Regional inequalities, economic crises and policies: An international panel analysis

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Abstract

This paper examines the effects of economic downturns on regional inequalities. In a sample of 25 OECD countries for 1990-2014 period, we show that economic downturns are associated with a significant and long-lasting reduction in regional inequalities. Expansionary fiscal policy as well as higher share of the European development (cohesion) funds facilitate the response of lagging regions to negative nation-wide shocks, contributing to further stimulate the reduction in regional disparities. Additional evidence suggests that the effect of downturns tends to be larger in economies with a higher initial level of regional disparities in unemployment and human capital endowment.

Keywords: crises, economic downturns, fiscal policy, European cohesion funds, regional disparities, resilience.

JEL classification: E32, O40, R11, R12.

1. INTRODUCTION

Regional disparities in output within countries have increased substantially in OECD economies. The average OECD economy has seen a trend rise in regional inequality (as captured by the standard deviation of real per-capita GDP) by about 35 percent since the early 1990s.

Beyond the direct social welfare and equity consequences of this rising trend, there is growing evidence that regional inequality may have important implications for economic outcomes. Although a certain level of regional inequality may be associated with higher levels of growth due to agglomeration forces, high inequality may reflect a decline of internal factor mobility (Ganong and Shoag 2017) and be a limiting factor for long-run growth (Ezcurra 2009). Recent politics and new evidence (see Iammarino et al. 2019 and references cited therein) further rooted regional inequality in the policy debate.[1] Recent studies suggest that higher within-country regional inequality can lead to lower social trust and increasing political polarization and support for more populist policies at the national level (Algan and Cahuc 2014; Guriev 2018).

The COVID-19 pandemic has also generated concern about the future evolution of regional inequality. The first EU-wide Annual Regional and Local Barometer (2020)—produced by the European Committee of the Regions—warns that the COVID-19 crisis is negatively impacting sub-national authorities' revenues and health systems with the risk of increasing regional disparities.

While several factors have been proposed in the literature as drivers of persistent income disparities (Gennaioli et al. 2014, and references cited therein), the global recession has brought the role of nation-wide recessions and regional resilience to the forefront. Regions may have different exposure to such common shocks which in turn may be compounded by differences in regional adjustment mechanisms.

Alongside this, over the past decades there has been an intense debate in the literature about the long-term relationship between growth and regional disparities, but little consensus has been reached regarding the sign of this relationship both from theoretical and empirical points of view. The seminal paper by Solow (1956)—and other studies using a neoclassical framework (i.e. Alesina and Rodrick, 1994; Benhabib and Rustichini, 1996)—argue that growth is positively associated with a reduction in regional disparities due to diminishing returns to

[1] See also the following VoxEU columns: https://voxeu.org/article/regional-inequality-europe; https://voxeu.org/article/monetary-policy-and-regional-inequality.

capital. Within the neoclassical framework (diminishing return to capital and exogenous technical progress), economies converge towards their steady states at a declining growth rate. If economies have technological homogeneity and identical preferences, market forces will lead to absolute convergence (economies will converge towards the same steady-state). Otherwise, if economies are heterogeneous, there will be only conditional convergence (economies will converge towards different steady-states). On the contrary, other studies (e.g. Myrdal, 1957; Kaldor, 1970) suggest that economic growth tends to increase regional inequality since growth is a spatially selective and cumulative process.[2]

The empirical evidence on this point is also mixed. Since the seminal paper by Williamson (1965) who find an inverted-U shaped relationship between regional inequalities and national development, a large body of the literature has analyzed the relationship between regional disparities and growth. Barrios and Strobl (2009) confirm the evidence of a bell-shaped relationship between regional inequalities and national development for several European economies. Barro and Sala-i-Martin (1991), and Sala-i-Martin (1996) find convergence across regions, while others find mixed results depending on the period of analysis, the methodology adopted and the outcome variable (e.g., Giannetti 2002; Magrini et al. 2015; Peiró-Palomino 2019).

Following the Great Recession, there has been an intensification of research on economic resilience (see, among the others, Martin, 2012; Martin and Sunley, 2015). At the regional level, studies have mainly investigated the ability of regions to withstand and recover from the 2008-crisis and have tried to identify key factors affecting economic resilience such as sectoral composition, urbanization levels, and territorial capital endowment (Đokic et al., 2016; Garcilazo and Oliveira Martins, 2015; Mazzola et al., 2017; Lo Cascio et al., 2018). How regions respond to shocks may be linked to the issues of long-run growth and hence to the convergence or divergence pattern of regional incomes per capita (Fingleton et al., 2012).

From a policy point of view, national macroeconomic decisions—including fiscal policy—may help regions differently during downturns. At the same time, regional policies may be used counter-cyclically during severe recessions (European Commission, 2017). Indeed, the growing regional disparity of GDP per-capita beginning in the 1980s has also stimulated the debate on the role of policies in offsetting this upward trend. Checherita et al.

[2] Space is a source of advantages due to the cumulative nature of productive processes. Spatial proximity generates economies that reduce production and transaction costs (Capello, 2010). Note that this explanation is also in line with the findings of the new economic geography theory (Krugman, 1991), and endogenous growth theory (Romer, 1986), that suggest a positive relationship between the process of regional integration and the degree of concentration of economic activity.

(2009) find that net fiscal transfers helped achieving regional redistribution, though weakening average growth. Similarly, Agnello et al. (2016) find that fiscal consolidations lead to an increase in regional disparities, particularly when packages are more severe and implemented through spending cuts rather than tax rises. Fiscal policy has also been found to play a larger stabilization role than regional labor mobility in adjusting to shocks in European countries compared to the USA and Canada (Obstfeld and Peri 1998; Furceri et al. 2020a).

In this context, the role of regional policy (i.e. through European development funds) in reducing regional disparities has been also debated and questioned. While the empirical evidence is mixed, it tends to suggest that development funds had helped the regional convergence process (Aiello and Pupo, 2012; Ederveen et al. 2003; and Cappelen et al. 2003).[3] In particular, Pellegrini et al. (2013), by using a regression discontinuity design show that the European Funds contributed to increase annual regional per-capita growth between 0.6 and 0.9 percent. The literature has also stressed the importance of regional policy effectiveness. For example, Arbolino et al. (2019) explore the relationship between Structural Funds payments and resilience in the crisis period (2007-2013) for Italy and find that differences in regional resilience are explained by the ability of regional policy makers to manage the European Union cohesion policy funds.

