Effect of Economic Complexity on Services Export Diversification: Do Foreign Direct Investment Inflows Matter?

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Abstract

This article has examined the effect of economic complexity on services export diversification. It has built on two arguments. The first one draws from Eichengreen and Gupta (2013b) and states that countries that export complex products would have a high penetration in the international goods market, and establish a network that could be exploited to expand their range of services export items. Second, by inducing higher inflows of foreign direct investment (FDI), greater economic complexity could contribute to fostering services export diversification. The empirical analysis supported these two arguments. The implications of the outcomes are discussed in the conclusion.

Keywords: Economic complexity; Services export diversification; Foreign direct investment inflows

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1. Introduction

Several recent studies have underlined the positive influence of services export diversification on economic growth (e.g., Gnangnon, 2021a) or the positive effect of services export sophistication on economic growth (e.g., Anand et al., 2012; Mishra et al., 2011; Stojkoski et al., 2016). On the other side, other studies have pointed out that economic complexity is a strong predictor of economic growth (e.g., Hausmann and Hidalgo, 2009; Hidalgo, 2021; Koch, 2021; Poncet and Starosta de Waldemar, 2013; Stojkoski et al., 2016) and more generally promotes significantly economic development (e.g., Caldarelli et al., 2012; Hidalgo et al., 2007).

One could therefore, question whether there is a relationship between economic complexity and services export diversification, notably whether economic complexity could contribute to fostering services export diversification.

Diversifying services export items means expanding the range of services items across different services sectors, including both traditional and modern services[2]. The concept of "economic complexity" indicates the amount of knowledge and advanced capabilities embedded in the production process. Therefore, it reflects the sophistication of a country's productive (including export) structure, exemplified by the diversity of its export products mix - export product diversification - (i.e., the number of products it exports) and the ubiquity of its products, that is, the number of products exported by this country (e.g., Hartmann et al., 2017; Hausmann and Hidalgo, 2009, 2011; Hausmann et al., 2014; Hidalgo et al., 2007). Thus, a "complex" or "sophisticated" economy is the one that export a high number of products, and whose and whose export products cannot be easily reproduced by other countries (i.e., it has a low ubiquity), because the production of such goods requires exclusive capabilities.

The current paper aims to address one side of the relationship between economic complexity and services export diversification, notably the effect of economic complexity on services export diversification[3].

Many studies have been undertaken on the macroeconomic determinants of export product diversification. However, only recently has attention been paid to the macroeconomic

[2] For example, according to Eichengreen and Gupta (2013a), "traditional services" include trade and transport, tourism, financial services and insurance. Modern services encompass communications, computer, information and other related services. Sahoo and Dash (2017) have considered that traditional services covers transport and travel services, while modern services include transportability and tradability, financial services, insurance, business processing and software services.

[3] The other aspect of this relationship, i.e., whether services export diversification influences economic complexity, could be an avenue for future research.

determinants of services export diversification[4] (e.g., Anand et al., 2012; Gnangnon, 2020a,b; Gnangnon, 2021b,c,d). Anand et al. (2012) have investigated, *inter alia,* the prerequisites for the development of sophisticated goods and services. Gnangnon (2021b) has examined the effect of manufacturing exports on services export diversification. Gnangnon (2020a) has looked at the effect of greater access to the Internet on services export diversification. Gnangnon (2020b) has investigated the effect of poverty on services export diversification; Gnangnon (2021c) has considered the effect of Aid for Trade flows on services export diversification and Gnangnon (2021d) has examined the effect of multilateral trade liberalization on services export diversification.

Gnangnon (2021b) has obtained that an increase in the share of manufacturing exports in total exports is associated with greater services export diversification, with less developed countries experiencing a higher positive effect of manufacturing exports on services export diversification than relatively advanced countries do. In the same vein, Gnangnon (2020a) has found, *inter alia*, that greater export product diversification induces a greater services export diversification. Both studies have built on a theoretical argument put forth by Eichengreen and Gupta (2013b) (see also Sahoo and Dash, 2014). Eichengreen and Gupta (2013b) (and Sahoo and Dash, 2014) have postulated and provided empirical support for the hypothesis that goods exports can influence services exports through a "network effect": a rise in goods exports enhances countries' integration into the international trade market and allow them to establish a network in this market that they could use to expand their services exports. In a similar spirit and relying on the same argument, Gnangnon and Priyadarshi (2016) have reported that export product diversification induces greater commercial services exports in Least developed countries.

The present analysis builds on the above-mentioned previous works on the macroeconomic determinants of services export diversification, to investigate the effect of economic complexity on services export diversification. One could question the value addition of this analysis given that as noted above, Gnangnon (2021b) has examined respectively the effect of manufacturing exports and export product diversification, and Gnangnon (2020a) has considered, among others, the effect of export product diversification on services export diversification.

The value addition of the present study rests on the fact that the concept of "economic complexity" is different from those of "export product diversification" and "manufacturing exports". In fact, export product diversification refers, in general, to the expansion of the range of

[4] Sahoo and Dash (2017) and Eichengreen and Gupta (2013a) have not investigated the macroeconomic determinants of services export diversification per se, but rather the factors underpinning the services export structure. To do so they have made a distinction between traditional services and modern services.

products exported by a country, with a view to altering the share of commodities in the export bundle. This involves (in particular for developing countries) increasing the share of manufacturing (including sophisticated manufacturing products) exports in total exports. Both concepts of "export product diversification" and "manufacturing exports" do not really capture countries' capabilities and productive knowledge, that the notion of "economic complexity" captures (e.g., Hartmann et al., 2017). As noted above, "economic complexity" reflects both the diversity of a country's export products mix and the ubiquity of its products.

We postulate that economic complexity could positively affect services export diversification, not only through the "network effect" as hypothesized by Eichengreen and Gupta (2013b), but also through greater FDI inflows, insofar as the latter induce a higher degree of services export diversification.

The empirical analysis has used a panel dataset of 109 countries (both developed and developing countries) over the period 1985-2014, and provided support for each of these arguments.

The rest of the paper is organized as follows. Section 2 presents a theoretical discussion on the effect of economic complexity on services export diversification. Section 3 lays down the empirical strategy adopted to address the issue at hand. This section first presents the model specification (sub-section 3.1) and briefly discusses the econometric approach used to estimate the model (sub-section 3.2). Section 4 discusses empirical outcomes, and Section 5 concludes.

