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"The winner takes it all" or a story of the optimal allocation of the European Cohesion Fund.*

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Abstract

This paper aims to determine an optimal allocation of the European Cohesion Fund (ECF) and compares it with the observed allocation. This optimal allocation is the solution of a donor optimization problem which maximizes recipient countries' GDP per capita to achieve economic convergence in the EU. Compared to the observed allocation, our solution can identifiy the recipient countries that can benefit from higher ECF transfers than the observed levels, as those having low relative GDP per capita, large population size and where the ECF has a strong capacity to support economic growth. Result is robust to changes in the specification of the donor's utility function.

Keywords: Economic growth; European cohesion policy; Foreign aid.

JEL classification: F35, I30, O47

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1 Introduction

One serious challenge of the European Union (EU) is the integration of the former socialist and Southern Mediterranean economies.[1] As it is indicated in Figure 1, relatively to the EU's average, some countries such as Greece, Portugal and Cyprus have a lower GDP per capita in 2015 than in 2007. As well, some Eastern European countries as Slovenia or Estonia are concerned, their significant trade linkages with the Euro area made them deeply exposed to the last European economic crisis.

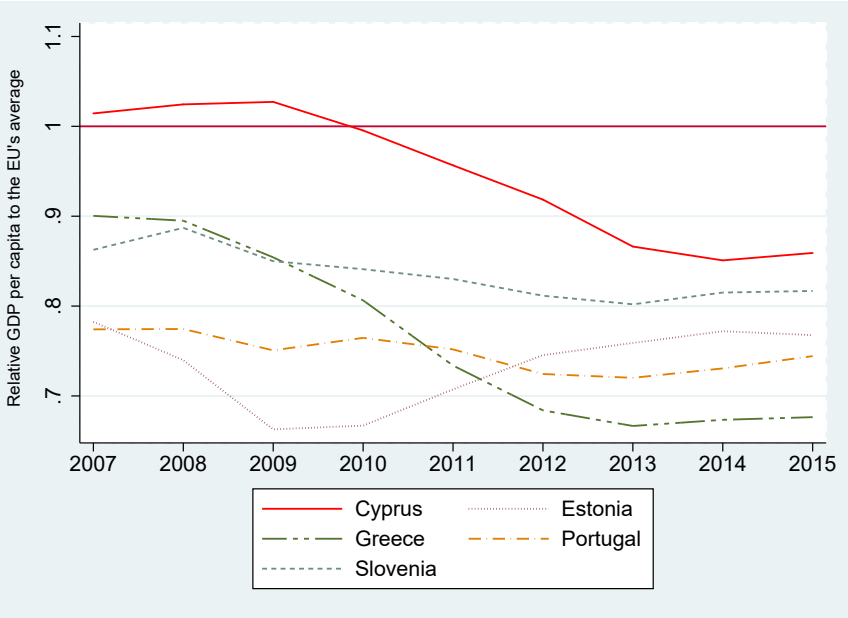

Figure 1: ECF recipient countries having lower relative GDP per capita in 2015 than in 2007.

In 1994, the EU launched the European Cohesion Fund (ECF) to make the European economic integration be successful. This fund is targeted to member countries having a GDP per capita lower than 90% of the EU's average, measured in purchase power parity (PPP). Those countries need to fund their economic transition but are not allowed to have too high deficit and national debt levels because of the Stability and Growth Pact (SGP) which limits public debt up to 60% of GDP and budget deficit to 3% of GDP. The ECF has been implemented to alleviate this trade-off: this fund pushes public investment projects funding up to 85% of the total cost (additionality principle).[2] The expenditures of the ECF could be considered as productive public expenditures, they are even classified as "investment grants" under the European System of Accounts (ESA 1995 and 2000). In 2014 prices, the ECF is about €63 billion for the programming period 2014-2020. As it is displayed in Figure 2, Poland gets the lion's share with more than

[1] This process started in June 1993 with the Copenhagen Council and the announcement of the accession criteria.

[2] One half of the fund is allocated towards transport infrastructures to establish the Trans-European Transport Networks (TTN). The remaining 50% is concentrated on environmental infrastructures.

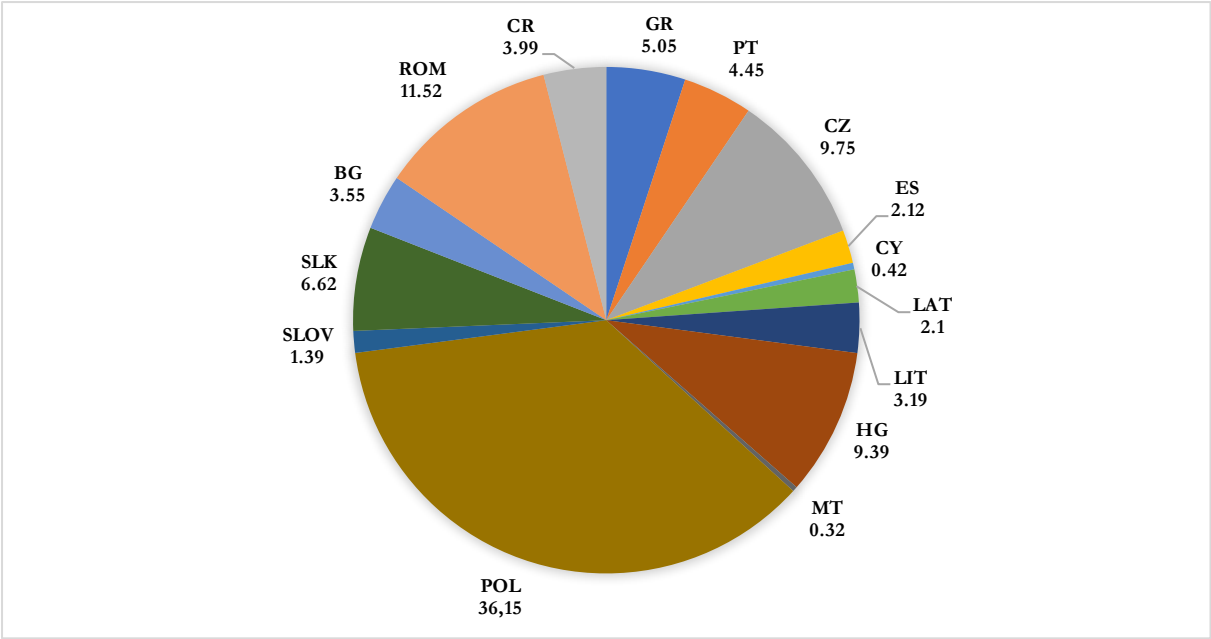

Figure 2: ECF observed allocation (period 2014-2020).