Against this background, this paper offers new empirical evidence on the impact of economic downturns on regional inequality. Our results suggest that economic downturns are typically associated with a significant and long-lasting *reduction* in regional inequality. This result is robust to several robustness checks and to an Instrumental Variable (IV) strategy, in which downturns in major trading partners are used as instruments. We also find that more expansionary fiscal policy and higher share of European development funds facilitate the response of lagging regions to nation-wide shocks, contributing to further reduce regional disparities especially in the period after the Great Recession.

While studies have looked into these issues, we improve upon previous research in several ways. First, unlike previous studies focusing mainly on regional disparities in single countries (or specific crises, i.e. the Great Recession), this paper tries to generalize the effect of several economic downturns analyzing a broad sample of 25 advanced countries for more than two decades. Second, we assess how the response of regional disparities to downturns varies before and after the global financial crisis in 2008, as well as whether it depends on the type of policy and initial regional conditions.

[3] Conversely, Boldrin and Canova (2001) and Dall'Erba and Le Gallo (2008) find a non-significant effect.

The paper contributes to three streams of the literature. The first is on regional resilience (see Martin and Gardiner, 2019; and Mazzola and Pizzuto, 2020; for a broad review of studies mainly focusing on single country frameworks, or specific crises) and on the relationship between growth and regional inequality (Williamson, 1965). The second is on the dynamic response of economic activity to downturns and crises that has mainly focused on national economies, often overlooking the spatial (uneven) impact of such exogenous shocks (e.g., Cerra and Saxena 2008, Furceri and Zdzienicka 2012a). The third is on the role of national (or supranational) policies in affecting regional disparities (see for example Furceri et al., 2019 for monetary policy; Gbohoui et al., 2019 for fiscal policy; and Arbolino et al., 2019 for cohesion policy).

The remainder of the paper is organized as follows. The next section describes the data and presents the methodology used in the empirical analysis. Sections 3 discusses the results and Section 4 concentrates on the specific role of policies and regional characteristics. Finally, Section 5 concludes and provides additional policy insights.

2. DATA AND METHODOLOGY

2.1. Data on regional inequality

Our main data source is the OECD Dataset on Regional Account. This dataset provides data on per-capita GDP, long-term unemployment rates, human capital endowments and fiscal policy variables for an unbalanced panel of 25 OECD countries (Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Japan, Mexico, The Netherlands, New Zealand, Norway, Poland, Portugal, Slovak Republic, Slovenia, Spain, Sweden, Switzerland, United Kingdom, United States) for the period 1990-2014. [4]

To measure regional inequality, we compute the standard deviation of per-capita GDP of NUTS 2 regions (in USD, constant prices, constant PPP, base year 2010). Figure 1 presents the evolution of regional inequality in each country over time starting from 1995. The figure shows that regional disparities have typically increased over the last two decades. The increase has been larger in Poland, Ireland, Australia and Slovak Republic. There are, however, some exceptions. In particular, the dispersion in per-capita GDP is lower in the last year considered with respect to the first in the Netherlands, Switzerland, Japan and Portugal.

[FIGURE 1]

[4] We complement the OECD data with the European Structural and Investment Funds data provided by the European Commission. For descriptive statistics see Table A1 in the Appendix.

2.2. Downturns

To classify downturns, we refer to the OECD Composite Leading Indicators database. This database provides information about business cycles and turning points based on the nonparametric dating algorithm early developed by Bry and Boschan (1971). This algorithm isolates local maxima (peaks) and minima (troughs) in the national GDP time series subject to certain censoring rules. Recessions are defined as periods from peaks to troughs and expansions as those from troughs to peaks. In detail, to classify downturns we construct a downturn dummy which takes values equal to one when a country experiences a downturn in a year, and zero otherwise.

Following this approach, we identify 88 downturn episodes in the period 1990-2014, of which 54 before 2008. Among these, we find the Nordic banking crisis of the early 1990s, the economic downturns of some European countries in early 2000s after the currency crisis of the European Monetary System, as well as the Great Recession (see Table A2 for details).

2.3. Methodology

We use two empirical specifications to examine the effect of economic downturns on regional inequality. The first consists of tracing-out the average response of regional inequality to major economic downturns. The second allows this response to vary across countries and regions according to structural and policy factors.

Specifically, the first specification follows the approach proposed by Jordà (2005) and is advocated, among others, by Stock and Watson (2007), Teulings and Zubanov (2014) and Abiad et al. (2015). This method allows the direct estimation of Impulse Response Functions (IRFs) based on local projections of the effect of downturns on regional inequalities and is particularly suited to assess the dynamic response of the variable of interest in the aftermath of a shock—such as a downturn.

In detail, in order to evaluate the impact of shocks on regional inequalities, we estimate the following equation for each future period *k*:

$$\sigma_{i,t+k} - \sigma_{i,t-1} = \alpha_i^k + \varphi_t^k + \beta^k D_{i,t} + \sum_{j=1}^{l} \gamma_i^k \Delta\sigma_{i,t-j} + \sum_{j=1}^{l} \rho_i^k D_{i,t-j} + \vartheta^k X_{i,t-1} + \varepsilon_{i,t}^k \quad (1)$$

for k = 0, 1, 2, 3, 4.

where:

σ_i is a measure of regional inequalities (the standard deviation of the regional real per-capita GDP) for country *i*; α_i represents country fixed effects, to control for unobservable country specific factors which may affect regional inequality; φ_t are time fixed effects, included to take account of global shocks, such as changes in oil prices or in the global business cycle; β measures the unconditional effect of economic downturns on regional inequality; $D_{i,t}$ is a dummy variable that takes value 1 for the occurrence of an economic downturn in country *i* in time *t*; γ_i captures the persistence in changes in regional inequalities; $\Delta\sigma_{i,t-j}$ are past changes in regional inequalities; since regional inequality is highly serially correlated, the inclusion of this variable allows to implicitly control for short-term factors affecting regional inequality that are potentially correlated with economic downturns; $D_{i,t-j}$ are lags of the downturn dummies to take into account serial correlations in our measure of shock; $X_{i,t-1}$ is the average regional real per-capita income to control for the economic size of each country.

Impulse response functions are obtained using the estimated coefficient β^k and the confidence intervals are computed based on the estimated standard errors of the same coefficients. Equation (1) is estimated for an unbalanced panel of 25 economies over the period 1990-2007 and for the period 1990-2014—to shed light on the role played by the Great Recession.

