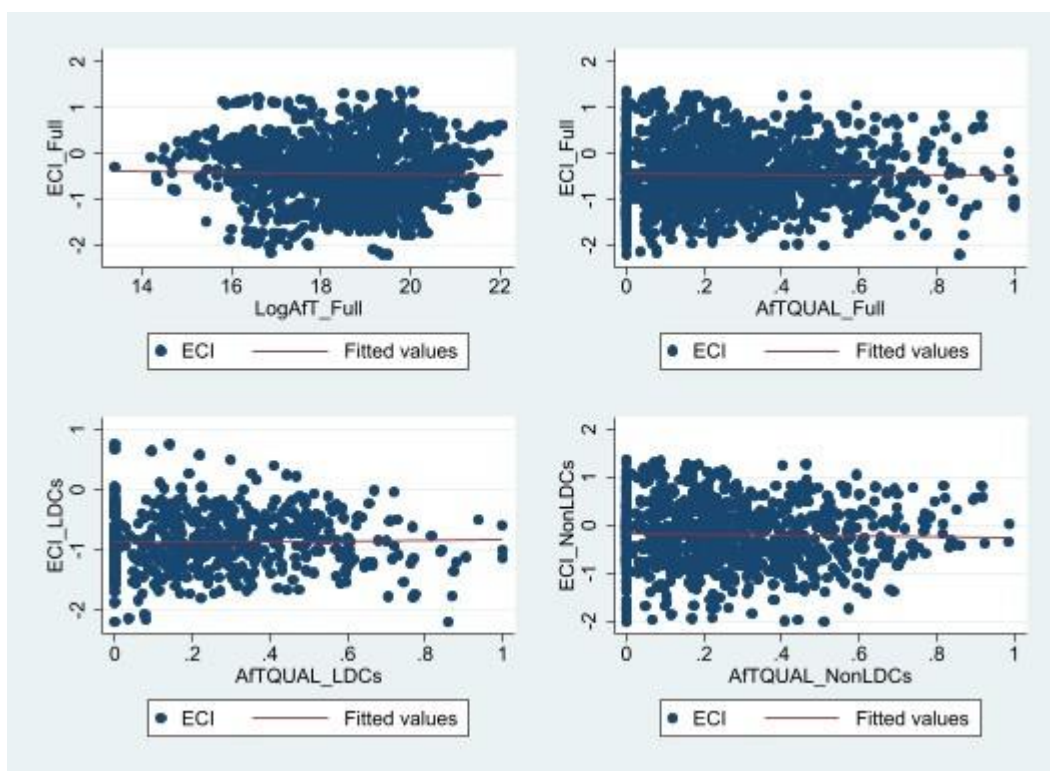
Note: The variable "AfT" is expressed in millions of US dollar, constant prices 2019.

**Figure 3:** Development of Predictability, Volatility and Quality of total AfT flows\_Over the full sample



Source: Author

**Figure 4:** Scatterplot between total AfT flows, the Quality of total AfT flows and economic complexity\_Over the full sample and the sub-samples of LDCs and NonLDCs



Source: Author

Notes: "Full" means Full sample. "LDCs" means the sub-sample of LDCs: "NonLDCs" means the sub-sample of NonLDCs.

## TABLES and APPENDICES

**Table 1:** Effects of total AfT flows, their predictability and volatility on economic complexity  
*Estimator:* FEDK

Variables	Full sample	LDCs	NonLDCs
	ECI (2)	ECI (3)	ECI (4)
Log(AfT)	-0.0685*** (0.0170)	-0.0812*** (0.0257)	-0.0511*** (0.0171)
AfTPRED	0.0730*** (0.0139)	0.0592*** (0.0189)	0.0585*** (0.0129)
Log(AfTVOL)	-0.0176*** (0.00289)	-0.0164* (0.00801)	-0.0171*** (0.00516)
Log(GDPC)	0.296*** (0.0962)	0.313 (0.231)	0.286*** (0.0431)
HUM	0.0519 (0.0798)	0.165 (0.164)	-0.0811* (0.0427)
FDEV	0.434*** (0.0971)	0.145 (0.765)	0.486*** (0.0861)
Log(REER)	0.0323 (0.0293)	0.0446 (0.0432)	0.0327 (0.0317)
RENT	-0.00569*** (0.00182)	-0.00838*** (0.00231)	-0.00195 (0.00171)
INST	-0.0401*** (0.0129)	-0.0416 (0.0304)	-0.0501*** (0.0121)
TERMS	-0.000323 (0.000205)	8.90e-05 (0.000347)	-0.000551** (0.000249)
Log(POPD)	-0.0439 (0.0893)	-0.307* (0.163)	0.467*** (0.0758)
Constant	-1.598*** (0.404)	-0.679 (0.930)	-3.566*** (0.630)
Observations - Countries	1,272 - 86	450 - 30	822 - 56
Within R-squared	0.1171	0.0682	0.2532

*Note:* \**p*-value<0.1; \*\**p*-value<0.05; \*\*\**p*-value<0.01. Robust standard errors are in parenthesis.