2. Theoretical discussion on the effect of economic complexity on services export diversification

The first theoretical argument concerning the effect of economic complexity on services export diversification draws from the "network effect" hypothesis proposed by Eichengreen and Gupta (2013b). The authors have postulated that a country with a high penetration in goods markets is likely to be able to use its networks to export its services items. Building on this argument, we argue that greater economic complexity would improve countries' penetration in the goods market. In turn, this improved level of integration into the international trade markets for goods would allow the country to establish therein a network that could be used to expand the range of their services export items, and hence diversify their services export basket.

Additionally, economic complexity can affect services export diversification through its effect on FDI inflows, and the magnitude of this effect is likely to rise with the size of FDI inflows. This hypothesis is built on three main arguments.

First, previous studies (e.g., Gnangnon, 2020a,b; Gnangnon, 2021b,c,d) have hypothesized that as FDI inflows influence services exports (e.g., Ansari and Ojemakinde, 2003; Grünfeld and Moxnes, 2003; Huang and Viana, 1995; Srivastava, 2006; Wong et al., 2009), they could be either associated with services export diversification (i.e., the expansion of the range of services export items) or result in the growth of services export at the intensive margins, i.e., a higher services export concentration. The empirical findings have revealed slightly mixed outcomes concerning the effect of FDI inflows on services export diversification. For example, Gnangnon (2021b) has obtained that higher FDI inflows induce greater services export diversification. Additionally, the positive effect of the manufacturing export share on services export diversification increases as FDI inflows rise. Gnangnon (2020a) has also obtained a positive effect of FDI inflows on services export diversification. In contrast, in assessing the effect of multilateral trade liberalization on services export diversification, Gnangnon (2021d) has explored whether this effect depends on the size of FDI inflows. The author has uncovered a positive effect of FDI inflows on services export concentration, but multilateral trade liberalization promotes services export diversification in countries that enjoy higher FDI inflows.

Second, greater economic complexity can contribute strongly to the attraction of FDI inflows. This is because foreign investors, i.e., multinational enterprises (MNEs) can opt for locating their activities in 'complex' countries so as to take advantage of the high productive knowledge, as well as other features of this country. This is because the level of economic complexity reflects the degree of social capital, institutional quality, as well as the ability of the population to create social and professional networks in the state where they reside. Sadeghi et al. (2020) have obtained empirically that countries that enjoy greater economic complexity experience higher FDI inflows. This is exemplified by the existence of an important "home bias" in manufacturing investment decisions, i.e., a spatial clustering of firms' affiliates that belong to the same industrial group: firms tend to set up new affiliates closed to existing affiliates within the same industrial group (Mayer et al., 2010). These suggest that countries with greater economic complexity are likely to attract higher FDI flows (e.g., Gómez-Zaldívar et al. 2021).

Third, FDI inflows can foster economic complexity. In fact, MNEs can be an important source of innovation in the host countries (e.g., UNCTAD, 2003) not only because they engage in cost discovery[5] activities in host countries, but also because they can supply local producers with better inputs (e.g., Eck and Huber, 2016; Javorcik et al., 2018) as well as technical and

[5] According to Hausmann and Rodrik (2003), a firm that wishes to introduce a new product into the country do not know a priori the underlying cost structure of the economy. The success of its project would allow other firms to learn and follow suit. In this case, the returns to the cost discovery born by the firm (which is a pioneer) are socialized. However, if the firm's project fails, then it would bear alone the losses.

organizational competencies (e.g., Saliola and Zanfei, 2009). Additionally, MNEs that operate in the input-sourcing sectors can be an important vehicle for transferring knowledge (acquired through Research and Development activities) in the host countries (e.g., Annique and Rodríguez, 2018; Javorcik, 2004; Havranek and Irsova, 2011). These positive spillovers associated both innovation and knowledge transfer can significantly contribute to the enhancement of economic complexity in the host countries of MNEs. On the empirical side, Eck and Huber (2016) have uncovered that spillovers from multinationals to local Indian firms (including through supplier linkages) have spurred the manufacturing of sophisticated products in India. Javorcik et al. (2018) have shown for Turkey that the presence of foreign affiliates has helped Turkish firms to introduce greater complexity of new products. Xu and Lu (2009) and Hausmann (2016) have shown that FDI inflows can contribute to strengthening the sophistication of goods and services in the destination countries. Li et al. (2021) have also obtained that the deregulation of FDI inflows that took place in 2002 in different China's industries, has led to a greater level of export product sophistication. However, Antonietti and Franco (2021) have found empirical evidence that FDI inflows (Granger) cause economic complexity[6] in developing countries.

Overall, we formulate the following two hypotheses.

Hypothesis 1: an improvement in the level of economic complexity would be associated with greater services export diversification, notably through the "network" channel, as well as the avenue of FDI inflows.

Hypothesis 2: As the effect of economic complexity on services export diversification can work through higher FDI inflows, economic complexity could promote services export diversification if greater economic complexity takes place in countries that attract higher FDI inflows and if FDI inflows help to diversify the services export items mix. Specially, we expect that economic complexity would exert a higher positive effect on services export diversification as countries enjoy higher FDI inflows.

3. Empirical approach

This section presents the model specification **(sub-section 3.1)**, a graphical analysis of key variables of interest **(sub-section 3.2)**, and briefly discusses the econometric approach used to estimate the model **(sub-section 3.3)**.

[6] The authors have also obtained that economic complexity does not (Granger) cause FDI inflows in developing countries.

3.1. Model specification

We explore the effect of economic complexity on services export diversification, including through the FDI inflows avenue by drawing from previous works on the determinants of services export diversification, and considering the following baseline model:

$$SEC_{it} = \alpha_1 SEC_{it-1} + \alpha_2 ECI_{it} + \alpha_3 Log(GDPC)_{it} + \alpha_4 EDU_{it} + \alpha_5 FINDEV_{it} + \alpha_6 TRPOL_{it} + \alpha_7 POLITY_{it} + \alpha_8 Log(POP)_{it} + \mu_i + \lambda_t + \omega_{it} \quad (1)$$

i and t are the subscripts respectively for a country and a time-period in the panel dataset. The latter is constructed using available data, and covers 109 countries (both developed and developing countries) over the period of 1985-2014. In particular, non-overlapping sub-periods of 5-year average data have been used to avoid modelling cyclical dynamics (see Gnangnon, 2020a,b; Gnangnon, 2021b,c,d). The sub-periods are 1985-1989; 1990-1994; 1995-1999; 2000-2004; 2005-2009; and 2010-2014.