The second specification examines the role of policies (both macroeconomic and regional) in shaping the response of regional disparities to economic downturns. In particular, following the approach proposed by Auerbach and Gorodnichenko (2013), we extend the baseline specification as follows:

$$\sigma_{i,t+k} - \sigma_{i,t-1} = \alpha_i^k + \varphi_i^k + \beta_1^k G(z_{i,t}) D_{i,t} + \beta_2^k (1 - G(z_{i,t})) D_{i,t} + \sum_{j=1}^{l} \gamma_i^k \Delta\sigma_{i,t-j} + \\ + \sum_{j=1}^{l} \rho_i^k D_{i,t-j} + \vartheta^k X_{i,t-1} + \varepsilon_{i,t}^k \qquad (2)$$

in which *z* is an indicator of policy, normalized to have zero mean and unit variance, and $G(z_{i,t})$ is the corresponding smooth transition function:

$$G(z_{i,t}) = \frac{\exp(-\gamma z_{i,t})}{1+\exp(-\gamma z_{i,t})}, \quad \gamma > 0 \qquad (3)$$

This approach is equivalent to the smooth transition autoregressive model developed by Granger and Terävistra (1993). The advantage of this approach is twofold. First, compared to a model in which each dependent variable would be interacted with a measure of policy (or

regional condition), it permits a direct test of whether the effect of downturns varies across different regimes. Second, compared to estimating structural vector autoregressions for each regime, it allows the effect of downturns to change smoothly between regimes by considering a continuum of states to compute the impulse response functions, thus making the response more stable and precise. Specifically, β_1^k is the coefficient in the case of low regime of the considered variable (that is, when z goes to minus infinity) and β_2^k is the coefficient in the case of high values of the state variable (that is, when z goes to plus infinity). In both specifications, confidence bands are computed using standard errors clustered at the country level.

3. BASELINE RESULTS AND SPECIFICATION ISSUES

3.1. Baseline

Table 1 presents the results from estimating the impact of economic downturns on regional inequality using equation (1) for the period 1990-2007. It shows, for each period (column) k, the response of regional income dispersion to economic downturns. Looking at the table, it is immediately apparent that economic downturns have a negative, statistically significant and long-lasting effect on regional disparities.

[TABLE 1]

In particular, we find that a downturn is associated with a reduction in inequality of about 2 percent over the medium-term—that is, four years after the downturn—with a peak effect of 3 percent the year just after the downturn. The effect is also economically significant since it corresponds to approximately ½ standard deviation of the average change of regional inequality in the sample. The results are in in line with previous studies reporting a pro-cyclical behavior of regional disparities (see section 1).[5] They are also robust to alternative measures of regional disparities—such as the coefficient of variation (both unweighted and weighted for the population), the Theil index and the Gini index (Table 2).

[TABLE 2]

[5] The results presented in Table A3 in the Appendix suggest that when differentiating between severe downturns (identified as those downturns with annual growth rates below the first quartile of the distribution of annual growth rates) and moderate downturns (all the others), the reducing effects of the former on regional inequality tend to be larger and longer lasting.

Note that while regional disparities are quite persistent in our sample of countries investigated, our results show that conditional on the initial level of regional disparities, recessions tend to foster convergence (see also Table A5)—that is, recessions, on average, have a direct effect on regional inequality that is not mediated through structural impediment affecting the persistence in regional disparities.[6] This evidence is also confirmed when further controlling in our specification for differences in some dimensions that can represent structural impediments to convergence—such as human capital endowment and long-term unemployment rates (Tables A6 and A7).

Overall, our results are consistent with those of several studies (i.e. Helbling and Bayoumi, 2003; Antonakakis, 2012; Duval et al. 2014; Furceri et al. 2020a) on Business Cycle Synchronization (BCS) that suggest an increase in BCS during recessions. For regional economies a possible explanation is that expansion cycles begin in advanced central regions where the interaction of agglomeration effects and market size provides an advantage over other regions (Petrakos and Psycharis 2015). Hence, periods of economic growth tend to be associated with increasing spatial disparities (and lower BCS), due to the better position of the leading regions which capture the opportunities generated by an expanding economy. On the contrary, during nation-wide downturns both leading and lagging regions tend to be exposed to demand and supply contractions—with negative effects being potentially larger in the former due to the higher market size, economic integration and exposure to the international markets. This will increase BCS and eventually reduce regional disparities. Our results are also in line with those of Rodríguez-Pose and Fratesi (2007) who find pro-cyclical patterns in the evolution of regional disparities in selected European countries. Their results suggest a relationship between these pro-cyclical patterns and the emergence of less dynamic "sheltered economies" among peripheral regions.

3.2. Robustness checks

Controlling for outliers

Since it is possible that the results may be sensitive to the presence of countries with extremely high/low levels of inequality and outliers, we repeat our estimates by performing two exercises. First, we drop from the sample those countries with the lowest and the highest

[6] The estimates of the standard deviation on its own lags, suggest that the standard deviation is an AR(1) process with autocorrelation coefficients equal to 0.8 for the first lag and about 0 for the second lag (see Table A4). This persistence can reflect structural impediments to convergence.

level of average regional income inequality (New Zealand and Belgium, respectively). Second, we estimate the baseline model by sequentially dropping from the sample one country at a time. The results presented in Table A8 in the Appendix are broadly consistent with the baseline results presented in Table 1, denoting the robustness of our main findings.

Controlling for additional variables affecting regional inequality

We further check the robustness of the results by including additional control variables in the regression. Particularly, following Bouvet (2010) we include in the analysis, in turn, the share of employed in Agriculture, the share of employed in Industry, the share of national population under 15 years old, the share of national population 65 years old and over, and the share of foreign population (in % of total population). The results are reported in Table A9 in the Appendix, and are very similar to, and not statistically different from, the baseline. [7]

The pro-cyclical behavior of regional inequality

Regional disparities may also respond differently to expansions and recessions. To test for this hypothesis, we perform two exercises. First, we estimate equation (1) considering GDP growth instead of downturn dummies. Table 3 show that the pro-cyclical behavior of regional inequality suggested by the previous results also holds in this case.

[TABLE 3]

Second, we estimate the following equation to capture the magnitude of the effects in the different phases of the business cycle:

$$\sigma_{i,t+k} - \sigma_{i,t-1} = \alpha_i^k + \varphi_t^k + (C_{i,t})[\beta^k growth_{i,t} + \sum_{j=1}^{l} \rho_i^k growth_{i,t-j}] + (1 - C_{i,t})[\beta^k growth_{i,t} + \sum_{j=1}^{l} \rho_i^k growth_{i,t-j}] + \sum_{j=1}^{l} \gamma_i^k \Delta\sigma_{i,t-j} + \vartheta^k X_{i,t-1} + \varepsilon_{i,t}^k \quad (4)$$

[7] Another factor that may affect the response of regional inequality to economic downturns is price flexibility. Recent research (Furceri et al. 2020a) shows how price flexibility is more important as a labor demand shock absorber in countries belonging to the Euro Area with respect to U.S. states. However, past research on selected countries (Obstfeld and Peri, 1998) shows how intranational relative prices tend to fluctuate less than international relative prices. To the extent that the sensitivity of prices is different across regions, this may affect regional income inequality. Limited data availability on prices at the regional (NUTS 2) level prevented us to control also for this factor.

where $C_{i,t}$ is a dummy variable that takes value 1 in case of expansion periods (i.e. non-downturns) and 0 otherwise (i.e. downturns). The results in Table 4 confirm the pro-cyclical behavior of regional inequality in both recessions and expansions.

