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Benoît Dicharry, Phu Nguyen-Van, Thi Kim Cuong Pham. “The winner takes it all” or a story of the optimal allocation of the European Cohesion Fund. *European Journal of Political Economy*, 2019, 59, pp.385-399. 10.1016/j.ejpoleco.2019.05.003 . hal-02514874

**HAL Id: hal-02514874**

**<https://hal.univ-lorraine.fr/hal-02514874>**

Submitted on 20 Jul 2022

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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 identify 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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\*The authors are grateful to the participants at the European Public Choice Society congress (Roma, 2018), Journées LAGV (Aix-en-Provence, 2018), and AFSE congress (Paris, 2018), and other seminars for helpful comments on a previous draft of this paper. The usual caveat applies.

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# “The winner takes it all” or a story of the optimal allocation of the European Cohesion Fund

March 26, 2019

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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.<sup>1</sup> 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.

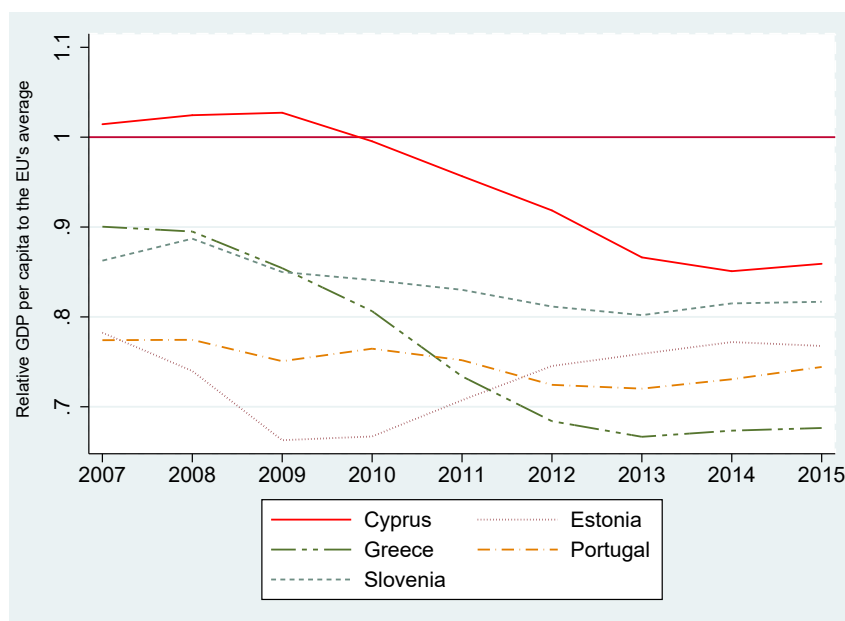


Figure 1: ECF recipient countries having lower relative GDP per capita in 2015 than in 2007.

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). Being part of the EU requires sound fiscal policies as public debt was limited to 60% of GDP by the accession criteria for countries applying for the EU membership. As well, since 1997, actual member countries 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. Concerning the poor EU's economies, the ECF alleviates the trade-off between fiscal discipline and the financing of economic development: this fund pushes public investment projects funding up to 85% of the total cost (additionality principle).

<sup>1</sup>The integration process started in the 1980s for Greece, Spain and Portugal, the emphasis was put on the Eastern European countries from February 1992 with the adoption of the Maastricht Treaty. The latter increased substantially the financial resources for cohesion policy leading to the future creation of the European Cohesion Fund (ECF). In June 1993, the Copenhagen Council resulted in the announcement of the accession criteria to be a member State of the EU.

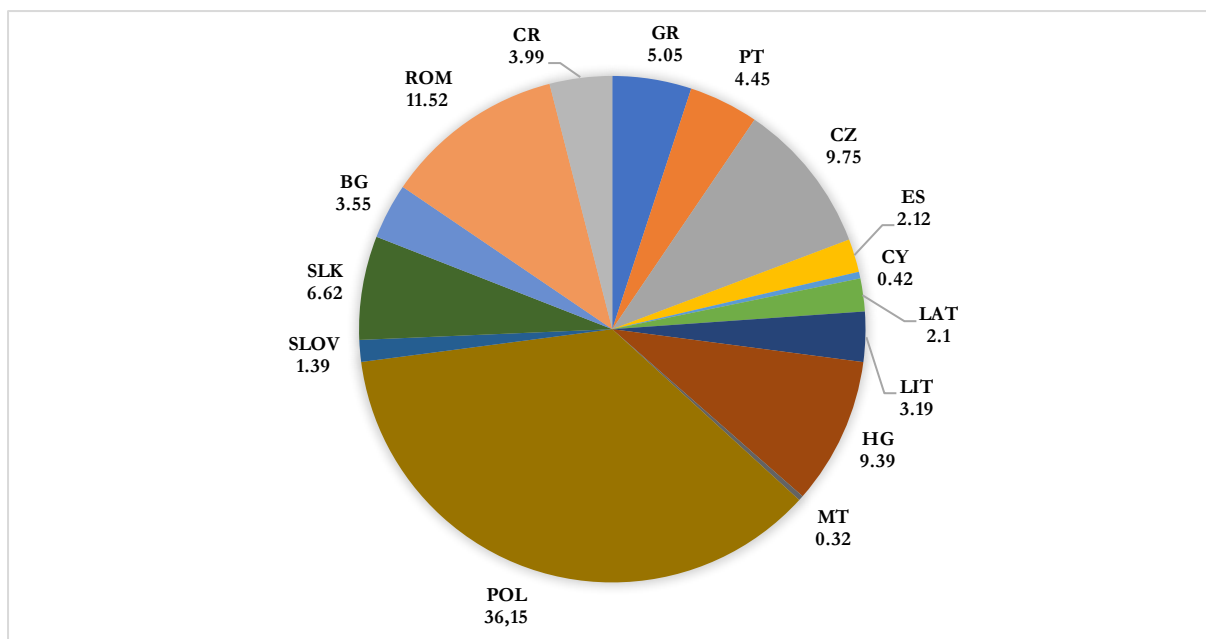


Figure 2: ECF observed allocation (period 2014-2020). Source: European Commission.