The variables "SEC" is the indicator of services export concentration. As described in Appendix 1, the indicators of services export concentration (diversification) are constructed using the database on commercial services exports developed by the International Monetary Fund (IMF) (see Loungani et al. 2017). "SEC" is primarily measured by the Theil index of services export concentration, denoted "THEIL". For robustness check analysis, "SEC" is also measured by the Herfindahl-Hirschman index of services export concentration, denoted "HHI" (see also Gnangnon, 2020a,b; Gnangnon, 2021a,b,c,d as well as Appendix 1 for further details on the calculation of these indices). Values of "THEIL" and "HHI" are comprised between 0 and 100, with values closed to 100 showing greater services export concentration, and values closed to 0 reflecting lower degrees of services export concentration, i.e., higher levels of services export diversification.

The variable "ECI" is our main variable of interest, and represents the index of economic complexity (of exports). It is computed using the methodology described in Hausmann and Hidalgo (2009). The economic complexity indicator reflects the diversity and ubiquity of a country's export structure. Higher values of this index indicate greater economic complexity.

As stated above, the other variables contained in model (1) are derived from previous studies on the determinants of services export diversification (or services export sophistication/services export structure) (e.g., Anand et al., 2012; Eichengreen and Gupta, 2013b; Gnangnon, 2020a,b,c; Gnangnon, 2021b,c,d). They include the real per capita income, denoted "GDPC" and which acts as a proxy for the economic development level; the human capital level ("EDU"); the depth of

financial development ("FINDEV"); the degree of trade policy liberalization[7] ("TRPOL"); an indicator of institutional quality, proxied by the level of democratization ("POLITY"); and the population size ("POP"). We have applied the natural logarithm to the variables "GDPC" and "POP" to reduce their skewed distribution. To avoid rehearsing here the discussion on the expected theoretical effect of each of these control variables on services export diversification, we refer the readers to previous works on the determinants of services export diversification (e.g., Gnangnon, 2020a,b; Gnangnon, 2021b,c,d).

α_1 to α_8 are parameters that would be estimated. μ_i are countries' specific time invariant effects. λ_t are time dummies, and aim to capture the effect of global shocks on countries' services export diversification path. ε_{it} is an error-term.

We provide in Appendix 1 the detailed description of all variables in model (1) as well as their respective source. Appendix 2 reports the descriptive statistics on these variables, and Appendix 3 lists the 109 countries contained in the full sample.

3.2. Data analysis

Before turning to the discussion on the econometric approach used to conduct the empirical analysis, we find useful to provide an insight into the relationship between economic complexity and services export diversification by using the dataset over the non-overlapping sub-periods. Therefore, we present in Figure 1 the development of the Theil index of services export concentration ("THEIL") and the economic complexity index ("ECI") over the entire period, and in particular for the sub-samples of high-income countries (HICs) and other countries in the full sample (i.e., NonHICs, also referred to as developing countries). The category of HICs is derived from the classification of countries by the World Bank (see Appendix 3 for the list of HICs used in the present analysis). We have used these two sub-samples to check whether the developments of "THEIL" and "ECI" over time are similar in HICs and developing countries. In fact, we should expect these developments to be different across HICs and NonHICs, not only because HICs and developing countries might display different paths of services export concentration (diversification), but also because HICs are expected to experience higher levels of economic complexity than developing countries. We also depict in Figure 2 the scatter plot between the

[7] Given the time span of the data (i.e., 1985-2014) and the large coverage of the panel dataset in terms of countries, we cannot use indicators of services trade restrictiveness, which would have been more appropriate here. For this reason, we have used the de jure trade policy indicator, which is one major component of the de jure KOF globalization index (see Dreher, 2006 and Gygli et al. 2019). Note that the indicators concerning the services trade restrictiveness could be accessed online at: https://qdd.oecd.org/subject.aspx?Subject=063bee63-475f-427c-8b50-c19bffa7392d

variables "ECI" and "THEIL" (which is our primary measure of services export concentration) over the full sample, as well as the sub-samples of HICs and NonHICs.

[Insert Figure 1, here]

We note from Figure 1 that, on average, HICs display a higher level of economic complexity than developing countries. This is not surprising. Interestingly, on average, the index of economic complexity always holds positive values for HICs, and negative values for developing countries. While in HICs, economic complexity exhibited a downward trend (moving from the value of 1.02 in 1985-1989 to 0.84 in 2010-2014), it slightly fluctuated in developing countries. In developing countries, it slightly increased from -0.51 in 1985-1989 to -0.47 in 1990-1994, and then fell to -0.50 in 2000-2004. It has then rebounded to reach -0.49 in 2005-2009, and again declined to -0.51 in 2010-2014. At the same time, we note that from 1985-1989 to 2000-2004, HICs exhibited, on average, a higher degree of services export concentration than NonHICs. However, from 2000-2004 to 2010-2014, this trend was reversed because NonHICs had a higher level of services export concentration than HICs. In HICs, the Theil index of services export concentration steadily moved upward from 44.24 in 1985-1989 to 58.9 in 2000-2004 (thereby reflecting a tendency for these countries to enhance concentration on a relatively limited services export items). The index then slightly declined to reach 56.3 in 2010-2014. Developing countries experienced a strong rise in their level of services export concentration, from 31.4 in 1985-1989 to 72.9 in 2010-2014.

[Insert Figure 2, here]

Figure 2 shows a positive correlation pattern between the indicators "THEIL" and "ECI" over the full sample, and in particular NonHICs (i.e., developing countries), where the slope of the positive correlation is higher than that of the full sample. In contrast, the correlation pattern is unclear for HICs.

Overall, Figures 1 and 2 convey several messages. On average, the level of economic complexity is far higher in HICs than in developing countries (it is positive for HICs and negative for developing countries). Meanwhile, from 2000-2004 to 2010-2014, services export concentration tended to increase in both HICs and developing countries (although the increase was small for HICs, but large for developing countries), but its level remained higher in developing countries than in HICs.