36% of the total available amount. The two poorest countries of the EU, Romania and Bulgaria, get 16% of the total amount. Small and wealthy countries such as the Baltics (Estonia, Latvia and Lithuania), Slovenia and the Slovak Republic get significant shares though: they account for about 15% of the total amount. Regarding the ongoing strong budget constraints affecting the European budget, we wonder whether the ECF could be allocated in a better way to foster the economic convergence in the EU.

A consequent literature criticized the way the European structural funds (ESF) are allocated between recipient countries, which affects the effectiveness of the European cohesion policy (see Ederveen et al. (2006), Bachtler & McMaster (2008), Becker et al. (2010), Becker (2012), Tomova et al. (2013), Huliaras & Petropoulos (2016), Maynou et al. (2016), Surubaru (2017)).[3] Butkus & Matezuviciute (2016) recalled that the ability of ESF to promote economic growth depends on factors such as trade openness, structure of national economies, decentralization level of fiscal policy, institutional environment, lack of corruption and stability of the macroeconomic environment. However, one caveat is that these studies did not suggest any allocation of any ESF able to maximize the impact of the European cohesion policy on economic growth and to promote economic convergence.

Through a normative approach, our study fills this goal by providing an optimal allocation of the ECF and compare the latter with the observed one. To do this, we posit a theoretical problem where an altruistic donor chooses an allocation of ECF to maximize the global welfare of recipient countries. Our analysis is implemented in two

[3]The EU cohesion policy is based on five European structural funds that are the European regional development fund (ERDF), the European social fund (ESF), the European cohesion fund (ECF), the European agricultural fund for rural development (EAFRD), and the European maritime and fisheries fund (EMFF).

steps: First, we estimate the ability of the ECF to stimulate GDP per capita thanks to a growth equation using data covering the 17 ECF recipient countries for the period 1995-2015. Based on GMM estimation, we find that the ECF mostly has a conditional effect on growth, depending on recipient countries' national debt and inflation levels. Second, thanks to the estimation results of the growth equation, we run simulations of the ECF's optimal allocation which corresponds to the solution of the donor's optimization problem. Our results indicate that the ECF should be concentrated on poor countries having a large population size, and where the ECF has a strong ability to promote economic growth. Poland and Romania are the two winner countries, they receive a great majority of the ECF funds. This result is robust to changes in the specification of the donor's utility function.

The remaining of the paper is structured as follows: Section 2 provides the theoretical framework where the donor's problem and its solution are exposed. Section 3 describes the data of the growth equation, and displays estimation results. Section 4 is related to the simulation of the optimal allocation of the ECF and policy implications regarding the observed allocation of the fund. We finally conclude our study in Section 5 and provide some research perspectives.

2 A theoretical framework for the ECF optimal allocation

In this section, we construct a theoretical framework to determine an optimal allocation of the ECF. This fund is a financial assistance designed to take the challenge of the European economic convergence by increasing EU lagging countries' GDP per capita.

We adopt an utilitarian approach where an altruistic donor maximizes the sum of recipient countries' utilities. Our approach refers to Collier & Dollar (2002) who displayed an optimal aid allocation maximizing poverty reduction. In the case of the ECF, the donor is represented by the European Commission which decides how the ECF is allocated among recipient countries, i.e countries having a GDP per capita lower than 90% of the EU's average.[4]

We assume that, for each recipient country i, its utility depends on the extent of its economic gap relatively to the EU, i.e the ratio between its own GDP per capita y_i and 90% of the EU's average, (noted as $0.9\overline{y}$). We assume that y_i depends on the ECF transfers A_i. The term $0.9\overline{y}$, indicating 90% of the EU's average GDP per capita, is assumed constant and taken as given by recipient countries. As well, we exclude the case of $y_i > 0.9\overline{y}$: otherwise, a recipient country would not be eligible anymore for the ECF.[5]

[4]It should be mentionned that the ECF is in fact mostly funded by Western European countries. These countries are above the 90% threshold, which makes them be net contributors to the European budget.

[5]For instance, Ireland and Spain have been excluded from the list of beneficiaries respectively in 2003

We assume that the European Commission, thanks to the ECF, intends to maximize recipient countries' GDP per capita relatively to the EU's average. For a sake of simplicity, we consider a CRRA function as follows:

$$U\left(\frac{y_i}{0.9\bar{y}}\right) = \frac{1}{1-\sigma}\left(\frac{y_i(A_i)}{0.9\bar{y}}\right)^{1-\sigma} \tag{1}$$

where $\sigma = \frac{-U''(R)}{RU'(R)}$, with $R \equiv \frac{y_i}{0.9\bar{y}}$, is interpreted as the donor's aversion to the gap R between recipient countries GDP and the EU's average GDP per capita. In other words, σ may be interpreted as the donor's aversion to the recipient countries' poverty compared to the EU's average GDP per capita. As σ increases, the altruistic donor is more concerned with recipient countries having low relative GDP per capita. U is increasing and concave with y_i, i.e. $U_{y_i} > 0$ and $U_{y_i y_i} \leq 0$.

The donor chooses then the optimal ECF allocation maximizing the sum of utilities of n recipient countries:

$$\max_{\{A_i\}_{i=1}^n} \sum_{i=1}^n \alpha_i U\left(\frac{y_i(A_i)}{0.9\bar{y}}\right) \qquad \text{(P)}$$

s.t.

$$\sum_{i=1}^n A_i N_i \leq \bar{A} \tag{2}$$

$$A_i \geq 0, \forall i = 1, 2, ..., n \tag{3}$$

where α_i corresponds to the weight of each recipient country in the utility function of the donor. In our analysis, we consider that α_i is the demographic weight of recipient country i in the total population of all recipient countries. N_i is the total population of recipient country i, A_i is the ECF transfer to country i in terms of percentage of its GDP, and $A_i N_i$ corresponds to the ECF amount received by country i. Equation (2) represents the constraint of funds availability where $\bar{A}$ is the total available amount. The constraint on the positiveness of the ECF transfers is given by equation (3).