The expenditures of the ECF could be considered as productive public expenditures *à la Barro (1990)*. As a matter of fact, one half of the fund is allocated towards transport infrastructures to establish the Trans-European Transport Networks (TTN) and the remaining half are concentrated on environmental infrastructures. The ECF's expenditures are even classified as "investment grants" under the European System of Accounts (ESA 1995 and 2000). The productive nature of the ECF leads to suppose that this European fund stimulates recipient countries' economic growth and helps to fasten economic convergence in the EU. The ECF is about €63 billion (in 2014 prices) for the programming period 2014-2020. Figure 2 displays that Poland gets the lion's share with more than 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. The EU cohesion policy results in transfers between a global donor i.e. the European Commission, and some recipient countries.<sup>2</sup> Moreover, some criticism was addressed to the way European structural funds (SF) are allocated between recipient countries, which affects the global effectiveness of the European cohesion policy (Cappellen et al. (2003), Rodríguez-Pose & Fratesi (2004), Ederveen et al. (2006), Becker (2012),

<sup>2</sup>The EU cohesion policy is based on five European structural funds (SF) 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).

Mendez et al. (2013), Tomova et al. (2013), Rodríguez-Pose & Garcilazo (2015), Huliaras & Petropoulos (2016), Crescenzi & Giua (2016)). However, there was no suggestion about an allocation of SF able to maximize the impact of the European cohesion policy on economic growth in order to promote economic convergence. Through a normative approach, our study fills this gap by providing an optimal allocation of the ECF and compare the latter with the observed one.

In this paper, 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 steps: First, we estimate the ability of the ECF to stimulate GDP per capita thanks to a growth equation using data covering the 15 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, and where the ECF has a strong ability to promote economic growth (i.e. low inflation and low public debt). More precisely, the findings suggest to shift the ECF away from small and wealthy countries (such as the Czech Republic, Malta, Cyprus, Slovenia or the Slovak Republic) and concentrate the fund on bigger, poorer and more efficient countries (Poland and Romania). 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 discusses the related literature on the conditional effectiveness of financial transfers between donors and recipient countries focusing on foreign aid and European structural funds. Section 3 provides the theoretical framework where the donor's problem and its solution are exposed. Section 4 describes the data of the growth equation, and presents estimation results. Section 5 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 6 and provide some research perspectives.

## 2 Related literature

The discussion about the effectiveness of ECF can be based on the previous works on foreign development aid. One major issue highlighted by this literature is the conditional effectiveness of financial transfers between donors and recipient countries. In their seminal paper, Burnside & Dollar (2000) found that foreign aid has a positive effect on growth only in recipient countries which have good fiscal, monetary and trade policies. Collier & Dollar (2002) used the World Bank's Country Policy and Institutional Assessment (CPIA) as a measure of policy quality and showed that aid may promote economic growth and reduce the poverty in recipient countries if the quality of their policies is sufficiently

high. Guillaumont & Chauvet (2001) and Chauvet & Guillaumont (2009) indicated that the marginal effect of aid on growth is conditional on the recipient countries' economic vulnerability, i.e. the marginal effect of aid on growth is an increasing function of economic vulnerability.

Regarding European structural funds (SF), an important literature underlined their conditional impact on economic growth (Cappelen et al. (2003), Rodríguez-Pose & Fratesi (2004), Ederveen et al. (2006), Becker (2012), Mendez et al. (2013), Tomova et al. (2013), Rodríguez-Pose & Garcilazo (2015), Huliaras & Petropoulos (2016), Crescenzi & Giua (2016)). The quality of institutions or government are key variables driving this conditional effectiveness (Ederveen et al. (2006), Becker (2012), Rodríguez-Pose & Garcilazo (2015)). Ederveen et al. (2006) used trade openness as a 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 SF. They found that the impact of the ERDF on economic growth positively depends on the level of trade openness.

As well, Becker (2012) concluded that regions with poorer governance and lower levels of education fail to make good use of EU transfers. Rodríguez-Pose & Garcilazo (2015) emphasized that SF's impact on GDP in regions receiving more than €150 per capita, which is the case of most of the Eastern European regions, is purely conditioned by the quality of government. Other studies pointed out low planning capacity, inefficient bureaucratic procedures and lack of experienced staff as factors delaying decisions and thwarting outcomes (Cappelen et al. (2003), Rodríguez-Pose & Fratesi (2004)). These issues refer to the importance of administrative capacity in determining the ability of SF to promote economic growth. Mendez et al. (2013) defined administrative capacity as the capacity of national and regional institutions to design robust strategies, to allocate resources and to administer EU funding efficiently. In a study focused on Greece, Huliaras & Petropoulos (2016) described the consequences of a weak administrative capacity and bad quality of government: As with foreign aid, SF in Greece have ended up supporting a bloated bureaucracy, strengthening patronage patterns and reinforcing clientelistic networks. They also had a negative impact on incentives. They were treated by Greek government officials as an external rent, rather than a support for domestic efforts.