3.3. Econometric approach

Following previous studies (e.g., Gnangnon, 2020a,b; Gnangnon, 2021b,c,d), we estimate model (1) and several other variants of this model (described below) using the two-step system GMM estimator of Blundell and Bond (1998). This entails estimating a system of equations, which

combines an equation in differences and an equation in levels. Lagged first differences are used as instruments for the levels equation, and lagged levels are used as instruments for the first-difference equation. The first difference GMM estimator of Arellano and Bond (1991) performs poorly[8] compared to the two-step system GMM estimator, notably when time series are persistent and the time coverage of the panel dataset is small[9] (e.g., Arellano and Bover, 1995; Blundell and Bond, 1998; Blundell et al., 2001).

The two-step system GMM estimator helps to address several endogeneity concerns arising from model (1) (see also Gnangnon, 2020a,b; Gnangnon, 2021b,c,d). One of these concerns relates to the feedback effect from services export diversification to economic complexity. For example, while we are expecting to see an effect of economic complexity on services export diversification, it could be well envisaged that services exports diversification notably towards sophisticated services items could influence the production of sophisticated manufacturing goods (e.g., Bas, 2014; Jiang and Zhang, 2021; Su et al., 2020), and thus enhance the countries' level of economic complexity. Therefore, we consider the variable measuring the level of economic complexity as endogenous in the analysis. Following also Gnangnon (2020a,b) and Gnangnon (2021b,c,d), we also treat the variables "GDPC", "FINDEV", "TRPOL", "EDU", "POLITY2" as endogenous in the regressions. The variable "POP" is treated as exogenous.

The validity of the two-step system GMM estimator is assessed through a number of statistical tests. The latter include the Arellano-Bond test of presence of first-order serial correlation in the first-differenced error term (denoted AR(1)) and the Arellano-Bond test of the absence of second-order autocorrelation in the first-differenced error term (denoted AR(2)). Model (1) is correctly specified if we reject the null hypothesis[10] of absence of first-order serial correlation in the first-differenced error term (for the AR(1) test), and if we do not reject both the null hypothesis[11] of the AR(2) test (i.e., absence of second-order correlation in the first-differenced error term), and the null hypothesis of the Sargan test of over-identifying restrictions[12]. The Sargan test tests the joint validity of the instruments (the null hypothesis being here that the internal instruments chosen are valid).

[8] The use of the difference-GMM estimator is associated with weak instruments problems, which are due to the weak correlation between lagged variables in level and variables in first difference (e.g., Alonso-Borrego and Arellano, 1999; Bond, 2002; Roodman, 2009).

[9] Our panel dataset has these features as the time span of the data is short (6 sub-periods) and the number of countries is 109.

[10] This means that the p-value linked with the AR(1) test should be lower than 0.10 at the 10% level of statistical significance.

[11] This means that the p-value linked with the AR(2) test should be higher than 0.10 at the 10% level of statistical significance.

[12] We expect here that the p-value related to the Sargan test of over-identifying restrictions should be higher than 0.10 at the 10% level of statistical significance.

We also report the number of instruments used in the regressions, as the rule of thumb requires that a higher number of instruments than the number of countries may significantly reduce the power of the afore-mentioned statistical tests (e.g., Roodman, 2009).

[Insert Table 1, here]

To test empirically hypotheses 1 and 2 set out in section 1, we estimate (by means of the two-step system GMM estimator) not only model (1) (as it stands), but also several other specifications of this model. The outcomes of all these estimations are presented Table 1. Specially, the outcomes of the estimation of model (1) (as it stands and where the variable "SEC" is measured by "THEIL") are presented in column [1] of Table 1.

Column [2] of Table 1 reports the estimates arising from the estimation of model (1) where "SEC" is measured by "HHI", for robustness check.

Column [3] of the Table contains the outcomes that allow examining the effect of economic complexity on services export concentration in HICs versus developing countries. These outcomes are obtained by estimating another specification of model (1) (with "THEIL" as the dependent variable) that includes the dummy "HIC" and its interaction with the variable "ECI". The dummy "HIC" takes the value 1 for HICs, and 0, otherwise.

To complement the findings in column [3] of Table 1, we examine, more generally, how the effect of economic complexity on services export concentration varies across countries in the full sample. To do so, we estimate another specification of model (1) (once again with "THEIL" as our primary measure of services export concentration) that involves introducing in the baseline model (1) an interaction between the indicator of economic complexity, and the real per capita income variable. The results of this estimation are presented in column [4] of the Table.

Now, results provided in columns [5] to [7] of Table 1 help to examine whether FDI inflows represent one possible avenue through which economic complexity can affect services export diversification. We first introduce in model (1) the variable capturing FDI inflows (i.e., the net FDI inflows in percentage of GDP - denoted "FDI"). It is possible that the estimates of this new model specification would generate a coefficient of "ECI" that can be significant at the conventional significance levels, while that of "FDI" will not be significant at the conventional significance levels. Inversely, the coefficient of "FDI" can be significant at the conventional significance levels, whereas the coefficient of "ECI" will not be significant. In such a case, we can infer that the effect of economic complexity works through the channel of FDI inflows, and this would need to be tested by interacting the variables "ECI" and "FDI" in another specification of model (1). However, if the coefficients of both "ECI" and "FDI" are significant at the conventional significance levels, this will signify that the effect of economic complexity on services export

concentration works through other channels[13] (including in addition to the FDI channel). Once again, the interaction between "ECI" and "FDI" would allow assessing the extent to which the effect of economic complexity on services export concentration depends on the volume of FDI inflows. The outcomes of the estimation of the specification of model (1) that includes the variable "FDI" are reported in column [5] of Table 1.

Columns [6] and [7] display estimates obtained from the estimation of specifications of model (1) respectively with the Theil index, and the Herfindahl-Hirschman index (used for robustness check) as measures of "SEC", and in which we introduce the interaction between the indicator of economic complexity and "FDI". The results in these two columns of the Table help to investigate whether the effect of economic complexity on services export concentration depends on the volume of FDI inflows.