The Lagrangian of the optimization problem (P) is:

$$L(A_i, \lambda, \mu_i) = \sum_{i=1}^n \alpha_i U\left(\frac{y_i(A_i)}{0.9\bar{y}}\right) + \lambda\left(\bar{A} - \sum_{i=1}^n A_i N_i\right) + \sum_{i=1}^n \mu_i A_i, \tag{4}$$

where and λ and μ_i are the Lagrange multipliers of constraints (2) and (3), respectively. A solution of the model $(\hat{A}_1, \hat{A}_2, ..., \hat{A}_n)$, $\hat{\lambda}$ and $\hat{\mu_i}$ must satisfy the following first order

and 2013 because of their GDP per capita levels higher than 90% of the EU average .

conditions (FOCs), $\forall i = 1, ..., n$:

$$\frac{\partial L(\hat{A})}{\partial \hat{A}_i} = -\hat{\lambda} N_i - \hat{\mu}_i + \alpha_i U_y y_A = 0, \quad (5)$$

$$\sum_{i=1}^{n} N_i \hat{A}_i = \bar{A}, \quad (6)$$

$$\hat{\mu}_i \geq 0, \hat{A}_i \geq 0. \quad (7)$$

where U_y denotes the marginal utility of GDP per capita and y_A the marginal effect of the ECF on GDP per capita. Equation (7) corresponds to the complementarity condition between $\hat{A}_i$ and $\hat{\mu}_i$. For a country i receiving a strictly positive ECF amount $\hat{A}_i > 0$, we have $\hat{\mu}_i = 0$. On the opposite, if $\hat{A}_i = 0$, we must have $\hat{\mu}_i > 0$.

If we consider the case of a country receiving a strictly positive ECF amount, i.e. $\hat{A}_i > 0$ and $\hat{\mu}_i = 0$, equation (5) gives us the optimal value of λ:

$$\hat{\lambda} = \alpha_i \frac{U_y(y_i(A_i))y_A(A_i)}{N_i}, \forall i = 1, ..., n \text{ such that } \hat{A}_i > 0 \quad (8)$$

This expression gives the value for $\hat{\lambda}$ which equalizes the right hand side term in over all the ECF recipient countries at the optimal solution of the optimization program (P). As $\hat{\lambda}$ stands for the shadow value of the ECF, it represents the marginal benefit of one extra-unit of ECF expressed in utility units. This equality shows that, when the optimization problem is solved, the marginal cost of one extra-unit of ECF is the same as its marginal benefit for every recipient countries. If we now consider only the case of a country j receiving no ECF transfer $(A_j = 0)$, we obtain the following conditions:

$$\hat{\mu_j} = \hat{\lambda} N_i - \alpha_j U_y(y_i(A_i))y_A(A_i), \forall j = 1, ..., n \text{ such that } \hat{A}_j = 0 \quad (9)$$

The results above can be summarized in the following proposition:

Proposition 1 *Considering the donor's optimization program (P), the ECF optimal allocation* $\{\hat{A}_i\}_{i=1}^n$ *must respect the three following conditions:*

1. $\hat{A}_i > 0$ *if* $\hat{\lambda} = \alpha_i \frac{U_y(y_i(A_i))y_A(A_i)}{N_i}$ *and* $\hat{\mu}_i = 0$,
2. $\hat{A}_j = 0$ *if* $\hat{\mu}_j = \hat{\lambda} N_j - \alpha_j U_y(y_i(A_i))y_A(A_i)$, *and* $\hat{\mu}_j > 0$,
3. $\sum_{i=1}^{n} \hat{A}_i N_i = \bar{A}$.

where $\hat{\lambda}$ *is the multiplier associated to the total amount of ECF, and* $\hat{\mu}_i$ *is the multiplier associated to the positiveness of recipient countries' ECF transfers.*

The second derivative of U_i with respect to $\hat{A}_i$ is :

$$\frac{\partial^2 U(\hat{A}_i)}{\partial \hat{A}_i^{\,2}} = U_{yy} y_A^2 + y_{AA} U_y, \quad (10)$$

where U_{yy} is the second derivative of U with respect to y_i and y_{AA} is the second derivative of y_i with respect to A_i. As the budget constraint is linear with respect to A_i, this second derivative of U_i must be non positive to ensure the existence of a solution. Thus, from (10), the following condition should be satisfied:

$$\frac{y_{AA}}{y_A^2} \leq -\frac{U_{yy}}{U_y}. \tag{11}$$

The right-hand side term of equation (11) is always positive because of the increasing and concave utility function with respect to GDP per capita. However, we do not know the sign of the left-hand side term of equation (11). An empirical estimation of the growth equation will allow us to conclude whether there exists a solution with real data. This will be the object of the following section. More precisely, we consider the role of the ECF and other factors being likely to affect recipient countries' GDP per capita such as the quality of macroeconomic management and institutions. We will see that estimation results satisfy condition (11), leading to the existence of a solution of the optimization problem. The estimation results of this growth equation will then be employed to make simulations of the ECF's optimal allocation, the latter being the solution of the donor's optimization program (P).

3 Estimation of the growth equation

3.1 Determinants of economic growth

This subsection describes the set of variables employed in the growth equation. The latter allows us to estimate the impact of the ECF on GDP per capita, i.e y_A and y_{AA}, in order to check condition (11) for the existence of a solution to our optimization problem (P).

We first consider some relevant exogenous factors able to explain recipient countries' growth such as geographical localization and history after World War Two (WW2). Concerning the former, De Menil (2003) underlined the importance of being close to a EU-15 country to explain the satisfying growth performances of Poland, Hungary and the Czech Republic during the 1990s. These authors argued that this favorable localization lowered the political cost of implementing market oriented structural reforms, citizens being more directly confronted to Western European high living standards. As well, Bevan & Estrin (2004) stressed the role of localization on foreign direct investment inflows (FDI) for Poland and the Czech Republic. These countries have greatly benefited from the European integration by becoming part of the German supply chain (Hinterland) since being a neighbour of Germany helped reducing their transactions costs.[6] Regarding the history of ECF recipient countries after WW2 , we focus on countries having experienced a socialist

[6]Transports and communication costs, costs of dealing with a different language, informational costs and those related to sending personnel abroad.

era and the length of this period or *market memory*, as it has been called by De Melo et al. (2001) in order to capture the lack of familiarity with market institutions. These authors found that the initial degree of macroeconomic distortions caused by central planning has an adverse impact on current economic performance.