Other variables as sound fiscal and macroeconomic policies (Tomova et al. (2013)) or favourable socio-economic conditions (Crescenzi & Giua (2016)) are as well mentioned by the literature. More precisely, Tomova et al. (2013) showed that sound fiscal policies (proxied by low levels of government debt and deficit) and sound macroeconomic policies (proxied by low levels of net foreign liabilities) are beneficial to ESF's efficiency. Crescenzi & Giua (2016) found that the relationship between Regional Policy funding and regional growth is the strong and positive in areas with favourable socio-economic conditions (proxied by the social filter index).

### 3 A theoretical framework for the ECF optimal allocation

Our theoretical framework is based on the literature of foreign aid allocation where a normative approach is used in order to determine its optimal allocation (Burnside & Dollar (2000), Collier et al. (2001), Llavador & Roemer (2001), Collier & Dollar (2002), Cogneau & Naudet (2007), Carter (2014)). In their seminal works, Collier et al. (2001), Collier & Dollar (2002) proposed an optimal aid allocation maximizing a social welfare function which is the sum of utilities of aid-recipient countries. A country's utility is measured in terms of number of poor reduced thanks to economic growth. The latter is in turn influenced by aid, institutional quality, and policy quality. Consequently, the aid allocation reducing the poverty is determined by the initial poverty of recipient countries and the aid effectiveness which depend on the recipient countries's institutional quality, and their policy quality.

Related to this literature, we use 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 assume that an altruistic donor maximizes the sum of recipient countries' utilities. 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.<sup>3</sup>

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  $0.9\bar{y}$ ). We assume that  $y_i$  depends on the ECF transfers  $A_i$ . The term  $0.9\bar{y}$ , 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  $y_i > 0.9\bar{y}$ : otherwise, a recipient country would not be eligible anymore for the ECF.<sup>4</sup> 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:

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

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,  $\sigma$  may be interpreted as the donor's aversion to the recipient countries' poverty compared to the EU's average GDP per capita. As  $\sigma$  increases, the altruistic donor is more concerned

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<sup>3</sup>It should be mentioned 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.

<sup>4</sup>For instance, Ireland and Spain have been excluded from the list of beneficiaries respectively in 2003 and 2013 because of their GDP per capita levels higher than 90% of the EU average .



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:

$$\begin{aligned} \max_{\{A_i\}_{i=1}^n} \sum_{i=1}^n \alpha_i U\left(\frac{y_i(A_i)}{0.9\bar{y}}\right) \quad (P) \\ \text{s.t.} \end{aligned}$$

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

$$A_i \geq 0, \forall i = 1, 2, \dots, n \quad (3)$$

where  $\alpha_i$  corresponds to the weight of each recipient country in the utility function of the donor. In our analysis, we consider that  $\alpha_i$  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:

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

where  $\lambda$  and  $\mu_i$  are the Lagrange multipliers of constraints (2) and (3), respectively. A solution of the model  $(\hat{A}_1, \hat{A}_2, \dots, \hat{A}_n)$ ,  $\hat{\lambda}$  and  $\hat{\mu}_i$  must satisfy the following first order conditions (FOCs),  $\forall i = 1, \dots, n$ :

$$\frac{\partial L(\hat{A})}{\partial \hat{A}_i} = -\hat{\lambda} N_i - \hat{\mu}_i + \alpha_i U_{y_i} y_{A_i} = 0, \quad (5)$$

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

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

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  $\lambda$ :

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

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:

$$\hat{\mu}_j = \hat{\lambda}N_j - \alpha_j U_y(y_j(A_j))y_A(A_j), \forall j = 1, \dots, n \text{ such that } \hat{A}_j = 0 \quad (9)$$

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  $\hat{\mu}_j = \hat{\lambda}N_j - \alpha_j U_y(y_j(A_j))y_A(A_j)$ , 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:

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

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 ( $P$ ).

## 4 Estimation of the growth equation

### 4.1 Determinants of economic growth

This subsection describes the set of variables employed in our growth equation. 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.<sup>5</sup> Regarding the history of ECF recipient countries after WW2, we focus on countries having experienced a socialist 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)).<sup>6</sup> 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.<sup>7</sup> 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.<sup>8</sup> Therefore, we could expect that countries having implemented significant market reforms would ben-

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<sup>5</sup>Transports and communication costs, costs of dealing with a different language, informational costs and those related to sending personnel abroad.

<sup>6</sup>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.

<sup>7</sup>We refer to Poland, the Czech and Slovak republics, the Baltics, Hungary and Slovenia.

<sup>8</sup>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.

efit from higher GDP per capita.

We finally estimate the impact of the ECF on GDP per capita, i.e  $y_A$  and  $y_{AA}$  from condition (11), in order to check the existence of a solution to our optimization problem (P). Referring to the literature dealing with the European cohesion policy, we study the ECF's conditional impact on GDP per capita. As Ederveen et al. (2006), Becker (2012), Rodríguez-Pose & Garcilazo (2015), Crescenzi & Giua (2016), these conditioned factors correspond to quality of institutions and government.