[TABLE 4]

3.3. Addressing endogeneity

A possible concern in estimating equation (1) with OLS is reverse causality—that is, the possibility that changes in regional inequality affect the occurrence of downturns. To test for this possibility, we estimate a Probit model which considers the probability of occurrence of an economic downturn as a function of past changes in regional disparities:

$$Prob(D_{it} = 1) = F(constant + \sum_{j=1}^{3} \beta_j \Delta\sigma_{i,t-j-1} + \sum_{j=1}^{3} \delta_j D_{i,t-j} + \omega_{it}) \quad (5)$$

where, $\Delta\sigma_{i,t-j}$ are past changes in regional inequalities and $D_{i,t-j}$ is the lagged dummy variable that identifies crises. The results, available upon request, suggest that the lagged value of changes in regional income dispersion does not explain the occurrence of economic downturns.

To further address endogeneity concerns, we adopt an IV approach, in which we instrument the occurrence of a downturn in an economy *i*, with contemporaneous downturns dummies in its major trading partners. The conjecture is that a country is more likely to experience a downturn when its main trading partners are also in recessions. Specifically, we computed the instrument as follows:

$$I_{i,t} = \sum_{j=1,.n\,(j\neq i)} D_{j,t}\, w_{i,j,t} \quad (6)$$

where $I_{i,t}$ is the instrument of the downturn dummy for country *i* at time *t*; $D_{j,t}$ is the downturn dummy (contemporaneous) for country *j* at time *t*; and $w_{i,j,t}$ is the share of total exports and imports between country *i* and country *j* in the total exports and imports for country *i*: $\frac{Export_{i,j,t}+Import_{i,j,t}}{Export_{i,t}+Import_{i,t}}$.

The first-stage estimates suggest that the instruments are statistically significant and exhibit the expected sign.[8] In addition, we can plausibly consider the instruments to be

[8] In particular, the estimation results are the following:

$$D_{i,t} = 0.637\, I_{i,t} + \varepsilon_{i,t}$$
(4.98)

with t-statistics in parentheses, and an F-statistics of 24.81—well above the Kleibergen–Paap-rk-Wald-F statistic of weak exogeneity. In addition, the Hansen J statistic *p*-value for overidentification suggests that we can consider

exogenous. For example, downturns in other countries are not related to regional inequality in a domestic economy and do not have any effect on the latter other than through increasing the occurrence of a downturn in the domestic economy. To further check whether our instrument satisfies the "exclusion restriction" we perform two additional exercises. First, we test whether the instrument have a direct effect on regional inequality by including it as additional control in the baseline model. Second, we also test directly the association of the baseline residuals and the instrument. If the coefficients turn out significant, one can reasonably argue that the instrument are part of the error term and thus, not satisfying the exclusion restriction. The results in Tables A10 and A11 in the Appendix suggest that such relationship is indistinguishable from zero which supports the excludability of the instrument.

The results that we obtain following the IV approach are similar to and not statistically different from the baseline—even though the point estimates are larger (Table 5). [9]

[TABLE 5]

3.4. The Great Recession

To assess the specific role of the Great Recession we re-estimated equation (1) for the period 1990-2014. The results suggest that the effect of downturns becomes less precisely estimated and typically not statistically significant (Table 6, panel a). A potential reason behind this result is that the inclusion of time fixed effects absorbs most of the shocks in the post-2008 period, given the global nature of the crisis. To check whether this is the case, we reproduced the estimation using country-specific time trends rather than time fixed effects. The findings of these analyses seem to confirm that the downturns are associated with a reduction in regional inequality (Table 6, panel b)—even though the effects are less precisely estimated than the baseline.[10] Two tentative explanations of this pattern may be suggested. First, lagging regions in developed countries have become much more interconnected with more advanced ones in recent years so that they have increasingly become less protected than before against global shocks. Second, during the Great Recession, national governments have carried out fiscal austerity policies which have damaged proportionally more less developed regions. The

these variables to be strongly exogenous. Finally, the estimates of the effects of these instruments on regional inequality are not statistically significant once we have controlled for downturn dummy in country *i*.

[9] As an additional exercise we re-estimated the IV model using the lag of our instrument, thus considering those downturns in trading partners which occurs just before the downturn in the national economy considered. The results presented in Table A12 in the Appendix, show very similar results to those presented in the text.

[10] To further shed lights on the role of the Great Recession, we estimate equation (1) using growth as regressor for the entire period 1990-2014. The results of the first exercise confirm the reduction of regional disparities in the aftermath of economic downturns over the whole period (1990-2014). However, once we distinguish between pre- and post-2008, results seem to weaken in the period following the Great Recession probably due to the heterogeneous behavior in the reaction to the crisis within each country.

interaction between policy decisions and downturns will be explored further in the following section.

[TABLE 6]

4. THE ROLE OF MACRO AND REGIONAL POLICIES

This section examines the role of macroeconomic and regional policies (fiscal policy and European development funds) in mediating the effect of nation-wide shocks to regional inequality. We also analyze how regional characteristics (such as the initial level of disparities in unemployment and human capital endowment) may affect the regional impact of shocks.

Policies

We first consider the role of fiscal policy (proxied by the change in primary balance) in affecting regional disparities in the aftermath of shocks. To test for this hypothesis, we estimate equation (2) both including and excluding the period following the Great Recession. The results of this exercise suggest that expansionary fiscal policy not only has a direct effect on regional inequality (Agnello et al. 2016) but also helps lagging regions to recover faster than leading regions following economic downturns (Table 7, panels a and c). In particular, the effects are statistically significant and larger than the average effect in countries with expansionary fiscal policy (the medium-term effect on regional inequality increases from -1.8 to about -4.5/-6.5 percent, depending on the period analyzed), while they are mostly positive (i.e. increasing regional inequality), though not significantly different from zero, for episodes associated with tightening fiscal policy. Notably, the effects are robust to the inclusion/exclusion of the post-2007 period. This result may help explain the weaker effect we find in the baseline estimation for the period after the Great Recession— which has been characterized by fiscal austerity in many countries.