One other determinant of GDP per capita is the level of economic freedom (Goldsmith (1995), Dawson (2003)).[7] It has been observed that the former socialist countries that joined the EU as soon as 2004 are those which implemented a so-called *shock therapy* to increase the level of national economic freedom.[8] Pitek et al. (2013) found that moderate government spending, high monetary and investment freedoms have been significant determinants of economic growth between 1990 and 2008 in Eastern European countries. Besides, Dell'Anno & Villa (2013) analyzed the impact of the speed of these reforms on economic growth and found that the contemporaneous speed of transition lowers current economic growth, but the impact becomes positive in the medium-long run.[9] Therefore, we could expect that countries having implemented significant market reforms would benefit from higher GDP per capita.

We also consider previous empirical studies on the effectiveness of the European cohesion policy to study the ESF conditional impact on GDP per capita. Authors as Ederveen et al. (2006) found that the quality of institutions determines the ability of ESF to drive economic growth. They used trade openness to proxy for institutional quality considering that the more a country is open, the more it is under trade competition, which increases the pressure for an efficient use of ESF. They studied the ability of the European Regional Development Fund (ERDF), one of the five ESF, in promoting economic growth and found that the impact of the ERDF on economic growth depends on the level of trade openness. As a result, they suggested a reallocation of the ERDF towards Northern EU members because of their aid-conducive institutions.[10] At the regional level, results are mixed: Rodríguez-Pose & Garcilazo (2015) found that the quality of local government increases the effectiveness of regional policy while studies like Coppola et al. (2018) underlined that institutional quality is not relevant.

Moreover, macroeconomic management is relevant to explain the growth performances of ESF. Recipient countries must respect the SGP, otherwise European transfers could be suspended following an excessive deficit procedure that can be launched by the European Commission.[11] The rationale behind this rule is that high deficit and public debt levels

[7]Economic freedom is based on the security of property rights, the ability to trade with any domestic or foreign entity and the extent of property confiscation through the taxation and inflation levels.

[8]We refer to Poland, the Czech and Slovak republics, the Baltics, Hungary and Slovenia.

[9]See also Aghion & Blanchard (1994) who estimated that the past level of reforms leads to higher economic growth and this effect reaches its greatest value with a lag of 3 years.

[10]As well, institutional quality can be proxied by administrative capacity (ADM). Mendez et al. (2013) defined the latter as the capacity of national and regional institutions to design robust strategies, allocate resources and administer EU funding efficiently. ADM is made of three criteria that are the centralization degree of bureaucracy in EU funds management, the adequacy and quality of human resources and the administrative adaptability i.e the processing time of bureaucracy and alignment of national procedures with the European standards.

[11]Member States which run excessive budget deficits of more than 3% of GDP, or which fail to reduce

could be harmful to ECF's economic performance because of the additionality principle. Indeed, ECF recipient country's managing authority must provide, at least, the remaining 15% of a project's cost. If it does so with additional debt, the initial positive effects on growth could be offset because of a crowding-out effect rising from high initial national debt level. Tomova et al. (2013) found that cohesion policy funds have a higher economic impact when combined with sound fiscal and macroeconomic policies. In other words, countries respecting the SGP are those where ESF are the most efficient.

In a nutshell, the conditional effect of the ECF on GDP per capita will be studied through the inclusion of interaction terms between the ECF and variables dealing with macroeconomic management and institutional quality. The following section deals with the specification of the growth equation.

3.2 Econometric specification

Our growth equation is estimated by using a panel data framework (Islam (1995), Caselli et al. (1996)). To avoid business cycles effects, we use 4-years average data for all variables excepted GDP per capita and its lagged value. We use current GDP per capita and its lagged values from observations with a 4 years interval, i.e. 1995, 1999, 2003, 2007, 2011 and 2015. Concerning explanatory variables, we use their average values over the following 4 years periods: 1995-1998, 1999-2002, 2003-2006, 2007-2010 and 2011-2014. The resulting data are an unbalanced panel data sample covering 17 countries and period 1995-2015 (5 waves of 4 years intervals).[12]

Our dependent variable is the log real GDP per capita in international prices PPP 2011 ($y_{i,t}$). We assume that the latter depends on its lagged value ($y_{i,t-1}$). GDP per capita of country i in period t also depends on the log of ECF per capita ($A_{i,t}$) expressed in international prices PPP 2011. We then consider one dummy variable related to geographical location (Geo_i) and one variable indicating the number of years under socialism after WW2, ($Socialism_i$). As well, we assume that GDP per capita depends on levels of economic freedom ($Efreedom_{i,t}$), inflation ($Inflation_{i,t}$), national debt ($Debt_{i,t}$) and its squared term ($Debt^2_{i,t}$) to capture a non linear effect *à la Reinhart and Rogoff (2010)*. We also include institutional quality proxied by the corruption level ($Corruption_{i,t}$). We finally control for ECF recipient country's human capital level ($Human_{i,t}$). We hence consider the following baseline model:

$$y_{i,t} = \rho y_{i,t-1} + X'_{i,t}\beta + +\lambda_A A_{i,t} + \gamma_2 Period_{99-02} + \gamma_3 Period_{03-06} + \gamma_4 Period_{07-10} + \gamma_5 Period_{11-14} + \upsilon_t + \epsilon_{i,t} \quad (12)$$

their excessive debts (above 60% of GDP) at a sufficient pace, follow a particular set of rules known as the Excessive Deficit Procedure (EDP). A suspension of the Cohesion funds commitments could then be decided if the qualified majority is obtained following a vote of the European Council. See EU regulation 1303/2013, article 23, *Measures linking effectiveness of ESI funds to sound economic governance.*

[12] As the data correspond to series of average values with a small T(T=5), the non-stationarity issue is not a major issue here. Moreover, the model also includes time dummies to control for trend effects.