Moreover, we consider macroeconomic management conditions as in Tomova et al. (2013). We put an emphasis on public debt because of the crowding-out effect that may rise from an excessive public debt level regarding the ECF's ability to promote economic growth. As a matter of fact, high public debt could be harmful to the ECF's economic performance because of the *additionality principle*. This rule related to EU cohesion policy make ECF recipient country's managing authority 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 arising with a high initial national debt level. In other words, countries respecting the SGP should be those where SF are the most efficient. Note that the EU condemns slack budget discipline since European transfers could be suspended following an excessive deficit procedure that can be launched by the European Commission.<sup>9</sup> We therefore expect that high public debt levels will be detrimental to the ECF's marginal effect on GDP per capita.

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, quality of institutions and government. The following section deals with the specification of the growth equation.

## 4.2 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).<sup>10</sup>

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<sup>9</sup>Member States which run excessive budget deficits of more than 3% of GDP, or which fail to reduce 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*.

<sup>10</sup>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.

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 ( $Debt_{i,t}^2$ ) to capture a non linear effect *à la Reinhart and Rogoff (2010)*. We also include human capital ( $Human_{i,t}$ ). We finally control for the effects of the other EU funds through a single variable ( $EUfunds_{i,t}$ ) aggregating the ERDF, EAFRD and the ESF. We hence consider the following baseline model:

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

In Model (1),  $X_{i,t}$  includes ( $Geo_i$ ,  $Socialism_i$ ,  $Efreedom_{i,t}$ ,  $Debt_{i,t}$ ,  $Debt_{i,t}^2$ ,  $EUfunds_{i,t}$ ) 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). We also fit with Ederveen et al. (2006), Becker (2012), Rodríguez-Pose & Garcilazo (2015) and Crescenzi & Giua (2016) by estimating the role of institutional quality and quality of government 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 government effectiveness index ( $Government_{i,t}$ ) as a proxy of quality of government.<sup>11</sup>

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). Two sets of regressors are considered: (i) strictly exogenous 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 ( $Inflation_{i,t}$ ), economic freedom ( $Efreedom_{i,t}$ ), corruption ( $Corruption_{i,t}$ ), government Effectiveness ( $Government_{i,t}$ ), ECF transfers ( $A_{i,t}$ ) and the remaining European funds ( $EUfunds_{i,t}$ ).

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<sup>11</sup>Those two interactions are not estimated simultaneously because of multicollinearity issues.

### 4.3 Data and variables

Table A1 in Appendix summarizes the variables we use in the estimation of our growth equation. The data are an unbalanced panel data sample covering 15 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.<sup>12</sup> Descriptive statistics of variables are provided in Table 1.

Table 1: Descriptive statistics

Variable	Obs	Mean	Std. Dev.	Min.	Max.
GDP per capita (log) ( $y_{i,t}$ )	85	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 ( $Debt_{i,t}$ )	85	0.479	0.308	0.049	1.720
Debt squared ( $Debt_{i,t}^2$ )	85	0.324	0.439	0.002	2.960
Inflation ( $Inflation_{i,t}$ )	85	0.094	0.348	0.007	3.152
Heritage 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
Government Effectiveness ( $Government_{i,t}$ )	85	0.754	0.460	-0.428	1.805
Geographical Location ( $Geo_i$ )	85	0.529	0.502	0.000	1.000
Socialist Experience ( $Socialism_i$ )	85	0.647	0.481	0.000	1.000
Workforce Tertiary Education ( $Human_{i,t}$ )	85	0.526	0.194	0.171	1.117
ECF (log) ( $A_{i,t}$ )	85	3.408	1.400	0.432	5.354
EU funds (log) ( $EUfunds_{i,t}$ )	85	4.959	1.147	0.888	6.194
Period 1995-1998	85	0.167	0.375	0.000	1.000
Period 1999-2002	85	0.167	0.375	0.000	1.000
Period 2003-2006	85	0.167	0.375	0.000	1.000
Period 2007-2010	85	0.167	0.375	0.000	1.000
Period 2011-2014	85	0.167	0.375	0.000	1.000

### 4.4 Estimation results

Our analysis shows that Arellano-Bond tests in the regressions residuals, AR(1) and AR(2), the Sargan and Hansen overidentifying restrictions tests and tests for exogeneity are generally verified. Our dynamic panel data is unbalanced with more individual dimensions than time dimension ( $T=5$  and  $N=15$ ). 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) with the measure of Economic Freedom from Heritage Foundation.

We also do estimation with Fraser Institute’s measure of Economic Freedom and its 5 sub-areas (government size, sound monetary policy, regulation, legal system, and trade).

<sup>12</sup>The estimations of the paper are based on the periods 1995-1998, 1999-2002, 2003-2006, 2007-2010, and 2011-2014.

Analyses using Fraser Index on Economic Freedom are reported in Appendix. Table A2 provides definition of Fraser Institute’s measure of Economic Freedom, Table A3 presents its descriptive statistics and Table A4 provides growth equation’s estimations using this index. Figure A1 indicates indeed that the both measures of Economic Freedom are strongly correlated. We also observe that because the five Fraser sub-area indexes encompass some economic and policy variables (e.g. government size vs debt, sound monetary policy vs inflation, legal system and regulation vs corruption), the latter were excluded from the corresponding regressions. Results using those two different measures of Economic Freedom are quite similar. In particular, the effect of Fraser Institute’s general Economic Freedom index is positive like the Heritage counterpart (even it is not statistically significant). While the regressions with Fraser sub-area indexes give an additional information that three of the five dimensions of economic freedom (sound monetary policy, regulation, and trade) can have an impact on growth, their interactions with ECF remain similar to the case with Heritage index.