**Table 2:** Interaction effect between total AfT flows, their predictability and their volatility on economic complexity\_over the full sample

*Estimator.* FEDK

Variables	ECI (1)	ECI (2)	ECI (3)
Log(AfT)	-0.0674*** (0.0173)	-0.0686*** (0.0170)	-0.0692*** (0.0174)
AfTPRED	-0.0967 (0.0675)	0.0740*** (0.0135)	0.0656*** (0.0129)
Log(AfTVOL)	-0.0177*** (0.00279)	-0.0444 (0.0698)	-0.0169*** (0.00312)
[Log(AfT)]*[AfTPRED]	0.00929*** (0.00324)		
[Log(AfT)]*[Log(AfTVOL)]		0.00147 (0.00378)	
[AfTPRED]*[Log(AfTVOL)]			-0.0156*** (0.00550)
Log(GDPC)	0.285*** (0.0977)	0.296*** (0.0961)	0.297*** (0.0968)
HUM	0.0443 (0.0808)	0.0532 (0.0809)	0.0401 (0.0793)
FDEV	0.476*** (0.0940)	0.432*** (0.0989)	0.441*** (0.0940)
Log(REER)	0.0364 (0.0293)	0.0332 (0.0294)	0.0330 (0.0295)
RENT	-0.00561*** (0.00182)	-0.00567*** (0.00182)	-0.00579*** (0.00184)
INST	-0.0375*** (0.0132)	-0.0402*** (0.0128)	-0.0403*** (0.0131)
TERMS	-0.000310 (0.000199)	-0.000320 (0.000201)	-0.000339 (0.000204)
Log(POPD)	-0.0508 (0.0886)	-0.0418 (0.0888)	-0.0610 (0.0938)
Constant	-1.521*** (0.390)	-1.614*** (0.399)	-1.497*** (0.428)
Observations - Countries	1,272 - 86	1,272 - 86	1,272 - 86
Within R-squared	0.1189	0.1172	0.1203

Note: \**p*-value<0.1; \*\**p*-value<0.05; \*\*\**p*-value<0.01. Robust standard errors are in parenthesis.

**Table 3:** Effects of quality of total AfT flows on economic complexity  
*Estimator.* FEDK

Variables	Full sample	LDCs	NonLDCs
	ECI (1)	ECI (2)	ECI (3)
AfTQUAL	0.0727*** (0.0194)	0.0883* (0.0448)	0.0571*** (0.0170)
Log(GDPC)	0.320*** (0.107)	0.349 (0.250)	0.299*** (0.0484)
HUM	0.0182 (0.0798)	0.164 (0.148)	-0.124** (0.0529)
FDEV	0.391*** (0.0960)	0.124 (0.924)	0.448*** (0.0713)
Log(REER)	0.0166 (0.0323)	0.00302 (0.0568)	0.0265 (0.0344)
RENT	-0.00675*** (0.00208)	-0.00927*** (0.00250)	-0.00277 (0.00199)
INST	-0.0583*** (0.0207)	-0.0861** (0.0373)	-0.0531*** (0.0159)
TERMS	-0.161 (0.109)	-0.524** (0.190)	0.428*** (0.0857)
Log(POPD)	-0.000352* (0.000211)	-0.000156 (0.000319)	-0.000544** (0.000255)
Constant	-2.436*** (0.353)	-1.413 (0.866)	-4.315*** (0.500)
Observations - Countries	1,265 - 86	446 - 30	819 - 56
Within R-squared	0.0984	0.0530	0.2367

Note: \**p*-value<0.1; \*\**p*-value<0.05; \*\*\**p*-value<0.01. Robust standard errors are in parenthesis.