In Model (1), $X_{i,t}$ includes (Geo_i, $Socialism_i$, $Efreedom_{i,t}$, $Inflation_{i,t}$, $Debt_{i,t}$, $Debt^2_{i,t}$, $Corruption_{i,t}$) and ($Human_{i,t}$). (v_t) is the time effect and ($\epsilon_{i,t}$) is the error term of the regression. Individual fixed effects are not included because they are removed by system-GMM.

In order to determine a conditional effect of ECF on growth, we include interaction terms in our baseline model. We then estimate Model (2) where we consider the interaction between the ECF and macroeconomic management variables that are national debt and inflation. Testing those interactions is in line with the fiscal rules related to the SGP and Tomova et al. (2013) who found that a sound macroeconomic management is associated with an increased impact of ESF on GDP. We also estimate the role of institutional quality on the ECF's effect on growth with Model (3): Model (3a) adds interactions between the ECF and the corruption index ($Corruption_{i,t}$) as a proxy of institutional quality, and Model (3b) uses the governement effectiveness index ($Government_{i,t}$) as another proxy of institutional quality.

The presence of the lagged dependent variable term in the right hand side of the growth equation implies that Models (1), (2), (3a) and (3b) can be estimated by using the system-GMM method of Blundell and Bond (1998). we distinguish two sets of regressors are considered: (i) strictly exogeneous regressors (including Time Dummies, Geographical Location (Geo_i) and Socialism ($Socialism_i$)) and (ii) predetermined regressors (including initial GDP per capita $y_{i,t-1}$, Human Capital ($Human_{i,t}$), National Debt ($Debt_{i,t}$), Inflation Rate ($Inflation_{i,t}$), Economic Freedom ($Efreedom_{i,t}$), Corruption ($Corruption_{i,t}$), Government Effectiveness ($Government_{i,t}$), ECF Transfers ($A_{i,t}$)).

3.3 Data and variables

Table 5 in Appendix summarizes the variables we use in the estimation of our growth equation. The data are an unbalanced panel data sample covering 17 countries and period 1995-2015. Regarding the ECF, the EU provides data about how much is spent for each programming period: $1994-1999, 2000-2006, 2007-2013$ and $2014-2020$. To get annual amounts of ECF transfers as for other variables, we take the annual average for each of the programming periods.[13] Descriptive statistics of variables are provided in Table 1.

3.4 Estimation results

Our analysis shows that Arrellano-Bond tests in the regressions residuals, AR(1) and AR(2), the Sargan and Hansen overidentifying restrictions tests and tests for exogeneity

[13]The estimations of the paper are based on the periods 1995-1998, 1999-2002, 2003-2006, 2007-2010 and 2011-2014. We also provide in the Appendix estimations corresponding to the programming periods 1994-1999, 2000-2006 and 2007-2013. The size of coeffcients remain unchanged but the very small number of observations implies to take those estimation results very cautiously.

Table 1: Descriptive statistics.

Variable	Obs	Mean	Std. Dev.	Min.	Max.
GDP per capita (log) ($y_{i,t}$)	102	9.980	0.394	9.022	11.027
Lagged GDP per capita (log) ($y_{i,t-1}$)	85	9.932	0.398	9.022	10.798
Debt ($Debt_{i,t}$)	84	0.479	0.308	0.049	1.720
Debt squa. ($Debt^2_{i,t}$)	84	0.324	0.439	0.002	2.960
Inflation ($Inflation_{i,t}$)	85	0.094	0.348	0.007	3.152
Index of Economic Freedom ($Efreedom_{i,t}$)	85	64.660	7.138	47.030	81.480
Corruption ($Corruption_{i,t}$)	85	0.570	0.542	-0.567	1.740
Governement Effect. ($Governement_{i,t}$)	85	0.754	0.460	-0.428	1.805
Geo. Location (Geo_i)	85	0.529	0.502	0.000	1.000
Socialist Expe. $Socialism_i$)	85	0.647	0.481	0.000	1.000
Workforce Tertiary Edu. ($Human_{i,t}$)	85	0.526	0.194	0.171	1.117
ECF (log) ($A_{i,t}$)	85	4.440	0.685	2.484	5.370
Period 1995-1998	102	0.167	0.375	0.000	1.000
Period 1999-2002	102	0.167	0.375	0.000	1.000
Period 2003-2006	102	0.167	0.375	0.000	1.000
Period 2007-2010	102	0.167	0.375	0.000	1.000
Period 2011-2014	102	0.167	0.375	0.000	1.000

are generally verified. Our dynamic panel data is unbalanced with more individual dimensions than time dimension (*T=5* and *N=17*). Following Roodman (2009), it is therefore preferable to use the system GMM method of Blundell & Bond (1998) when N is larger than T. Table 2 displays the estimation results of Models (1), (2), (3a) and (3b).

Results obtained with system-GMM estimators indicate that the lagged term of GDP per capita is highly significant and has a positive effect on current GDP per capita. The high significancy of the lagged term of GDP per capita gives strength to the use of system GMM. As well, the size of this effect is rather similar across all specifications. Concerning the other regressors, Economic Freedom exhibits a significant positive impact on GDP per capita in Models (2), (3a) and (3b) in line with Dell'Anno & Villa (2013). Those estimates highlight the returns on the market-oriented reforms implemented in the 1990s in most of recipient countries. Regarding the ECF's direct impact on GDP per capita, we find that the associated parameter turns to be insignificant in all models.

Let us now turn to the analysis of the ECF's conditional efficiency. We observe that the impact of the ECF on GDP per capita is not conditioned to recipient countries' institutional quality. Indeed, both the interaction terms related to corruption and governement effectiveness do not exhibit any significance, which goes against Ederveen et al. (2006). Instead of institutional quality, the impact of the ECF on GDP per capita is however conditioned to public debt and inflation. Estimation results from Models (2), (3a) and (3b) show that the impact of the ECF on GDP per capita depends on inflation and public debt levels. For instance, from Model (2), the marginal effect of the ECF on GDP per

capita can be expressed as:

$$\frac{\partial y_{i,t}}{\partial A_{i,t}} = -0.395 I_{i,t} + 0.457 D_{i,t} - 0.392 D_{i,t}^2. \tag{13}$$

Table 2: Growth equation estimation results.