4. Estimations' outcomes

At the outset, the coefficient of the lagged dependent variable is always positive and significant at the 1% level across all columns of Table 1. This is consistent with the findings in the empirical literature, and indicates the need for considering a dynamic specification when examining the macroeconomic determinants of services export diversification, notably here the effect of economic complexity on services export diversification. The results of the statistical tests that allow checking the validity of the two-step system GMM estimator are presented at the lower-end part of Table 1. It could be noted that all specifications of model (1) described above pass the AR(1) and AR(2) tests as well as the Sargan test of over-identifying restrictions. In fact, the p-values of the AR(1) test are closed to zero, and in particular lower than 0.1. The p-values linked with the AR(2) are all higher or equal to 0.10. Finally, the p-values related to the Sargan test are higher than 0.10, and confirm the validity of instruments used in the regressions. Besides, the number of instruments used in all regressions is lower than the number of countries in the full sample.

Taking up now the estimates in Table 1, we first note from column [1] of this Table that the coefficient of "ECI" is negative and significant at the 1% level. This suggests that ***economic complexity influences negatively and significantly services export concentration, that is, it exerts a strong positive and significant effect on services export diversification***. A 1-point increase in the index of economic complexity is associated with a 6.23-point fall in the Theil index of services export concentration. The result in column [2] of the Table confirms this finding as the

[13] It is worth noting that one of these channels is the "network" one. In fact, we do not have a measure of this "network" that would be introduced in the model to explicitly test whether the "network" channel effect of economic complexity on services export concentration.

coefficient of "ECI" is still negative and significant at the 1% level, but is far higher in magnitude (it is more than the double) than the coefficient of "ECI" in column [1]). A 1-point increase in index of economic complexity is associated with a 15.44-point decrease in the Herfindahl-Hirschman index of services export concentration. ***All these outcomes confirm our hypothesis 1 that greater economic complexity promotes the diversification of services export items, with this effect working at least through the "network effect" channel, and possibly the FDI inflows channel (that we will test later)***.

Estimates related to control variables in columns [1] and [2] exhibit similar sign, even though they do not display the same magnitude and the same level of statistical significance. Focusing on outcomes in column [1] of Table 1 (as the "THEIL" index is our main indicator of services export concentration), we find that a rise in the real per capita income is associated with a higher level of services export diversification. An improvement in the education level appears to be associated with a greater services export concentration, and this tends to indicate that all things being equal, the educated workforce tends to be employed in a relatively limited range of services export items. This outcome may also reflect differentiated effects across countries in the full sample, as well as the existence of an interplay between the level of economic complexity and the level of education in affecting services export diversification patterns - but these could be a topic for future research. The improvement in the level of democracy (as a proxy for the institutional quality) appears to affect positively and significantly services export concentration. Trade policy liberalization does not significantly influence services export diversification at the conventional significance levels, while financial development and the population size do not affect significantly services export concentration at the 5% level.

Results in column [3] of Table 1 indicate that economic complexity exerts a higher negative (positive) and significant (at the 1% level) effect on services export concentration (services export diversification) in HICs than in NonHICs. In other words, economic complexity induces a greater level of services export diversification in HICs than in NonHICs. This is exemplified by the negative and significant coefficient (at the 1% level) of the interaction variable "ECI*HIC". At the same time, we note that the coefficient of "ECI" is also negative and significant at the 5% level. Thus, the net effects of economic complexity on services export concentration (THEIL index) are negative in HICs and NonHICs, and amount respectively to -16.1 (= -7.298 - 8.79) and -7.298. These outcomes allow concluding that a 1-point increase in the index of economic complexity is associated with a fall in the Theil index of services export concentration by 16.1-point in HICs, and by 7.3-point in developing countries.

Results in column [4] of Table 1 tend to confirm the findings in column [3] of the Table: even though the outcomes in column [3] reflect average effects of economic complexity on the Theil index of services export concentration across sub-samples of HICs and NonHICs, those in column [4] show how this effect varies across countries in the full sample (rather than an "average effect" over sub-samples). We observe from column [4] of Table 1 that the interaction term of the variable ("[ECI*Log(GDPC)]") is negative and significant at the 1% level, while the coefficient of "ECI" is positive and significant at the 5% level. The negative and significant interaction term shows that the magnitude of the negative effect of economic complexity on services export diversification rises as countries experience a rise in their real per capita income. In the meantime, when we take together these two outcomes, we conclude that at least at the 5% level, there is a level of the real per capita income above which the positive effect of economic complexity on services export concentration turns out to be negative. This turning point of the real per capita income[14] variable appears to be 764 US$ [(= exponential (18.11/2.728)]. Therefore, we deduce that in countries (i.e., very low-income countries) whose real per capita income ranges between US$ 183.4 and 764 US$, economic complexity induces an increase in the level of services export concentration, though the magnitude of this positive effect diminishes as the income per capita rises. In contrast, countries with a real per capita income higher than 764 US$ (that is, comprising between 764 US$ and US$ 89835.2) experience a positive effect of economic complexity on services export diversification, and the magnitude of this positive effect increases as the real per capita income rises. This finding aligns with the ones in column [3] of the Table, whereby HICs experience a higher positive effect of economic complexity on services export diversification than NonHICs.

Estimates in column [5] show negative coefficients of "ECI" and "FDI", with the former being significant at the 5% level, and the latter being significant at the 1% level. Both outcomes show that both economic complexity and FDI inflows are significantly associated with greater services export diversification. These results also suggest that, in addition to the avenue of FDI inflows, there are likely other potential channels[15] through which economic complexity can affect services export diversification. This could be a subject of future research. These outcomes lead us to move onto the interpretation of estimates in columns [6] and [7], which to recall, serve to

[14] It is noteworthy here that in the full sample, the values of the real per capita income range between US$ 183.4 and US$ 89835.2.

[15] As noted above, one of these channels is the "network" channel. However, we do not have an indicator of the "network" established in international market by countries to test empirically how economic complexity can affect services export diversification through this avenue.

examine whether FDI inflows matter for the effect of economic complexity on services export diversification.

We note from column [6] that the interaction term of the variable ["ECI*FDI"] is negative and significant at the 1% level, while at the same time the variable "ECI" shows a coefficient that is not significant at the conventional significance levels. We, therefore, infer that economic complexity consistently influences positively services export diversification (the Theil index), and the magnitude of this effect rises as the size of FDI inflows (% GDP) moves upward. This finding confirms our hypothesis 2. This hypothesis is further confirmed by outcomes in column [7] that show a negative and significant (at the 5% level) coefficient of "ECI" and concurrently, a negative and significant (at the 1% level) interaction term of ["ECI*FDI"]. Taken together, ***these two results indicate that economic complexity always influences services export diversification (the Herfindahl-Hirschman index index), and the magnitude of this positive effect consistently increases as the share of net FDI inflows (% GDP) increases***.