**Table 4:** Effect of AfT flows, AfT predictability and AfT volatility on economic complexity\_over the full sample  
*Estimator.* Method of Moments Quantile Regression (MMQR)

Variables	Location <sup>a</sup>	Scale <sup>b</sup>	Q10 <sup>th</sup>	Q20 <sup>th</sup>	Q30 <sup>th</sup>	Q40 <sup>th</sup>	Q50 <sup>th</sup>	Q60 <sup>th</sup>	Q70 <sup>th</sup>	Q80 <sup>th</sup>	Q90 <sup>th</sup>
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
Log(AfT)	-0.0692*** (0.0153)	0.00724 (0.00683)	-0.0808*** (0.0191)	-0.0776*** (0.0174)	-0.0747*** (0.0163)	-0.0720*** (0.0156)	-0.0693*** (0.0153)	-0.0666*** (0.0154)	-0.0638*** (0.0160)	-0.0611*** (0.0169)	-0.0574*** (0.0186)
AfTPRED	0.0708*** (0.0161)	-0.00570 (0.00727)	0.0799*** (0.0203)	0.0774*** (0.0186)	0.0752*** (0.0173)	0.0731*** (0.0165)	0.0709*** (0.0162)	0.0688*** (0.0162)	0.0666*** (0.0168)	0.0644*** (0.0177)	0.0616*** (0.0196)
Log(AfTVOL)	-0.0168*** (0.00605)	-0.000373 (0.00304)	-0.0162** (0.00770)	-0.0164** (0.00695)	-0.0165** (0.00644)	-0.0167*** (0.00615)	-0.0168*** (0.00605)	-0.0170*** (0.00616)	-0.0171*** (0.00649)	-0.0172** (0.00698)	-0.0174** (0.00787)
Log(GDPG)	0.210*** (0.0786)	-0.0111 (0.0422)	0.228** (0.0983)	0.223** (0.0882)	0.218*** (0.0818)	0.214*** (0.0787)	0.210*** (0.0785)	0.206** (0.0815)	0.201** (0.0876)	0.197** (0.0957)	0.192* (0.109)
HUM	-0.0171 (0.0936)	0.108** (0.0447)	-0.190 (0.138)	-0.142 (0.123)	-0.0992 (0.111)	-0.0599 (0.102)	-0.0193 (0.0941)	0.0215 (0.0889)	0.0632 (0.0867)	0.104 (0.0881)	0.158* (0.0938)
FDEV	0.341** (0.152)	-0.00474 (0.0787)	0.349* (0.192)	0.347** (0.173)	0.345** (0.160)	0.343** (0.154)	0.341** (0.152)	0.340** (0.157)	0.338** (0.166)	0.336* (0.180)	0.334 (0.205)
Log(REER)	0.0144 (0.0496)	0.0878*** (0.0245)	-0.126* (0.0671)	-0.0873 (0.0608)	-0.0524 (0.0557)	-0.0204 (0.0521)	0.0126 (0.0500)	0.0459 (0.0495)	0.0798 (0.0507)	0.113** (0.0533)	0.157*** (0.0596)
RENT	-0.00564*** (0.00174)	0.00117 (0.000922)	-0.00751*** (0.00214)	-0.00699*** (0.00193)	-0.00653*** (0.00180)	-0.00610*** (0.00174)	-0.00566*** (0.00174)	-0.00522*** (0.00182)	-0.00476** (0.00195)	-0.00433** (0.00213)	-0.00373 (0.00244)
INST	-0.0373** (0.0185)	-0.0180* (0.00984)	-0.00848 (0.0266)	-0.0165 (0.0235)	-0.0236 (0.0213)	-0.0302 (0.0197)	-0.0369** (0.0186)	-0.0437** (0.0182)	-0.0507*** (0.0186)	-0.0574*** (0.0197)	-0.0665*** (0.0220)
Log(POPD)	-0.220 (0.150)	-0.0379 (0.0718)	-0.160 (0.196)	-0.177 (0.177)	-0.192 (0.164)	-0.205 (0.155)	-0.220 (0.150)	-0.234 (0.151)	-0.249 (0.156)	-0.263 (0.165)	-0.282 (0.183)
TERMS	-0.000382 (0.000306)	0.000349** (0.000150)	-0.000941** (0.000379)	-0.000786** (0.000344)	-0.000648** (0.000322)	-0.000521* (0.000310)	-0.000389 (0.000307)	-0.000257 (0.000315)	-0.000123 (0.000333)	7.88e-06 (0.000358)	0.000184 (0.000400)
Constant	0.0584 (0.963)	-0.494 (0.497)	0.849 (1.263)	0.630 (1.132)	0.434 (1.043)	0.254 (0.988)	0.0685 (0.964)	-0.118 (0.977)	-0.309 (1.026)	-0.494 (1.103)	-0.743 (1.243)
Observations - Countries	1,272 - 86	1,272 - 86	1,272 - 86	1,272 - 86	1,272 - 86	1,272 - 86	1,272 - 86	1,272 - 86	1,272 - 86	1,272 - 86	1,272 - 86