	Model 1		Model 2		Model 3a		Model 3b	
Variable	Coef.	S.E.	Coef.	S.E.	Coef.	S.E.	Coef.	S.E.
Lagged GDP (log)	0.630***	0.092	0.674***	0.100	0.648***	0.104	0.614***	0.102
Human Capital	-0.007	0.053	0.011	0.061	0.069	0.077	0.132	0.086
Debt	0.076	0.134	-1.960	1.243	-2.511*	1.489	-2.831*	1.692
Debt squared	-0.053	0.056	1.670	1.040	2.069*	1.24	2.284*	1.362
Economic Freedom	0.010	0.004	0.011***	0.003	0.014***	0.005	0.012**	0.005
Corruption	0.033	0.022	-0.008	0.029	0.011	0.157		
Gov. Effect.							-0.139	0.298
Geo. Location	0.037	0.018	0.014	0.021	-0.006	0.032	-0.008	0.034
Socialist Expe.	-0.041	0.019	0.013	0.064	0.013	0.065	-0.011	0.067
ECF	0.036	0.023	-0.072	0.076	-0.124	0.104	-0.183	0.166
ECF* Inflation			-0.395***	0.12	-0.377***	0.131	-0.357***	0.153
ECF*Debt			0.457*	0.279	0.617*	0.344	0.680*	0.394
ECF*Debt squared			-0.392*	0.237	-0.497*	0.284	-0.548*	0.314
ECF*Corruption					-0.004	0.035		
ECF*Gov. Effect.							0.039	0.068
Period 1999-2002	0.056	0.062	0.146**	0.065	0.179**	0.073	0.152*	0.093
Period 2003-2006	0.034	0.049	0.109**	0.049	0.133**	0.057	0.114*	0.069
Period 2007-2010	0.104***	0.306	0.154***	0.034	0.174***	0.040	0.157***	0.045
Period 2011-2014	-0.082	0.028	-0.035	0.031	-0.019	0.037	-0.026	0.037
Intercept	2.925***	0.811	2.981***	0.779	3.137***	0.783	3.832***	0.958
Arellano-Bond, AR(1)	-1.940*		-1.520		-1.660*		-1.670*	
Arellano-Bond, AR(2)	-1.410		-1.480		-1.510		-1.640	
Sargan, overid. restr.	50.080**		51.760**		41.310**		47.220***	
Hansen, overid. restr.	1.240		0.080		0.000		0.000	
Observations	85		85		85		85	

Notes: This table displays the estimation results of the growth equation following Models (1), (2), (3a) and (3b). Dependent variable: GDP per capita. Results are obtained with system GMM method of Blundell & Bond (1998). *, ** and *** denote 10%, 5% and 1% significance levels. Strictly exogenous regressors include Time Dummies, Geography and Socialism. Predetermined regressors are Human Capital, National Debt, Corruption, Inflation, ECF Transfers and lagged GDP per capita.

We find that inflation reduces the marginal effect of ECF on GDP per capita, which gives rationales to the aim pursued by the EU's monetary authorities to keep inflation to a low level. Regarding public debt, we notice that the ECF is efficient in countries having moderate national debt levels with a pattern *à la Reinhart & Rogoff (2010)*. Equation (13) indicates that national debt is complementary to the ECF up to a estimated ratio of 58.3% of GDP.[14] Beyond this level, national debt is detrimental to the ECF's effect. This result, in line with Tomova et al. (2013), legitimates the rules imposed by the SGP where national debt of one country cannot go beyond 60% of its GDP. This result is even more relevant in the context of the ECF and its additionality principle, i.e national

[14]Estimation results of Model (3a) indicate a rather similar number, 63% of GDP.

governments must fund at least 15% of an investment project's cost. Indeed, national debt could harm the ECF's economic impact in significantly indebted countries because of a strong crowding-out effect rising from a high initial national debt level.

4 Simulation of the optimal allocation of ECF

4.1 Observed allocation and optimal allocation

In this section, estimation results of Model (2) are employed to simulate the optimal solution of the donor's optimization problem (P). We can then compare this optimal allocation to the observed one in 2015. As it has been shown in the first order conditions of our optimization problem, an optimal allocation of the ECF leads to the same $\hat{\lambda}$ for every recipient countries. The optimal allocation sets $\hat{A}_i$ is defined in Proposition 1. For all $\hat{A}_i > 0$, the optimal value of λ (equation (8)) is rewritten as:

$$\hat{\lambda} = \alpha_i \frac{1}{0.9\bar{y}} \Big(\frac{y_i}{0.9\bar{y}} \Big)^{-\sigma} \frac{y_A(\hat{A}_i)}{N_i}. \tag{14}$$

The ECF's optimal allocation is estimated for the programming period 2014-2020 with data from the year 2015. A total of 15 countries have been receiving the ECF during this period. The estimation results from Model (2) allow us to give the empirical values of $y_A(A_i)$. We then set the value of the parameter σ which indicates to what extent the donor is adverse to low relative GDP per capita. We consider two cases: (i) $\sigma = 0.2$ and (ii) $\sigma = 0.8$. A higher value of σ means that the donor is more sensitive to the ratio ratio $y_i/0.9\bar{y}$ between recipients countries' GDP per capita and the average level of GDP per capita in the EU countries. Empirical simulations of both the ECF optimal allocations are provided in Table 3.

Poland beneficiates from the largest increase of its ECF transfers and becomes the main recipient country in both optimal allocations with 77.4% of total funds when $\sigma = 0.2$ and 58.8% when $\sigma = 0.8$. As well, Romania is better off: this country stands for 14.75% of the total allocation when $\sigma = 0.2$, 24.45% when $\sigma = 0.8$. Both Poland and Romania concentrate the great majority of ECF transfers with a cumulated share above 80%. The 13 remaining recipient countries see their transfers being reduced and, in total, concentrate less than 20% of total transfers in both optimal allocations.[15] Some countries such as Cyprus, Malta, Estonia, Latvia, Lithuania, the Slovak and Portugal are even close to receive any ECF transfer. How could be these results be interpreted?

There are at least three arguments which may explain why Poland and Romania are taking it all: the ECF marginal efficiency level in both countries, their relative GDP per capita and population size. These values are reported in Table 4.