Next, we analyze the role of regional policies by including in equation (2) the total payments pertaining to EU development funds (as a share of GDP). The results show that higher share of EU development funds (as a share of GDP) strengthen the reduction in regional inequality in the aftermath of economic downturns. The medium-term effect on regional inequality is two/three times larger than the baseline (depending on the period analyzed), though the effects appear more persistent when excluding the period after the Great Recession

(Table 7, panels b and d). When including the period following the Great Recession, the effects appear less persistent than those related to fiscal policy (see Table 7, panels c and d).

[TABLE 7]

To further investigate the role of Cohesion Policy we alternatively estimate equation (2) by type of Fund (the database covers the regionalization of EU payments divided by type of Fund under different programming periods). The results presented in Table 8 suggest that the effects vary between European funds pertaining to countries (EU Cohesion Fund) and those pertaining to regions (ESF or European Social Fund; ERDF or European Regional Development Fund; EAFRD or European Agricultural Fund for Rural Development) with the first being typically larger and more persistent (about -8.0 percent in the medium term).

[TABLE 8]

Initial level of regional disparities

Regional inequality is typically persistent and driven by several regional structural characteristics (Camagni and Capello, 2010; Maza and Villaverde, 2011). To the extent that these characteristics affect inequality, it is likely that they may affect also the response of regional inequality to shocks. To check for this hypothesis, we estimate equation (2) alternatively using the initial level of disparities in regional long-term unemployment and in human capital endowment.

The results suggest a greater reduction in regional disparities in the aftermath of economic downturns for countries with initially larger disparities in long-term unemployment and human capital endowment (Table 9). This implies a role for employment and education policies in the process of the reduction of disparities mainly in the recovery phase.

[TABLE 9]

5. CONCLUSIONS AND POLICY IMPLICATIONS

Regional disparities in output within countries have increased substantially in OECD economies and are at the forefront of the policy debate. A recent concern is that the COVID-19 recession may further exacerbate existing inequality.

Using an unbalanced panel of 25 OECD countries from 1990 to 2014, and computing Impulse Response Functions of the evolution of regional income dispersions following an economic downturn, the paper shows that regional inequality tends to decline in the aftermath

of economic downturns. In particular, we show that, for the period 1990-2007, the peak effect is generally reached in the short term (-3%), and the reduction in regional disparities remain statistically significant up to the fourth year after the occurrence of the downturn. The unconditional effect seems to be weakened in post-2008 crisis period when the role of fiscal and cohesion policies have become crucial in stimulating the reduction in regional disparities. These results are robust to several checks and an Instrumental Variable (IV) strategy, in which we use as instrument downturns in major trading partners.

Our results are important from both a theoretical and a policy standpoint. Regarding theory, they are important for the empirical convergence analysis: to the extent that regional disparities respond differently to expansions and recessions, convergence analyses may lead to different results depending on the number of recessions and expansions covered by the sample of analysis. The results provide additional evidence suggesting that the enhancing effect in the reduction of disparities tends to be larger for countries with a higher initial level of regional disparities in unemployment and human capital endowment. Therefore, initial conditions of regions matter.

From a policy point of view, our results gain even more importance in the light of the economic crisis induced by the COVID-19 pandemic. Although the overall effect that the pandemic will have on regional inequality is not clear, the pandemic is already impacting regions differently. Regions with higher exposure to international tourism and trade, heavily relying on cultural industry, or with economic structures based on SMEs, manufacturing and self-employed will be most negatively affected while those with a focus on food production and processing will be less affected. Moreover, pandemics usually hit more heavily low-skilled workers (Furceri et al. 2020b) with a larger share of these being located in lagging regions.

Although it is clearly too early to say what are the effects that will prevail, much will depend on the ability of policies to offset the negative effects of the current crisis. The positive effect of expansionary fiscal policy and EU development funds in further stimulating the reduction in regional disparities in the aftermath of economic crises should encourage policymakers in promoting redistribution and insurance measures. In particular, government may design intergovernmental transfers in a way to cushion the negative effects of economic crises and to promote convergence without favoring moral hazard. Similarly, regional policy may provide some additional help in softening the negative effects of crises, though it should be mainly oriented to support long-run growth during and beyond the recovery period.

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TABLES

TABLE 1. Economic Downturns and Regional Inequality—Baseline (1990-2007)

	k=0	k=1	k=2	k=3	k=4
Downturn dummy$_{i,t}$	0.062	-3.192***	-1.592	-2.234**	-1.814**
	(0.065)	(-2.985)	(-1.481)	(-2.549)	(-2.722)
Downturn dummy$_{i,t-1}$	-3.095***	-1.435**	-2.621***	-2.738***	-5.260***
	(-2.833)	(-2.716)	(-3.232)	(-3.899)	(-6.188)
Downturn dummy$_{i,t-2}$	0.669	-1.177**	-0.638	-2.622*	-0.522
	(1.234)	(-2.328)	(-0.605)	(-1.834)	(-0.513)
D$\sigma_{i,t-1}$	-0.127	-0.226***	-0.206**	-0.481***	-0.611**
	(-1.268)	(-2.849)	(-2.819)	(-4.390)	(-2.517)
D$\sigma_{i,t-2}$	-0.063	0.016	-0.175	-0.198	-0.258
	(-0.635)	(0.138)	(-1.026)	(-0.724)	(-1.016)
Average per-capita GDP$_{i,t-1}$	-0.001*	-0.002**	-0.002*	-0.003***	-0.004***
	(-2.060)	(-2.714)	(-1.794)	(-2.867)	(-4.181)
Observations	213	190	167	145	123
Within R-squared	0.174	0.232	0.251	0.298	0.403

Note: k=0 is the year of the downturn. k=1,2,3,4 are the years after the downturn. Estimates based on equation (1). Robust t-statistics in parentheses. We apply Driscoll-Kraay (1988) standard errors to account for cross-sectional and time dependence in the error term $\varepsilon_{i,t}^{k}$. *** p<0.01, ** p<0.05, * p<0.1.