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 significance of the lagged term of GDP per capita gives strength to the use of system GMM. 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 all models, which is 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. In addition, we also observe that other European funds (variable EU funds per capita) do not directly exert a significant effect on GDP per capita of recipient countries (except a negative weakly significant effect in model 3a). Similar results have been founded by previous studies such as Rodríguez-Pose & Fratesi (2004), Dall’Erba & Le Gallo (2008), Le Gallo et al. (2011), Fratesi & Perucca (2014). Moreover, this variable includes the European Agricultural Fund for Rural Development whose specific impact on economic growth has been found insignificant by Crescenzi & Giua (2016). We could mention as well that the European Social Fund included in this variable aims to finance essentially social expenditures that are not productive in the sense of Barro (1990).

Let us now turn to the analysis of the ECF’s estimation results. They indicate that the ECF’s impact is purely conditional as the direct term is insignificant. 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 government effectiveness do not exhibit any significance, which goes against studies like Ederveen et al. (2006). Instead of institutional quality, the impact of the ECF on GDP per capita appears to be conditioned to public debt and inflation as it is indicated by models (2), (3a) and (3b). For instance, from Model (2), the marginal effect of the ECF

on GDP per capita can be expressed as:

$$\frac{\partial y_{i,t}}{\partial A_{i,t}} = -0.473I_{i,t} + 0.367D_{i,t} - 0.316D_{i,t}^2. \quad (13)$$

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 61.36% of GDP.<sup>13</sup> 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 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.<sup>14</sup>

## 5 Simulation of the optimal allocation of ECF

### 5.1 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  $\lambda$  (equation (8)) is rewritten as:

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

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  $\sigma$  which indicates to what extent the donor is adverse to low relative GDP per capita. We consider three cases: (i)  $\sigma = 0.2$ , (ii)  $\sigma = 0.5$ , and (iii)  $\sigma = 0.8$ . A higher value of  $\sigma$  means that the donor is more sensitive to the ratio  $y_i/0.9\bar{y}$  between recipients countries' GDP per capita and the average

<sup>13</sup>Estimation results of Model (3a) indicate a rather similar number, 60.93% of GDP.

<sup>14</sup>Table 4 indicates that the marginal impact of the ECF is even negative in countries where public debt is very high such as Greece and Portugal.



Table 2: Growth equation estimation results.

Variables	Model 1	Model 2	Model 3a	Model 3b
Lagged GDP per capita(log)	0.556*** (0.147)	0.660*** (0.123)	0.690*** (0.122)	0.626*** (0.129)
Human capital	0.077 (0.182)	-0.028 (0.147)	0.039 (0.135)	-0.081 (0.137)
Debt	0.347* (0.175)	1.492** (0.564)	1.634*** (0.534)	1.599* (0.794)
Debt squared	-0.141 (0.089)	-1.348*** (0.346)	-1.399*** (0.333)	-1.431*** (0.482)
Economic Freedom	0.021*** (0.005)	0.013*** (0.004)	0.013*** (0.004)	0.015*** (0.005)
Geo. location	0.073* (0.037)	0.032 (0.035)	0.040 (0.041)	0.028 (0.043)
Socialist experience	-0.009 (0.080)	0.016 (0.054)	0.002 (0.073)	0.040 (0.075)
ECF per capita (log)	0.011 (0.024)	-0.058 (0.042)	-0.061 (0.042)	-0.081 (0.075)
EU funds per capita (log)	-0.044 (0.033)	-0.023 (0.017)	-0.043* (0.024)	-0.019 (0.022)
Period 1999-2002	0.090 (0.077)	0.139** (0.062)	0.147* (0.080)	0.132 (0.081)
Period 2003-2006	0.034 (0.067)	0.095* (0.049)	0.093 (0.063)	0.097 (0.065)
Period 2007-2010	0.057 (0.055)	0.121*** (0.040)	0.113** (0.050)	0.128** (0.055)
Period 2011-2014	-0.077** (0.029)	-0.028 (0.031)	-0.036 (0.036)	-0.017 (0.039)
ECF*Inflation		-0.473*** (0.106)	-0.432** (0.166)	-0.430** (0.178)
ECF*Debt		0.367** (0.131)	0.416*** (0.134)	0.407* (0.199)
ECF*Debt squared		-0.316*** (0.079)	-0.339*** (0.080)	-0.334** (0.116)
ECF*Corruption			-0.007 (0.007)	
ECF*Gov. Effect.				0.003 (0.010)
Intercept	3.147** (1.253)	3.023*** (1.035)	2.749** (1.072)	3.241** (1.130)
Observations	85	85	85	85
Arellano-Bond AR(1), p-value	0.070*	0.045**	0.053*	0.038**
Arellano-Bond AR(2), p-value	0.350	0.308	0.171	0.258
Sargan overid. restr. test, p-value	0.034**	0.012**	0.011**	0.042**
Hansen overid. restr. test, p-value	1	1	1	1
Hansen GMM instr. test, p-value	1	1	1	1

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, government effectiveness, inflation, EU funds, ECF transfers and lagged GDP per capita.

level of GDP per capita in the EU countries. Empirical simulations of three ECF optimal allocations are provided in Table 3.

Table 3: Observed and optimal ECF allocations with  $\sigma = 0.2$ ,  $\sigma = 0.5$  and  $\sigma = 0.8$ .