First, both Poland and Romania are countries where the ECF has a strong marginal

[15] 7.9% with $\sigma = 0.2$, 16.9% with $\sigma = 0.8$.

Table 3: Observed and optimal ECF allocations with $\sigma = 0.2$ and $\sigma = 0.8$.

Country	Observed ECF	allocation % Total	Optimal $\sigma = 0.2$ ECF	allocation % Total	Optimal $\sigma = 0.8$ ECF	allocation % Total
Bulgaria	53.32	3.55	1.48	0.10	49.60	3.30
Croatia	102.38	3.99	37.88	1.48	53.78	2.10
Czech Republic	99.70	9.75	8.80	0.86	4.37	0.43
Estonia	173.95	2.12	8.36	0.10	0.81	0.01
Greece	50.33	5.05	0.00	0.00	40.60	4.070
Hungary	102.90	9.39	42.70	3.89	60.65	5.53
Latvia	114.68	2.10	1.40	0.030	0.02	0.00
Lithuania	118.56	3.19	0.85	0.02	6.39	0.17
Malta	79.88	0.32	10.60	0.04	8.16	0.03
Poland	102.67	36.15	219.98	77.44	166.90	58.80
Portugal	46.34	4.45	0.08	0.08	2.95	0.28
Romania	62.72	11.52	80.24	14.75	133.03	24.45
Slovenia	72.71	1.39	50.80	0.97	37.28	0.71
Slovak Republic	131.71	6.62	4.41	0.22	2.05	0.10
Cyprus	38.99	0.42	1.84	0.02	5.73	0.06
Average marginal efficiency	0.089		0.129		0.103	

Notes: The observed and optimal ECF transfers per capita are expressed in PPP $ 2011 prices. The share allocated to each ECF recipient country is expressed in % of its GDP. The average marginal efficiency is expressed as the elasticity of GDP per capita to the ECF.

Table 4: Estimated ECF recipient countries' economic performance and relative GDP per capita in 2015.

	Marginal efficiency (%)	Relative GDP per capita (%)	Population share (%)
Bulgaria	0.072	47.8	5.75
Croatia	0.121	58.3	3.38
Czech Republic	0.123	85.9	8.45
Estonia	0.038	77.4	1.05
Greece	-0.377	67.8	8.70
Hungary	0.119	70.3	7.88
Latvia	0.121	64.7	1.58
Lithuania	0.118	75.7	2.33
Malta	0.130	96.2	0.35
Poland	0.132	71.0	30.42
Portugal	-0.038	74.6	8.28
Romania	0.115	57.7	15.88
Slovenia	0.132	81.5	1.65
Slovak Republic	0.131	79.5	4.34
Cyprus	0.097	85.8	0.93
Average	0.089	72.9	

Notes: Marginal efficiency corresponds to the elasticities of recipient countries' GDP per capita with the ECF. Relative GDP per capita is expressed the ratio between recipient GDP and the EU's average in PPP. Population share indicates the demographic weight of one country in the total sample, corresponding to α_i in equation (14).

impact on GDP per capita, compared to other recipient countries. Heterogeneities in the ECF's economic performances between recipient countries are mainly driven by differences in public debt levels (as inflation is homogeneous across European countries). In Poland and Romania, an increase by 1% of the ECF transfers generates a rise of GDP per capita by 0.132% and 0.115% respectively. Among recipient countries, Poland is even the country where the ECF has the strongest marginal effect because its public debt, 53.4% of GDP in 2015, is one of the closest to the optimal level, estimated to 58.3% of GDP. Regarding the SGP, Poland is slightly under the 60% threshold fixed by the SGP, its debt level is very far from the one observed in Greece which exhibits the worst ECF's economic performance. Indeed, an increase by 1% of the ECF transfers generates a fall of GDP per capita by 0.377% because of a skyrocking national debt representing nearly 177% of GDP. A similar pattern could be observed in the case of Portugal as well. Overall, countries having a bad macroeconomic management regarding public debt do not achieve high ECF economic performances.

Let us now move towards our second criteria, relative GDP per capita. Romania and Poland are relatively poor countries with respectively 71% and 57.7% of the EU's average GDP per capita. Both Poland and Romania are under the sample's average (72.9%), Romania is even the second poorest country of the sample. On the contrary, Malta is above the 90% boundary fixed by the EU which would make this country not eligible anymore for the ECF.

Finally, both these countries beneficiate more of the optimal allocations thanks to a large demographic weight: Poland stands for 30.42% of the total sample population, Romania is the second most populated country. Because the demographic weight of each recipient country is considered in the donor's utility function with the parameter α_i, countries having the largest population sizes receive more ECF transfers. Most of remaining countries are characterized by either low ECF economic efficiency, high relative GDP per capita or small population size. For instance, despite one of the most important ECF economic efficiency and population size, the Czech Republic loses nearly all of its ECF funds because this country has the second highest GDP per capita of our sample.

It should be noticed as well that as σ is risen from 0.2 to 0.8, ECF transfers directed towards Romania, Bulgaria, and Greece are sharply increased (Table 3). Those countries respectively have the twelfth, fourteenth and fifteenth GDP per capita of our sample which means that they are among the poorest ECF recipient countries. The cases of Greece and Bulgaria are striking: both these countries see their ECF transfers jumping from nearly 0% when $\sigma = 0.2$ to more than 3% for Bulgaria and 4% in the case of Greece when $\sigma = 0.8$. This result strenghtens the fact that while economic efficiency is rewarded, economic fairness is not forgotten.

We recall that the aim of our optimal allocation is to increase the ECF's economic efficiency in order to help the EU achieving economic convergence. Table 3 indicates that both the optimal allocations perform better than the observed one: on average, a

1% increase of the ECF transfers generates a 0.129% increase of GDP per capita when $\sigma = 0.2$ and 0.103% when $\sigma = 0.8$ which is more than the 0.089% of the observed allocation. These results are driven by the good performances of Poland and Romania. The lower performance of the optimal allocation with $\sigma = 0.8$ is mainly due to a larger share directed towards Greece which drags down the overall economic performance of the ECF.

5 Conclusion

The European Cohesion Fund is an additional tool used by the EU to promote economic convergence between its member states. The ECF is targeted to those having a relative GDP per capita lower than 90% of the EU's average.