TABLE 2. Economic Downturns and Regional Inequality—Different measures of regional inequality

	k=0	k=1	k=2	k=3	k=4
a) Coefficient of variation (unweighted)					
Downturn dummy	0.146	-1.768*	-0.635	-2.031***	-1.800*
	(0.140)	(-1.768)	(-0.949)	(-3.152)	(-2.027)
Within R-squared	0.563	0.300	0.202	0.193	0.211
b) Coefficient of variation (weighted)					
Downturn dummy	1.110	-2.026	-1.250	-3.385***	-4.175***
	(1.251)	(-1.146)	(-0.879)	(-2.910)	(-3.176)
Within R-squared	0.182	0.204	0.266	0.292	0.339
c) Theil index					
Downturn dummy	2.083	-2.835	-0.853	-4.887***	-4.666***
	(1.173)	(-1.476)	(-0.532)	(-3.297)	(-2.956)
Within R-squared	0.161	0.174	0.206	0.262	0.330
d) Gini index					
Downturn dummy	1.155	-2.310**	-1.903***	-3.865***	-3.171***
	(1.508)	(-2.595)	(-2.863)	(-4.432)	(-3.485)
Within R-squared	0.173	0.185	0.218	0.235	0.284
Observations	213	190	167	145	123

Note: k=0 is the year of the downturn. k=1,2,3,4 are the years after the downturn. Estimates based on equation (1). Controls included but not reported. Robust t-statistics in parentheses. We apply Driscoll-Kraay (1988) standard errors to account for cross-sectional and time dependence in the error term $\varepsilon_{i,t}^{k}$. *** p<0.01, ** p<0.05, * p<0.1.

TABLE 3. Economic Downturns and Regional Inequality—GDP Growth

	k=0	k=1	k=2	k=3	k=4
GDP growth$_{i,t}$	0.644*	1.477***	1.493***	1.652***	2.636***
	(1.980)	(3.610)	(6.348)	(3.194)	(3.656)
GDP growth$_{i,t-1}$	0.691	0.537**	0.940*	1.831***	0.669
	(0.969)	(2.498)	(1.869)	(3.800)	(1.397)
GDP growth$_{i,t-2}$	-0.136	0.444	0.895*	0.293	0.916
	(-0.371)	(1.298)	(1.923)	(0.481)	(1.491)
D$\sigma_{i,t-1}$	-0.164	-0.299***	-0.284***	-0.523***	-0.624***
	(-1.421)	(-4.143)	(-3.116)	(-5.281)	(-3.255)
D$\sigma_{i,t-2}$	-0.093	-0.024	-0.219	-0.204	-0.265
	(-0.950)	(-0.208)	(-1.252)	(-0.734)	(-0.972)
Average per-capita GDP$_{i,t-1}$	-0.000	-0.001*	-0.001	-0.001	-0.001
	(-1.229)	(-1.839)	(-0.818)	(-1.077)	(-1.493)
Observations	213	190	167	145	123
Within R-squared	0.200	0.277	0.317	0.372	0.461

Note: k=0 is the year of the downturn. k=1,2,3,4 are the years after the downturn. Estimates based on equation (1) using GDP growth instead of the downturn dummy. Robust t-statistics in parentheses. We apply Driscoll-Kraay (1988) standard errors to account for cross-sectional and time dependence in the error term $\varepsilon_{i,t}^{k}$. *** p<0.01, ** p<0.05, * p<0.1.

TABLE 4. Economic Downturns and Regional Inequality—Expansions vs Recessions

	k=0	k=1	k=2	k=3	k=4
[GDP growth*C]$_{i,t}$	0.594**	1.548***	1.474***	1.734***	2.697***
	(2.079)	(4.812)	(8.487)	(3.777)	(3.699)
[GDP growth*(1-C)]$_{i,t}$	0.626	0.683	0.896***	0.922**	2.343**
	(1.516)	(1.260)	(5.205)	(2.269)	(2.782)
[GDP growth*C]$_{i,t-1}$	0.737	0.419***	0.933***	1.839***	0.613
	(1.166)	(3.167)	(3.597)	(4.124)	(1.118)
[GDP growth*(1-C)]$_{i,t-1}$	0.374	0.541*	0.566	2.381***	1.139
	(0.485)	(2.012)	(1.543)	(3.424)	(1.722)
[GDP growth*C]$_{i,t-2}$	-0.136	0.587**	1.004**	0.397	0.920**
	(-0.488)	(2.082)	(2.403)	(0.787)	(2.178)
[GDP growth*(1-C)]$_{i,t-2}$	0.185	0.074	1.178	1.093*	0.491
	(0.500)	(0.130)	(1.350)	(1.787)	(1.050)
Observations	213	190	167	145	123
Within R-squared	0.205	0.284	0.320	0.380	0.465
F-test	0.013	5.062**	4.133*	7.627**	1.208

Note: k=0 is the year of the downturn. k=1,2,3,4 are the years after the downturn. Estimates based on equation (4). Controls included but not reported. Robust t-statistics in parentheses. We apply Driscoll-Kraay (1988) standard errors to account for cross-sectional and time dependence in the error term $\varepsilon_{i,t}^{k}$. *** p<0.01, ** p<0.05, * p<0.1. C is a downturn dummy. The F-test tests the difference between the estimations of the interaction terms [GDP growth*C]$_{i,t}$ (i.e. expansions) and [GDP growth*(1-C)]$_{i,t}$ (i.e. recessions).

TABLE 5. Economic Downturns and Regional Inequality—Instrumental Variable

	k=0	k=1	k=2	k=3	k=4
Downturn dummy$_{i,t}$	-16.822***	-26.875***	-22.844***	-22.887***	-17.785***
	(-5.308)	(-5.152)	(-3.163)	(-5.392)	(-3.132)
Downturn dummy$_{i,t-1}$	1.287	3.661	0.422	0.684	-5.622***
	(0.817)	(1.138)	(0.126)	(0.194)	(-3.382)
Downturn dummy$_{i,t-2}$	-1.236	-4.166	-3.537	-3.521	-3.509**
	(-0.922)	(-1.622)	(-1.007)	(-1.282)	(-2.382)
Dσ$_{i,t-1}$	-0.066	-0.209	-0.275*	-0.511*	-0.888***
	(-0.687)	(-0.865)	(-1.751)	(-1.657)	(-3.114)
Dσ$_{i,t-2}$	0.138	0.294**	0.173*	0.229	0.065
	(1.569)	(2.171)	(1.667)	(1.517)	(0.259)
Average per-capita GDP$_{i,t-1}$	-0.000	-0.001	-0.001*	-0.002***	-0.003***
	(-1.164)	(-1.280)	(-1.684)	(-3.133)	(-5.295)
Observations	174	156	136	117	98
R-squared (centered)	-0.320	-0.129	0.266	0.449	0.693
Kleibergen-Paap_rk_LM_statistic	1.922	1.880	1.905	1.950	1.929
Kleibergen-Paap_rk_Wald_F_statistic	24.81	15.18	13.55	12.39	36.85

Note: k=0 is the year of the downturn. k=1,2,3,4 are the years after the downturn. Robust t-statistics in parentheses. We apply Driscoll-Kraay (1988) standard errors to account for cross-sectional and time dependence in the error term $\varepsilon_{i,t}^{k}$. *** p<0.01, ** p<0.05, * p<0.1.