Summing up results in Table 1, we can conclude that the empirical analysis lends support to the hypotheses 1 and 2 set out in section 1. First, ***economic complexity induces greater services export diversification, albeit at a higher level in HICs than in developing countries. Second, this effect works through the FDI inflows, as the rise in FDI inflows induces a greater positive effect of economic complexity on services export diversification***.

5. Conclusion

This paper has investigated the effect of economic complexity on services export diversification, including through the "network" hypothesis, initially developed by Eichengreen and Gupta (2013b) - as well as the channel of FDI inflows. According to the "network" channel, greater economic complexity would allow countries (including firms) to improve their integration into the international trade markets and consequently established a "network" that could be used to expand their services exports, and potentially export a wide range of services items.

The empirical analysis has shown that greater economic complexity has been associated with a higher level of services export diversification, and the magnitude of this positive effect is higher for HICs than for developing countries. More generally, only very low-income countries (i.e., those with a real per capita income lower than 764 US$) experience a negative effect of economic complexity on services export diversification. For the other countries (i.e, those whose level of real per capita income is higher than 764 US$, economic complexity is positively associated with

services export diversification, and the magnitude of this positive effect rises as the real per capita income improves.

Furthermore, the share of FDI inflows (in percentage of GDP) matters for the effect of economic complexity on services export diversification. Specially, economic complexity exerts a higher positive effect on services export diversification, as the share of net FDI inflows in GDP increases.

From a policy perspective, the analysis complements previous works on the effects of economic complexity (for example on economic growth, income inequality, poverty… etc), by showing that economic complexity also matters for fostering the diversification of countries' services export items. Enhancing economic complexity should be at the heart of policymakers' agenda, both at the national and international levels, given not only its strong positive effect on macroeconomic aggregates such as economic growth, income inequality, poverty…etc, but also on services export diversification, the latter being also an important engine for economic growth (e.g., Anand et al., 2012; Gnangnon, 2021a; Mishra et al., 2011; Stojkoski et al., 2016). Discussing policies that could be conducive to greater economic complexity is beyond the scope of the present article, as such policies are likely to be specific to each country's circumstances and characteristics (e.g., the works by Mealy and Coyle, 2021, Sørensen et al., 2020; Whitehead and Bhorat, 2021). Additionally, these policies should go beyond diversifying export the product mix, and involve a structural transformation of the production structure, including towards sophisticated goods that would be exported by few other countries (e.g., Atolia et al., 2021). The package of policies to foster economic complexity should include measures aiming at attracting MNEs, given their potential strong spillovers to local industries, including through innovation and knowledge transfer. These could ultimately contribute to enhancing economic complexity and the latter's positive effect on services export diversification.

The presents analysis opens an avenue for future research on whether services export diversification influences economic complexity.

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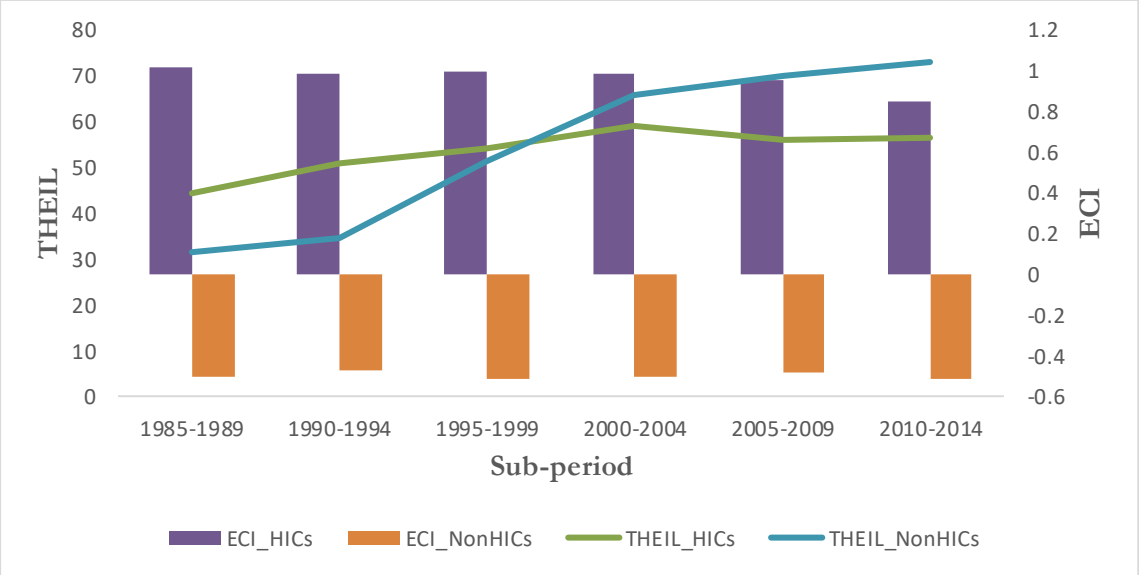
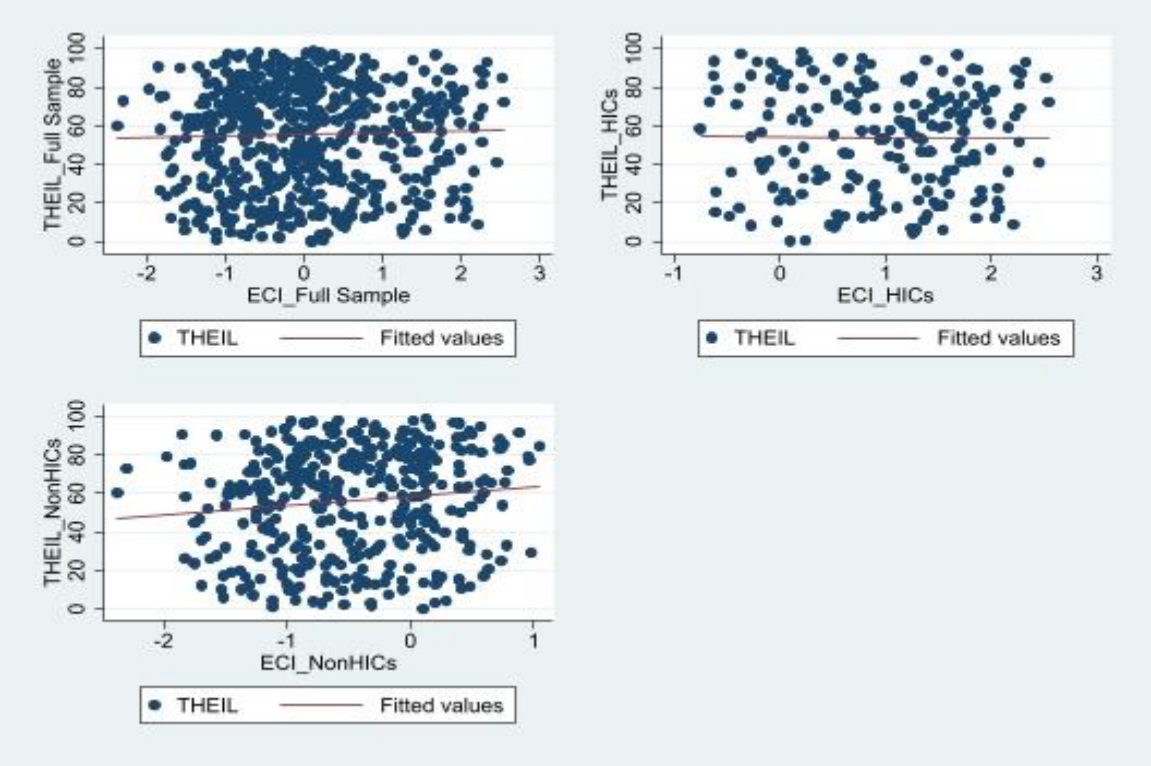
FIGURES