Note: \*p-value<0.1; \*\*p-value<0.05; \*\*\*p-value<0.01. Robust Standard Errors are in parenthesis. (a) indicates the location parameters, and (b) refers to the scale parameters.

**Table 5:** Effect of the **Quality of Total AfT** on economic complexity\_over the full sample  
*Estimator.* Method of Moments Quantile Regression (MMQR)

Variables	Location <sup>a</sup>	Scale <sup>b</sup>	Q10 <sup>th</sup>	Q20 <sup>th</sup>	Q30 <sup>th</sup>	Q40 <sup>th</sup>	Q50 <sup>th</sup>	Q60 <sup>th</sup>	Q70 <sup>th</sup>	Q80 <sup>th</sup>	Q90 <sup>th</sup>
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
<b>AfTQUAL</b>	0.0748*** (0.0273)	-0.00337 (0.0145)	0.0802** (0.0367)	0.0787** (0.0329)	0.0774** (0.0301)	0.0762*** (0.0283)	0.0747*** (0.0273)	0.0736*** (0.0275)	0.0723** (0.0287)	0.0710** (0.0310)	0.0693** (0.0350)
Log(GDPC)	0.236*** (0.0808)	-0.0126 (0.0419)	0.256** (0.101)	0.251*** (0.0916)	0.246*** (0.0851)	0.242*** (0.0815)	0.236*** (0.0808)	0.232*** (0.0831)	0.227*** (0.0881)	0.222** (0.0963)	0.216** (0.109)
HUM	-0.0564 (0.0941)	0.114** (0.0449)	-0.237* (0.139)	-0.188 (0.124)	-0.144 (0.112)	-0.103 (0.103)	-0.0549 (0.0941)	-0.0153 (0.0893)	0.0260 (0.0871)	0.0721 (0.0886)	0.128 (0.0942)
FDEV	0.305* (0.158)	-0.0376 (0.0785)	0.365* (0.197)	0.348* (0.179)	0.334** (0.166)	0.320** (0.160)	0.304* (0.158)	0.291* (0.161)	0.278 (0.170)	0.262 (0.184)	0.244 (0.207)
Log(REER)	0.00224 (0.0499)	0.0859*** (0.0243)	-0.135* (0.0687)	-0.0973 (0.0620)	-0.0639 (0.0569)	-0.0332 (0.0531)	0.00341 (0.0502)	0.0333 (0.0493)	0.0646 (0.0500)	0.0995* (0.0522)	0.142** (0.0579)
RENT	-0.00676*** (0.00174)	0.00146* (0.000883)	-0.00908*** (0.00214)	-0.00845*** (0.00195)	-0.00788*** (0.00182)	-0.00736*** (0.00176)	-0.00674*** (0.00175)	-0.00623*** (0.00180)	-0.00570*** (0.00191)	-0.00510** (0.00208)	-0.00438* (0.00235)
INST	-0.0570*** (0.0195)	-0.0201* (0.0103)	-0.0250 (0.0262)	-0.0337 (0.0234)	-0.0416* (0.0214)	-0.0487** (0.0202)	-0.0573*** (0.0195)	-0.0643*** (0.0197)	-0.0716*** (0.0206)	-0.0797*** (0.0222)	-0.0897*** (0.0251)
Log(POPD)	-0.343** (0.152)	-0.0631 (0.0722)	-0.242 (0.202)	-0.269 (0.183)	-0.294* (0.169)	-0.317** (0.159)	-0.344** (0.152)	-0.365** (0.151)	-0.388** (0.155)	-0.414** (0.164)	-0.445** (0.180)
TERMS	-0.000377 (0.000309)	0.000332** (0.000150)	-0.000907** (0.000394)	-0.000763** (0.000359)	-0.000633* (0.000332)	-0.000515 (0.000317)	-0.000373 (0.000310)	-0.000257 (0.000313)	-0.000136 (0.000327)	-1.08e-06 (0.000350)	0.000163 (0.000391)
Constant	-0.801 (0.972)	-0.241 (0.493)	-0.418 (1.301)	-0.522 (1.169)	-0.616 (1.074)	-0.702 (1.010)	-0.805 (0.972)	-0.889 (0.973)	-0.976 (1.007)	-1.074 (1.078)	-1.193 (1.205)
Observations-Countries	1,265 - 86	1,265 - 86	1,265 - 86	1,265 - 86	1,265 - 86	1,265 - 86	1,265 - 86	1,265 - 86	1,265 - 86	1,265 - 86	1,265 - 86