TABLE 6. Economic Downturns and Regional Inequality—The role of the Great Recession (1990-2014)

	k=0	k=1	k=2	k=3	k=4
a) Fixed Effects					
Downturn dummy$_{i,t}$	0.519	-3.776**	-0.115	-1.394	-2.262
	(0.427)	(-2.214)	(-0.064)	(-0.583)	(-1.274)
b) Time Trends					
Downturn dummy$_{i,t}$	-0.221	-6.266***	-2.594	-1.813	-1.265
	(-0.200)	(-3.717)	(-1.422)	(-1.244)	(-1.026)

Note: k=0 is the year of the downturn. k=1,2,3,4 are the years after the downturn. Estimates based on equation (1). Controls included but not reported. Robust t-statistics in parentheses. We apply Driscoll-Kraay (1988) standard errors to account for cross-sectional and time dependence in the error term $\varepsilon_{i,t}^{k}$. *** p<0.01, ** p<0.05, * p<0.1.

TABLE 7. Economic Downturns and Regional Inequality—The role of fiscal and cohesion policy

	k=0	k=1	k=2	k=3	k=4
Excluding the Great Recession (1990-2007)					
a) Fiscal policy					
Expansionary regime	-1.219	-6.129*	-6.228*	-8.159***	-4.363*
	(-0.620)	(-1.785)	(-1.846)	(-3.319)	(-1.983)
Contractionary regime	0.979	-1.001	1.893	2.472	0.313
	(0.738)	(-1.476)	(1.615)	(1.663)	(0.192)
F-test difference	0.799	1.622	4.605**	12.28***	1.809
b) **Total EU-development funds payments (as % to GDP)**					
Low share	1.008	-0.688	0.006	0.819	0.224
	(1.218)	(-0.763)	(0.009)	(0.851)	(0.202)
High share	-2.770	-5.384	-6.646**	-7.550***	-5.134***
	(-1.418)	(-1.615)	(-2.266)	(-5.632)	(-5.194)
F-test difference	6.289**	2.835	5.226**	22.02***	10.72***
Including the Great Recession (1990-2014)					
c) Fiscal policy					
Expansionary regime	-0.257	-2.115	-4.647	-8.504***	-6.490***
	(-0.146)	(-0.647)	(-1.560)	(-2.858)	(-2.923)
Contractionary regime	1.460	-5.484	3.341	3.731	0.880
	(0.990)	(-1.443)	(1.439)	(1.295)	(0.367)
F-test difference	0.676	0.289	4.845**	13.98***	4.732**
d) Total EU-development funds payments (as % to GDP)					
Low share	-0.112	1.446	1.328	3.717	2.717
	(-0.123)	(0.819)	(0.604)	(1.189)	(1.070)
High share	-2.356*	-3.519*	-5.359*	-4.406	-3.204
	(-2.058)	(-2.006)	(-2.079)	(-1.633)	(-0.958)
F-test difference	4.440*	4.472*	3.154*	4.198*	2.300

Note: k=0 is the year of the downturn. k=1,2,3,4 are the years after the downturn. Estimates based on equation (2). Controls included but not reported. Robust t-statistics in parentheses. We apply Driscoll-Kraay (1988) standard errors to account for cross-sectional and time dependence in the error term $\varepsilon_{i,t}^{k}$. *** p<0.01, ** p<0.05, * p<0.1. Expansionary regime (Low share) and Contractionary regime (High share) refer to the coefficients of the interaction variables (Downturn $\text{dummy}_{i,t}$* G(Z)) and (Downturn $\text{dummy}_{i,t}$* [1-G(Z)]), respectively. The F-test tests the difference between the estimations of the two regimes of the policy variable.

TABLE 8. Economic Downturns and Regional Inequality—The role of structural funds

	k=0	k=1	k=2	k=3	k=4
a) Cohesion fund (CF) payments as % to GDP					
Low share	-0.763	-2.551	-1.927	-0.759	-0.981
	(-0.613)	(-1.615)	(-1.214)	(-0.302)	(-0.316)
High share	-2.854*	-3.859	-6.545**	-6.197*	-8.080*
	(-2.261)	(-1.768)	(-2.567)	(-2.399)	(-2.227)
F-test difference	1.676	0.338	2.725	5.022*	3.123
b) European Social Fund (ESF) payments as % to GDP					
Low share	-0.458	1.114	1.182	3.814	2.886
	(-0.441)	(0.612)	(0.504)	(1.149)	(1.069)
High share	-1.999*	-3.408*	-5.687*	-5.075	-3.871
	(-1.963)	(-2.065)	(-1.932)	(-1.696)	(-1.001)
F-test difference	2.055	3.910*	2.495	3.468*	1.940
c) European Regional Development Fund (ERDF) payments as % to GDP					
Low share	-0.269	1.341	1.181	3.678	2.602
	(-0.275)	(0.737)	(0.514)	(1.141)	(1.003)
High share	-2.195*	-3.496*	-5.356*	-4.563	-3.212
	(-2.046)	(-2.007)	(-1.979)	(-1.615)	(-0.915)
F-test difference	3.440*	4.112*	2.646	3.637*	1.931
d) European Agricultural Fund for Rural Development (EAFRD) payments as % to GDP					
Low share	-0.017	1.534	1.161	3.629	2.441
	(-0.021)	(0.842)	(0.567)	(1.261)	(1.046)
High share	-2.310*	-3.370*	-4.813**	-3.936	-2.571
	(-1.788)	(-1.818)	(-2.177)	(-1.526)	(-0.843)
F-test difference	3.389*	3.547*	3.624*	5.310**	2.553