Figure 1: Evolution of ECI and THEIL over the sub-samples of HICs and NonHICs



Source: Author

Figure 2: Correlation pattern between ECI and THEIL over the entire sample and the sub-samples of HICs and NonHICs



Source: Author

TABLES and APPENDICES

Table 1: Effect of economic complexity on services export diversification
Estimator: Two-Step System GMM

Variables	THEIL	HHI	THEIL	THEIL	THEIL	THEIL	HHI
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
One period lag of the dependent variable	0.601***	0.547***	0.562***	0.618***	0.638***	0.558***	0.585***
	(0.0238)	(0.0216)	(0.0325)	(0.0254)	(0.0330)	(0.0263)	(0.0230)
ECI	-6.226***	-15.44***	-7.298**	18.11**	-4.784**	0.0949	-4.279**
	(1.735)	(2.106)	(2.960)	(8.102)	(2.298)	(1.962)	(1.702)
ECI*HIC			-8.793***				
			(3.049)				
ECI*Log(GDPC)				-2.728***			
				(0.870)			
ECI*FDI						-1.206***	-1.050***
						(0.197)	(0.193)
HIC			-11.08*				
			(6.616)				
FDI					-1.145***	-1.001***	-0.0400
					(0.226)	(0.219)	(0.158)
Log(GDPC)	-7.327***	-2.070	3.632	1.787	-7.230***	-3.305*	-0.0261
	(2.302)	(1.730)	(2.700)	(2.261)	(2.787)	(1.725)	(1.382)
EDU	0.284***	0.0177	-0.0276	-0.157	0.159	0.0601	-0.0640
	(0.0986)	(0.0779)	(0.102)	(0.103)	(0.118)	(0.0746)	(0.0625)
FINDEV	0.0681*	0.126***	0.0724*	0.0491	0.107**	0.0780***	0.110***
	(0.0351)	(0.0245)	(0.0394)	(0.0382)	(0.0420)	(0.0292)	(0.0277)
TRPOL	-0.0227	-0.0167	0.0807	-0.0301	-0.0174	-0.0740	-0.297***
	(0.0572)	(0.0683)	(0.0789)	(0.0766)	(0.0664)	(0.0450)	(0.0728)
POLITY	0.994***	0.341**	0.941***	1.397***	1.155***	1.225***	0.756***
	(0.161)	(0.171)	(0.249)	(0.232)	(0.214)	(0.181)	(0.185)

Log(POP)	1.966*	3.180***	-0.0381	-0.324	-1.467	-0.777	-0.659
	(1.041)	(0.995)	(1.583)	(1.309)	(1.541)	(1.170)	(0.904)
Observations - Countries	404 - 109	404 - 109	404 - 109	404 - 109	402 – 109	402 - 109	402 - 109
Number of Instruments	85	85	75	75	75	83	83
AR1 (P-Value)	0.0000	0.0007	0.0000	0.0000	0.0000	0.0000	0.0008
AR2 (P-Value)	0.1785	0.2041	0.2355	0.2063	0.1514	0.1862	0.10
Sargan (P-Value)	0.3394	0.1892	0.3790	0.4949	0.5023	0.4730	0.2651

*Note: *p-value<0.1; **p-value<0.05; ***p-value<0.01. Robust standard errors are in parenthesis. In the two-step system GMM estimations, the variables "ECI", "FDI", "GDPC", "FINDEV", "TRPOL", "EDU", "POLITY2" and the interaction variables have been considered as endogenous. The variable "POP" has been considered as exogenous. Time dummies have been included in the regressions. The regressions have used a maximum of 3 lags of the dependent variables as instruments and 2 lags of endogenous variables as instruments. Time dummies have been included in the regressions.*

Appendix 1: Definition and Source of variables

Variables	Definition	Sources
THEIL	This variable represents the Theil index of services export concentration. It has been calculated using the following formula (for example, see Agosin et al, 2011; Cadot et al., 2011): $THEIL = \frac{1}{n}\sum_{k=1}^{n}\frac{x_k}{\mu}\ln(\frac{x_k}{\mu})$, where $\mu = \frac{1}{n}\sum_{k=1}^{n}x_k$ n represents the total number of the (services) export lines (k) $n = \sum_{k=1}^{n}k$; x_k stands for the value of the services exports associated with the services line "k".	Author's calculation based on data extracted from the database developed by the International Monetary Fund (IMF) on the international trade in services (see online at: https://data.imf.org/?sk=07109577-E65D-4CE1-BB21-0CB3098FC504) - See also Loungani et al. (2017). The data used to compute the HHI indicator are sectoral data on services exports at 2-digit level, which is the maximum digit-level of disaggregated data available on services. In particular, we have relied on 11 major sectors of services (categories of services) - at the 1-digit level - and used the disaggregated data on services exports for sub-sectors at the 2-digit level. These 11 major services sectors are as follows (the sub-sectors are in brackets): **1. Charges for the use of intellectual property n.i.e.;** **2. Construction** (Construction abroad; Construction in reporting economy); **3. Financial services** (Financial Explicitly charged and other financial services; Financial intermediation services indirectly measured -FISIM-); **4. Insurance and pension services** (Auxiliary insurance services; Direct insurance; Pension and standardized guaranteed services; Reinsurance); **5. Maintenance and repair services n.i.e.**; **6. Manufacturing services on physical inputs owned by others** (Goods for processing abroad; Goods for processing in reporting economy); **7. Other Business Services** (Professional and management consulting services; Research and