Note: \**p*-value<0.1; \*\**p*-value<0.05; \*\*\**p*-value<0.01. Robust Standard Errors are in parenthesis. (a) indicates the location parameters, and (b) refers to the scale parameters.

**Appendix 1: Definition and Source of variables**

Variables	Definition	Sources
ECI	This is the economic complexity index. It reflects the diversity and sophistication of a country's export structure, and hence indicates the diversity and ubiquity of that country's export structure. It has been estimated using data connecting countries to the products they export, and applying the methodology in described in Hausmann and Hidalgo (2009). Higher values of this index reflects greater economic complexity.	MIT's Observatory of Economic Complexity <a href="https://oec.world/en/rankings/eci/hs6/hs96">https://oec.world/en/rankings/eci/hs6/hs96</a>
AfT	This is the indicator of the real gross disbursements of total Aid for Trade (expressed in constant prices 2019, US Dollar). It has been computed as the sum of three aid components, namely the real gross disbursements of Aid for Trade allocated to the buildup of economic infrastructure; the real gross disbursements of Aid for Trade for building productive capacities; and the real gross disbursements of Aid allocated for trade policies and regulation. All three components of total AfT flows are expressed in constant prices 2019, US Dollar.	Author's calculation based on data extracted from the OECD statistical database on development, in particular the OECD/DAC-CRS (Organization for Economic Cooperation and Development/Donor Assistance Committee)-Credit Reporting System (CRS). Aid for Trade data cover the following three main categories (the CRS Codes are in brackets): Aid for Trade for Economic Infrastructure, which includes transport and storage (210), communications (220), and energy generation and supply (230); Aid for Trade for Building Productive Capacity, which includes banking and financial services (240), business and other services (250), agriculture (311), forestry (312), fishing (313), industry (321), mineral resources and mining (322), and tourism (332); and Aid for Trade policy and regulations, which includes trade policy and regulations and trade-related adjustment (331).
AfTPRED	This is the indicator of the predictability of total AfT flows. It has been calculated as the residual of the regression of the indicator of total AfT flows disbursements on the one-year lag of the total AfT flows commitment (as the two-year lag of AfT commitments did not show a significant coefficient at the 10% level). Both indicators of total AfT flows disbursements and commitments are expressed in constant prices 2019, US Dollar.	Author's calculation based on AfT data described above.



AFTVOL	This is the indicator of the volatility of total AfT disbursements flows. It has been computed as the standard deviation over 3-year rolling windows (that is, from t-2 to t) of the growth rate of total AfT disbursements flows.	Author's calculation based on AfT data described above.
AFTQUAL	This is the indicator of what is termed "quality of AfT flows". It is a combination of total AfT flows, predictability of total AfT flows, and stability (low volatility) of total AfT flows. An increase in the values of the index "AFTQUAL" indicates an improvement in the quality of total AfT flows.	Author's calculation based on AfT data described above.
GDPC	This is the real per capita Gross Domestic Product (GDP) (constant prices 2015, US\$).	World Development Indicators (WDI) of the World Bank
REER	This is the measure of the real effective exchange rate (based on the consumer price index), computed using a nominal effective exchange rate based on 66 trading partners. An increase in the values of this index indicates an appreciation of the real effective exchange rate, i.e., an appreciation of the home currency against the basket of currencies of trading partners.	Bruegel Datasets (see Darvas 2012a, 2012b). The dataset can be found online at: <a href="http://bruegel.org/publications/datasets/real-effective-exchange-rates-for-178-countries-a-new-database/">http://bruegel.org/publications/datasets/real-effective-exchange-rates-for-178-countries-a-new-database/</a>
TERMS	This is the indicator of the terms of trade, measured by the net barter terms of trade index (2000 = 100).	Author's calculation based on data extracted from the WDI
RENT	This is the share of total natural resources rents in GDP	WDI
POPD	This is the measure of the population density, that is, the number of people per square km of land area.	WDI
FDEV	This is the financial development index, which summarizes how developed financial institutions and financial markets are in terms of their depth (size and liquidity), access (ability of individuals and companies to access financial services), and efficiency (ability of institutions to provide financial services at low costs and with sustainable revenues, and the level of activity of capital markets). The values of this indicator range between 0 and 1.	Data extracted from the IMF Financial Development Index Database (see online at: <a href="https://data.imf.org/?sk=F8032E80-B36C-43B1-AC26-493C5B1CD33B">https://data.imf.org/?sk=F8032E80-B36C-43B1-AC26-493C5B1CD33B</a> ) - See also Sahay et al. (2015).
HUM	This is the indicator of human capital. It is measured by the number of years of schooling and returns to education.	Penn World Tables PWT 10.0 (see Feenstra et al., 2015).
INST	This is the variable representing the institutional and governance quality in a given country. It has been computed by extracting the first principal component (based on factor analysis) of the following six indicators of governance. These indicators include a measure of political stability and absence of violence/terrorism; the regulatory	Data on the components of the variable "INST" has been collected from World Bank Governance Indicators (WGI) developed by Kaufmann, Kraay and Mastruzzi (2010) and recently updated.