Country	Observed		Optimal $\sigma = 0.2$		Optimal $\sigma = 0.5$		Optimal $\sigma = 0.8$	
	ECF/cap	% Total	ECF/cap	% Total	ECF/cap	% Total	ECF/cap	% Total
Bulgaria	53.32	3.55	36.41	2.42	49.48	3.29	50.83	3.38
Croatia	102.38	3.99	35.54	1.39	45.65	1.79	55.71	2.18
Czech Republic	99.70	9.75	3.03	0.30	5.74	0.56	1.15	0.11
Estonia	173.95	2.12	4.89	1.21	0.66	0.01	2.36	0.02
Greece	50.33	5.05	0.48	0.00	5.72	0.58	51.99	5.21
Hungary	102.90	9.39	27.04	2.47	48.07	4.38	92.28	8.41
Latvia	114.68	2.10	1.43	0.03	0.25	0.01	3.42	0.06
Lithuania	118.56	3.19	0.01	0.00	0.42	0.01	0.37	0.01
Malta	79.88	0.32	0.04	0.00	0.04	0.00	1.24	0.00
Poland	102.67	36.15	224.31	79.00	192.64	67.82	150.02	52.82
Portugal	46.34	4.45	0.01	0.00	0.06	0.01	0.01	0.00
Romania	62.72	11.52	75.29	13.83	114.36	21.01	146.60	26.94
Slovenia	72.71	1.39	28.49	0.55	33.41	0.64	36.41	0.70
Slovak Republic	131.71	0.83	0.79	0.04	0.07	0.00	1.90	0.10
Cyprus	38.99	0.42	0.06	0.00	1.64	0.02	4.91	0.05
Average marginal eff.	0.058		0.091		0.087		0.066	

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.

Poland beneficiates from the largest increase of its ECF transfers and becomes the main recipient country in three optimal allocations with 79% of total funds when  $\sigma = 0.2$ , 67.82% of total funds when  $\sigma = 0.5$ , and 52.82% when  $\sigma = 0.8$ . As well, Romania is better off: this country stands for 13.83% of the total allocation when  $\sigma = 0.2$ , 21.01% when  $\sigma = 0.5$  and 26.94% when  $\sigma = 0.8$ . Both Poland and Romania concentrate the great majority of ECF transfers with a cumulated share above 80%. Greece beneficiates from our optimality principle with an optimal ECF transfers higher than the observed one when  $\sigma = 0.8$ .<sup>15</sup> The 12 remaining recipient countries see their transfers being reduced and, in total, concentrate less than 20% of total transfers in both optimal allocations.<sup>16</sup> 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 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

<sup>15</sup>Greece beneficiates from 5.21% of the optimal allocation with  $\sigma = 0.8$ , while its share in the observed allocation is 5.05%

<sup>16</sup>This cumulated share is 7.17% with  $\sigma = 0.2$ , 10.59 % with  $\sigma = 0.5$ , and 15.03% with  $\sigma = 0.8$ .

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

	Marginal efficiency (%)	Relative GDP per capita (%)	Population share (%)
Bulgaria	0.067	47.8	5.75
Croatia	0.077	58.3	3.38
Czech Republic	0.088	85.9	8.45
Estonia	0.020	77.4	1.05
Greece	-0.336	67.8	8.70
Hungary	0.083	70.3	7.88
Latvia	0.084	64.7	1.58
Lithuania	0.089	75.7	2.33
Malta	0.098	96.2	0.35
Poland	0.094	71.0	30.42
Portugal	-0.059	74.6	8.28
Romania	0.082	57.7	15.88
Slovenia	0.080	81.5	1.65
Slovak Republic	0.095	79.5	4.34
Cyprus	0.023	85.8	0.93
Average		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  $\alpha_i$  in equation (14).

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 0.094% and 0.082%, respectively. Among recipient countries, Poland is one of countries 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 61.36% 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 0.336% because of a skyrocketing 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 a high ECF economic performance.

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  $\alpha_i$ , 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  $\sigma$  is risen from 0.2 to 0.5 and to 0.8, ECF transfers directed towards Hungary, Greece, Croatia, Romania, and Bulgaria are sharply increased (Table 3). Those countries respectively have the tenth, eleventh, thirteenth, fourteenth and fifteenth GDP per capita of our sample which means that they are among the poorest ECF recipient countries (Table 4). The cases of Hungary, Greece and Romania are striking: these countries see their ECF transfers increasing considerably with  $\sigma$ . For instance, the optimal ECF transfers to Greece moves from 0% when when  $\sigma = 0.2$  to 5.21% when  $\sigma = 0.8$  while ECF funds seem do not contribute to economic performance of this country. This result supports 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 0.091% increase of GDP per capita when  $\sigma = 0.2$ , a 0.087 increase of GDP per capita when  $\sigma = 0.5$  and 0.066% when  $\sigma = 0.8$  which is more than the 0.058% of the observed allocation. These results are driven by the good performances of Poland and Romania. The lower performance of the optimal allocations with  $\sigma = 0.5$  and  $\sigma = 0.8$  is mainly due to a larger share directed towards Greece which drags down the overall economic performance of the ECF.