This study has dealt with the issue of the allocation of the ECF between recipient countries. We have adopted a normative approach where an optimal allocation of the ECF is computed and compared to the observed allocation for the period 2014-2020. To obtain this optimal allocation, we have solved an optimization problem where a purely altruistic donor has maximized the global welfare of ECF recipient countries. The optimal solution of this theoretical problem has been then empirically simulated thanks to the estimation results of a growth equation based on system GMM estimators using a database covering 17 countries for the period 1995-2015.

We find that GDP per capita is significantly and positively affected by its own lagged value and the level of economic freedom. As well, our estimates show that the ECF's impact on GDP per capita is conditional to inflation and public debt. Recipient countries with moderate national debt and low inflation levels are those where the ECF is the most efficient. The optimal ECF allocation gives more funds to Poland and Romania thanks to their high ECF economic efficiency, low relative GDP per capita and large population size. This result is robust to a change in the donor's aversion to recipient countries' low relative GDP per capita. Poland and Romania stand for more than 80% of total funds while this figure is about 48% with the observed ECF allocation in 2015. Regarding economic efficiency, optimal allocation exhibits a higher marginal impact than the observed allocation.

The ECF optimal allocation we propose is based on economic criteria that are the initial relative GDP per capita and the ECF's economic performance conditioned on the quality of macroeconomic management. The necessity of a sound macroeconomic management is explicitely mentionned in EU regulations. The resulting optimal allocation we compute is therefore in line with the European legislative texts and gives additional theoretical background to the European fiscal rules. As well, we have considered a demographic criterion where recipient countries are weighted according to their population size, which avoids any demographic bias towards small recipient countries. This paper is a contribution to the debate relating to European structural funds' allocation criteria:

further extensions could be added to this study based on more political criteria such as the respect of European democratic principles in the ECF recipient countries.

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6 Appendix

Table 5: Data and variables definition.

Variable name	Definition	Unit	Source
GDP per capita ($y_{i,t}$)		PPP 2011$	World Bank
Lagged GDP per capita ($y_{i,t-1}$)	GDP per capita of the last period (4 years ago)	PPP 2011$	World Bank
Human Capital ($Human_{i,t}$)	Working labour force having achieved tertiary education	Percentage of working labour force	World Bank
Geographical localization ($Geo_{i,}$)	Be a neighbour of a EU-15 country	Dummy variable	
Socialist Experience ($Socialism_i$)	Length under a socialist governement after WW2	Number of years	
Government Effectiveness ($Government_{i,t}$)	Perceptions of the quality of public services, policy formulation and implementation, and the credibility of the government's commitment	Score between -2.5 to 2.5 (best score)	Worldwide governance indicators
Corruption ($Corruption_{i,t}$)	Perceptions of the extent to which public power is exercised for private gain, including both petty and grand forms of corruption, as well as "capture" of the state by elites and private interests	Score between -2.5 to 2.5 (best score)	Worldwide governance indicators
Economic Freedom ($Efreedom_{i,t}$)	Rule of Law, government size, regulatory efficiency, and performance on Market's openness (financial, investment and trade freedoms)	Score between 0 and 100 (best score)	Heritage Foundation
Inflation ($Inflation_{i,t}$)	Variation of consumer price index	Percentage of price index	World Bank
National Debt ($Debt_{i,t}$)	General government consolidated gross debt	Percentage of GDP	Eurostat
ECF per capita ($A_{i,t}$)	Programmed ECF transfers	PPP 2011$	European Commission

Table 6: Growth equation estimation results using time periods 1994-1999, 2000-2006 and 2007-2013.

	Model 1		Model 2		Model 3a		Model 3b	
Variable	Coef.	SE	Coef.	SE	Coef.	SE	Coef.	SE
Lagged GDP (log)	0.421***	0.084	0.511***	0.089	0.501***	0.082	0.512***	0.122
Human capital	0.019	0.063	0.346	0.053	0.342**	0.161	0.302	0.179
Debt	0.245	0.142	-0.837	2.876	-0.842*	2.845	-2.247	2.556
Debt squared	-0.138	0.048	-0.148	3.095	-0.128*	3.069	1.315*	2.773
Economic Freedom	0.013***	0.005	0.009***	0.004	0.009***	0.003	0.011***	0.007
Corruption	0.096	0.034	0.056	0.052	0.075	0.156		
Gov. effect.							-0.026	0.677
Geo. Location	0.004	0.022	-0.076	0.070	-0.076	0.069	-0.053	0.063
Socialist expe.	-0.044	0.067	-0.248	0.085	-0.024	0.085	-0.023	0.079
ECF	0.064*	0.03	-0.091	0.151	-0.087	0.149	-0.170	0.200
ECF* Inflation			-0.545	0.352	-0.552	0.355	-0.543	0.397
ECF* Debt			0.321	0.674	0.323	0.667	-0.632	0.590
ECF* Debt squared			-0.074	0.722	-0.079	0.716	-0.404	0.635
ECF*Corruption					-0.004	0.034		
ECF* Gov. Effect.							0.015	0.146
Period 2000-2006	0.131	0.048	0.228**	0.079	0.228**	0.079	0.215*	0.114
Period 2007-2013	0.237***	0.029	0.256***	0.046	0.257***	0.049	0.252***	0.074
Intercept	4.587**	0.829	4.529***	1.036	4.522***	1.058	4.818***	1.487
Arellano-Bond, AR(1)	-1.630		-1.440		-1.510		-1.630	
Arellano-Bond, AR(2)								
Sargan, overid. restr.	22.830**		20.120*		20.030*		18.850*	
Hansen, overid. restr.	6.490		0.660		0.000		0.000	
Observations	53		53		53		53	

Notes: This table displays the estimation results of the growth equation following Models (1), (2), (3a) and (3b). Dependent variable: GDP per capita. Results are obtained with system GMM method of Blundell & Bond (1998). *, ** and *** denote 10%, 5% and 1% significance levels. Strictly exogenous regressors include Time Dummies, Geography and Socialism. Predetermined regressors are Human Capital, National Debt, Corruption, Inflation, ECF Transfers and lagged GDP per capita. Mean variance Inflation factor is 2.83, highest is 4.950 for Socialism and lowest is 1.440 for ECF Transfers.