<p>quality; an index of rule of law index; the government effectiveness index; the index of Voice and Accountability; and the index of corruption. Higher values of this index are associated with better governance and institutional quality, while lower values reflect worse governance and institutional quality.</p>	
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**Appendix 2:** Descriptive statistics on variables used in the model

Variable	Observations	Mean	Standard deviation	Minimum	Maximum
ECI	1,272	-0.434	0.686	-2.196	1.371
AFT	1,272	269,000,000	417,000,000	657139	3,820,000,000
AfTPRED	1,272	0.043	0.576	-2.189	2.524
AfTVOL	1,272	0.751	2.764	0.007	51.647
AfTQUAL	1,265	0.268	0.213	0	1
REER	1,272	107.736	19.293	55.205	274.982
HUM	1,272	2.171	0.576	1.107	3.514
RENT	1,272	8.220	9.379	0.001	58.650
FDEV	1,272	0.221	0.148	0.029	0.739
INST	1,272	-1.163	1.279	-4.778	3.086
GDPC	1,272	3453.945	3262.775	281.970	16020.380
POPD	1,272	115.586	160.672	1.607	1239.738
TERMS	1,272	124.746	42.338	21.397	321.691

**Appendix 3:** List of countries contained in the full sample and LDCs

Full sample			LDCs
Albania	Ghana	Nigeria	Angola
Algeria	Guatemala	Pakistan	Bangladesh
Angola	Haiti	Panama	Benin
Argentina	Honduras	Paraguay	Burkina Faso
Armenia	India	Peru	Burundi
Bangladesh	Indonesia	Philippines	Cambodia
Benin	Iran, Islamic Rep.	Rwanda	Central African Republic
Bolivia	Jamaica	Senegal	Congo, Dem. Rep.
Botswana	Jordan	Serbia	Ethiopia
Brazil	Kazakhstan	Sierra Leone	Gambia, The
Burkina Faso	Kenya	South Africa	Haiti
Burundi	Kyrgyz Republic	Sri Lanka	Lao PDR
Cambodia	Lao PDR	Sudan	Lesotho
Cameroon	Lesotho	Syrian Arab Republic	Liberia
Central African Republic	Liberia	Tajikistan	Madagascar
Chile	Madagascar	Tanzania	Malawi
China	Malawi	Thailand	Mali
Colombia	Malaysia	Togo	Mauritania
Congo, Dem. Rep.	Mali	Tunisia	Mozambique
Congo, Rep.	Mauritania	Turkey	Nepal
Costa Rica	Mauritius	Uganda	Niger
Cote d'Ivoire	Mexico	Ukraine	Rwanda
Dominican Republic	Moldova	Uruguay	Senegal
Ecuador	Mongolia	Vietnam	Sierra Leone
Egypt, Arab Rep.	Morocco	Yemen, Rep.	Sudan
El Salvador	Mozambique	Zambia	Tanzania
Eswatini	Namibia		Togo
Ethiopia	Nepal		Uganda
Gabon	Nicaragua		Yemen, Rep.
Gambia, The	Niger		Zambia