As it has been underlined, the ECF’s observed allocation is very different from the optimal allocation we have computed. This may be as well related to some issues dealing with the political economy of the European Cohesion policy highlighted in the works of Rodden (2002), Wonka (2007), Gehring & Schneider (2018). Rodden (2002) stated that “empirical analysis demonstrates a close connection between the distribution of votes and fiscal transfers in the legislative institutions of the European Union.” Given that small countries’ electoral weight in the European Parliament is higher than their actual demographic weight, this helps explaining why we notice a *small country bias* in the observed allocation while the optimal allocations remove this bias by taking into account the real demographic weight of each recipient countries. One another political economy issue is related to an assumption made about the donor’s behaviour. Indeed, in our theoretical model, we have assumed that the donor is purely altruistic, which may not be the case in reality. Wonka (2007) suggested a principal-agent structure, where governments select reliable actors who are expected to take national interests into account at the EU-level. Gehring & Schneider (2018) stressed this idea as they demonstrated that the nationalities

of EU Commissioners influence budget allocation decisions in favor of their country of origin. They focused on the Commissioners for Agriculture and, on average, providing the Commissioner causes a 1 percentage point increase in a country's share of the overall EU budget, which corresponds to 850 million euros per year. This issue would constitute an interesting topic for our further investigation.

## 6 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. Both these countries 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 explicitly mentioned 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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## 7 Appendix



Table A1: Data and variables definition.

Variable name	Definition	Unit	Source
GDP per capita ( $y_{i,t}$ )	GDP per capita of the last period (4 years ago)	PPP 2011\$	World Bank
Lagged GDP per capita ( $y_{i,t-1}$ )		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 ( $Geo_{i,t}$ )	Be a neighbour of a EU-15 country	Dummy variable	
Socialist Experience ( $Socialism_{i,t}$ )	Length under a socialist government 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 ( $E.freedom_{i,t}$ )	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 ( $A_{i,t}$ )	Level of European Cohesion Fund (ECF) transfers	PPP 2011\$	European Commission
EU funds per capita ( $EU.funds_{i,t}$ )	Sum of European Regional Development Fund (ERDF), European Social Fund (ESF) and European Agricultural Fund for Rural Development (EAFRD) transfers	PPP 2011\$	European Commission

Table A2: Measure of Economic Freedom and different components of Economic Freedom from the Fraser Institute

Variable name	Definition	Unit	Source
Economic Freedom ( <i>Fraser</i> )	Government size, sound monetary policy, level of regulation, quality of legal system, freedom to trade	Score between 0 and 10 (best score)	Fraser Foundation
Size of government ( <i>Size gov. Fraser</i> )	Government consumption, transfers and subsidies, government enterprises and investment, top marginal income tax rate, top marginal income and payroll tax rate	Score between 0 and 10 (best score)	Fraser Foundation
Sound monetary policy ( <i>Sound monetary Fraser</i> )	Money growth, standard deviation of inflation, inflation of the most recent year, freedom to own foreign currency bank account	Score between 0 and 10 (best score)	Fraser Foundation
Legal system and property rights ( <i>Legal system Fraser</i> )	Judicial independence, impartial courts, protection of property rights, military interference in Rule of Law and politics, integrity of the legal system, legal enforcement of contracts, regulatory restrictions on the sale of real property, reliability of police, business costs of crime	Score between 0 and 10 (best score)	Fraser Foundation
Level of regulation ( <i>Regulation Fraser</i> )	Credit market regulations, labor market regulation, business regulations	Score between 0 and 10 (best score)	Fraser Foundation
Freedom to trade ( <i>Trade Fraser</i> )	Tariffs, regulatory trade barriers, Black market exchange rates, controls of the movement of capital and people	Score between 0 and 10 (best score)	Fraser Foundation

Notes: This table displays measure of Economic Freedom from Fraser Institute. This index includes 5 components: Size of Government, Sound Monetary Policy, Legal System and Property Rights, Regulation and Freedom to Trade.

Table A3: Descriptive statistics on Fraser Indicators.

Variable	Obs	Mean	Std. Dev.	Min.	Max.
Fraser Index of Economic Freedom	85	7.560	1.566	0.734	9.781
Size of government Fraser	85	5.549	1.118	1.463	7.298
Sound monetary Fraser	85	6.278	0.744	4.798	7.965
Legal system Fraser	85	8.225	2.084	0.735	9.781
Regulation Fraser	85	6.790	0.942	3.741	8.125
Trade Fraser	85	7.974	0.558	6.036	9.727