		development services; Technical, trade-related, and other business services); **8. Personal, cultural, and recreational services** (Audiovisual and related services; Other personal, cultural, and recreational services); **9. Telecommunications, computer, and information services** (Computer services; Information services; Telecommunications services); **10. Transport** (Air Transport; Other mode of Transport; Postal and courier services; Sea Transport); **11. Travel** (Business; Personal).
HHI	This is the Herfindahl index, which is also referred sometimes to as the Hirschman-Herfindahl index. It has been computed as follows: $HHI = \frac{\sum_k s_k^2 - 1/n}{1/n}$ where $s_k = x_k / \sum_{k=1}^{n} x_k$ represents the share of export line k (with amount exported x_k) in total exports: x_k stands for the amount of services exports associated with the services line "k"; n represents the total number of the services export lines (k) and $n = \sum_{k=1}^{n} k$. The calculated indicator has been normalized so that its values range between 0 and 100. Higher values of this index indicate greater services export concentration, while lower values show greater services export diversification.	Author's calculation based on the same data (extracted from the IMF database on the international trade in services) used to compute the HHI indicator described above.
ECI	This is the economic complexity index. It is calculated using the approach described in Hausmann and Hidalgo (2009). The economic complexity indicator reflects both the diversity and sophistication of a country's export structure, and how difficult it is to export each product. Higher values of this index reflects greater economic complexity.	MIT's Observatory of Economic Complexity (https://atlas.media.mit.edu/rankings)
FDI	Net inflows of Foreign direct investment (in percentage of GDP).	World Development Indicator (WDI) database of the World Bank
GDPC	Per capita Gross Domestic Product (constant 2010 US$)	WDI
TRPOL	This is the main measure of trade openness. It is in fact the De Jure measure of trade openness, i.e., the De Jure Trade Globalisation index (see Dreher, 2006 and Gygli et al. 2019). It is a composite index of trade regulations (prevalence of non-tariff trade barriers and compliance	See the database and other information online at: https://www.kof.ethz.ch/en/forecasts-and-indicators/indicators/kof-globalisation-index.html

	costs of importing and exporting), trade taxes, tariffs, and trade agreements (i.e., number of bilateral and multilateral free trade agreements).	
EDU	This is the proxy for human capital. It is measured by the gross secondary school enrolment (%).	Penn World Tables PWT 9.1 (see Feenstra et al., 2015).
FINDEV	Domestic credit to private sector (% of GDP). Missing values have been replaced with data on the domestic credit to private sector by banks (% of GDP).	Author's calculation based on data extracted from the WDI.
POP	This is the measure of the size of total population.	WDI
POLITY	This variable is an index extracted from Polity IV Database (Marshall et al., 2018). It represents the degree of democracy based on competitiveness of political participation, the openness and competitiveness of executive recruitment and constraints on the chief executive. Its values range between -10 and +10, with lower values reflecting autocratic regimes, and greater values indicating democratic regimes. Specifically, the value +10 for this index represents a strong democratic regime, while the value -10 stands for strong autocratic regime.	Polity IV Database (Marshall et al., 2018)

Appendix 2: Descriptive statistics on variables used in the model

Variable	Observations	Mean	Standard Deviation	Minimum	Maximum
THEIL	404	59.761	24.880	4.325	98.801
HHI	404	49.485	28.194	0.484	99.004
ECI	404	-0.016	0.968	-2.298	2.544
FDI	402	3.706	4.352	-3.134	40.020
EDU	404	74.192	29.437	5.391	159.160
FINDEV	404	48.413	41.725	0.186	208.736
TRPOL	404	55.368	23.938	10.986	96.971
POLITY	404	4.806	5.788	-10.000	10.000
GDPC	404	12421.360	17201.790	183.428	89835.230
POP	404	61,200,000	186,000,000	1002977	1,350,000,000

Appendix 3: List of countries contained in the Entire Sample

Entire sample		
Albania	Ghana	Norway**
Algeria	Greece**	Oman**
Angola	Guatemala	Pakistan
Argentina	Guinea	Panama
Australia**	Honduras	Paraguay
Austria**	Hungary**	Peru
Bangladesh	India	Philippines
Belarus	Indonesia	Poland**
Belgium**	Iran	Portugal**
Bolivia	Ireland**	Romania
Botswana	Israel**	Russia
Brazil	Italy**	Saudi Arabia**
Bulgaria	Jamaica	Senegal
Cambodia	Japan**	Serbia
Cameroon	Jordan	Slovak Republic**
Canada**	Kazakhstan	Slovenia**
Chile**	Kenya	South Africa
China	Kuwait**	Sri Lanka
Colombia	Lao P.D.R.	Sudan
Congo, Democratic Republic	Latvia**	Sweden**
Congo, Republic of	Lebanon	Switzerland**
Costa Rica	Lithuania**	Tanzania
Croatia**	Macedonia, FYR	Thailand
Czech Republic**	Madagascar	Togo
Côte d'Ivoire	Malaysia	Trinidad and Tobago**
Denmark**	Mauritania	Tunisia
Dominican Republic	Mexico	Turkey
Ecuador	Moldova	Ukraine
Egypt	Mongolia	United Kingdom**
El Salvador	Morocco	United States**
Estonia**	Mozambique	Uruguay**
Ethiopia	Myanmar	Venezuela
Finland**	Namibia	Yemen
France**	Netherlands**	Zambia
Gabon	New Zealand**	Zimbabwe
Georgia	Nicaragua	
Germany**	Nigeria	

*Note: Countries contained in the sub-sample of High-Income Countries (HICs) are marked with "**".*