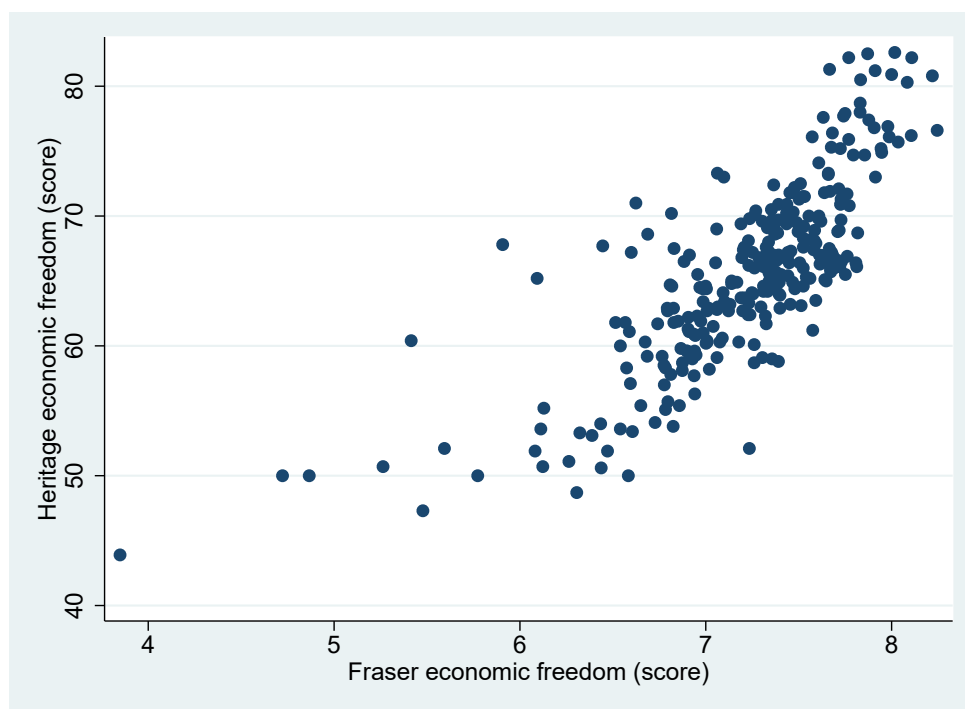


Figure A1: Heritage and Fraser economic freedom indexes (Correlation: 0.779).

Table A4: Growth estimation results using the Fraser foundation's index of economic freedom.

Variables	Model I	Model II	Model III	Model IV	Model V	Model VI
Lagged GDP per capita (log)	0.921*** (0.085)	0.893*** (0.076)	0.786*** (0.084)	0.877*** (0.107)	0.796*** (0.081)	0.782*** (0.099)
Human capital	-0.080 (0.111)	-0.011 (0.115)	-0.005 (0.080)	-0.106 (0.100)	0.068 (0.089)	0.025 (0.092)
Debt			1.977*** (0.490)	1.857*** (0.554)	-0.955 (0.737)	1.364* (0.664)
Debt squared			-1.459*** (0.291)	-1.557*** (0.360)	0.947* (0.465)	-1.181*** (0.400)
Geo. location	-0.018 (0.026)	0.011 (0.028)	0.031 (0.043)	0.003 (0.040)	0.000 (0.030)	0.027 (0.040)
Socialist experience	0.087* (0.050)	0.110* (0.053)	0.010 (0.052)	0.031 (0.057)	-0.008 (0.048)	0.011 (0.050)
ECF per capita	0.127 (0.108)	0.003 (0.075)	0.080 (0.097)	0.020 (0.170)	0.194 (0.216)	0.360 (0.239)
EU funds per capita	0.018 (0.026)	0.021 (0.031)	-0.059* (0.028)	-0.011 (0.023)	-0.021 (0.018)	-0.053* (0.029)
Period 1999-2002	0.138* (0.076)	0.181** (0.072)	0.041 (0.072)	0.139* (0.078)	0.259*** (0.053)	0.097 (0.070)
Period 2003-2006	0.100 (0.058)	0.108 (0.066)	0.042 (0.064)	0.096 (0.057)	0.172*** (0.046)	0.045 (0.061)
Period 2007-2010	0.110** (0.046)	0.101 (0.059)	0.034 (0.048)	0.118** (0.041)	0.175*** (0.042)	0.084** (0.038)
Period 2011-2014	-0.102** (0.036)	-0.092* (0.049)	-0.113*** (0.030)	-0.064** (0.029)	-0.022 (0.032)	-0.055* (0.028)
ECF*Inflation		-0.148 (0.261)			-0.481*** (0.125)	-0.474*** (0.147)
ECF*Debt			0.437*** (0.116)	0.383*** (0.128)	0.224 (0.151)	0.306* (0.148)
ECF*Debt squared			-0.331*** (0.067)	-0.340*** (0.084)	-0.223** (0.097)	-0.275*** (0.088)
ECF*Corruption		0.014 (0.010)	-0.000 (0.008)			-0.001 (0.009)
Fraser	0.079 (0.058)					
ECF*Fraser	-0.019 (0.015)					
Size gov. Fraser		0.076 (0.080)				
ECF* Size gov. Fraser		-0.007 (0.017)				
Sound monetary Fraser			0.171*** (0.039)			
ECF* Sound monetary Fraser			-0.025** (0.010)			
Fraser legal system				0.046 (0.075)		
ECF* Fraser legal system				-0.010 (0.017)		
Regulation Fraser					0.195* (0.098)	
ECF* Regulation Fraser					-0.028 (0.023)	
Trade Fraser						0.284** (0.102)
ECF*Trade Fraser						-0.047* (0.024)
Constant	0.264 (1.125)	0.676 (0.965)	1.862** (0.851)	1.421 (1.341)	0.860 (1.179)	0.385 (1.143)
Observations	85	85	85	85	85	85
Arellano-Bond AR(1), p-value	0.044**	0.081*	0.036**	0.009***	0.013**	0.032**
Arellano-Bond AR(2), p-value	0.087*	0.070*	0.136	0.403	0.457	0.163
Sargan overid. restr. test, p-value	0.018**	0.016**	0.021**	0.004***	0.069*	0.001***
Hansen overid. restr. test, p-value	1	1	1	1	1	1
Hansen GMM instr. test, p-value	1	1	25	1	1	1

Notes: \*, \*\* and \*\*\* denote 10%, 5% and 1% significance levels. In model II using the component "Size of government", Public Debt is dropped. In model III using the component "Sound monetary policy Fraser", Inflation is dropped.