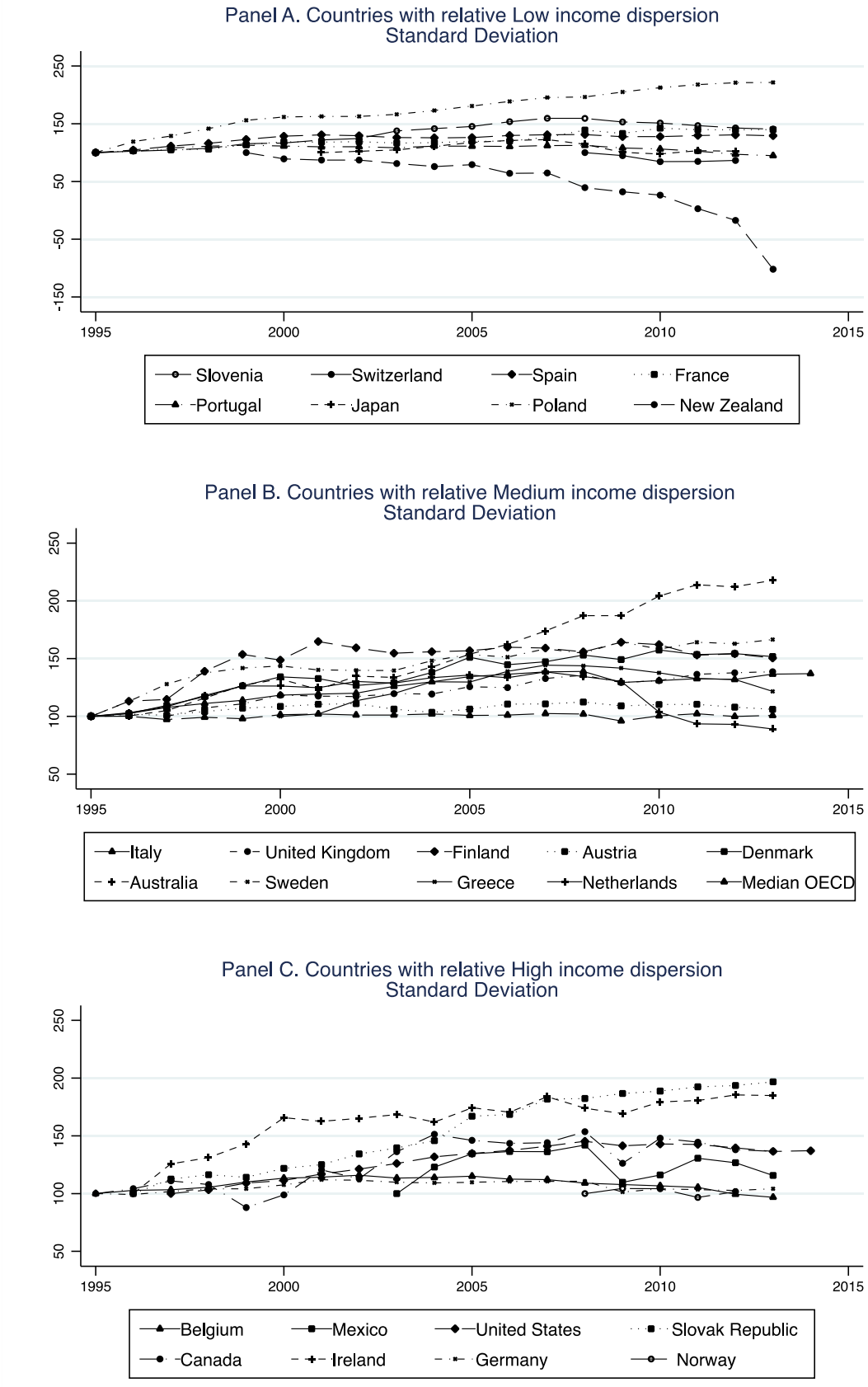
Note: k=0 is the year of the downturn. k=1,2,3,4 are the years after the downturn. Estimates based on equation (2) for the period 1990-2014. Controls included but not reported. Robust t-statistics in parentheses. We apply Driscoll-Kraay (1988) standard errors to account for cross-sectional and time dependence in the error term $\varepsilon_{i,t}^{k}$. *** p<0.01, ** p<0.05, * p<0.1. Low and high share regimes refer to the coefficients of the interaction variables (Downturn dummy$_{i,t}$* G(Z)) and (Downturn dummy$_{i,t}$* [1-G(Z)]), respectively. The F-test tests the difference between the estimations in the case of low and high regime of a policy variable.

TABLE 9. Economic Downturns and Regional Inequality—The role of Initial Disparities

	k=0	k=1	k=2	k=3	k=4
a) LTU Disparities					
Low regime	2.928	-6.195	6.151**	5.741*	3.883
	(1.159)	(-1.247)	(2.126)	(1.725)	(1.277)
High regime	-2.407*	-1.257	-9.055***	-10.649***	-9.743***
	(-2.025)	(-0.340)	(-3.996)	(-4.482)	(-3.100)
F-test difference	2.288	0.368	9.916***	13.08***	7.103**
b) Human capital disparities					
Low regime	2.312	-8.549	4.209	2.823	-0.180
	(0.916)	(-1.563)	(1.310)	(0.595)	(-0.063)
High regime	-2.595***	-0.778	-5.741***	-7.291*	-3.918
	(-2.814)	(-0.207)	(-3.189)	(-1.739)	(-1.686)
F-test difference	3.266*	0.741	9.946***	2.989*	1.244

Note: k=0 is the year of the downturn. k=1,2,3,4 are the years after the downturn. Estimates based on equation (2) for the period 1990-2014. Controls included but not reported. Robust t-statistics in parentheses. We apply Driscoll-Kraay (1988) standard errors to account for cross-sectional and time dependence in the error term $\varepsilon_{i,t}^{k}$. *** p<0.01, ** p<0.05, * p<0.1. Low and high regimes refer to the coefficients of the interaction variables (Downturn dummy$_{i,t}$* G(Z)) and (Downturn dummy$_{i,t}$* [1-G(Z)]), respectively. The F-test tests the difference between the estimations in the case of low and high regime of LTU (Human capital) disparities.

FIGURE 1. Evolution of Regional Disparities Across Countries



Note: Regional disparities = 100 in 1995 or in the first year of data availability.

Online Appendix for the paper

"Regional inequalities, economic crises and policies: An international panel analysis "

Table A1. Descriptive Statistics on the variables included in the analysis

Variable	Source	Obs.	Mean	Std. Dev.
Regional inequality measures				
Regional inequality change (SD)	Authors calculations based on regional GDP data retrieved from OECD - Regional Statistics	430	3.27	6.45
Regional inequality change (CV)		430	0.01	0.06
Regional inequality change (CVW)		430	0.78	5.38
Regional inequality change (THEIL)		430	1.06	10.85
Regional inequality change (GINI)		430	0.44	5.12
Fiscal policy				
Primary balance (change)	OECD	415	-0.08	2.50
EU Development funds payments as % to GDP				
Total EU-funds	European Commission - European Structural and Investment Funds	302	0.51	0.73
Cohesion Fund (CF)		109	0.23	0.20
European Social Fund (ESF)		234	0.10	0.14
European Regional Development Fund (ERDF)		298	0.26	0.40
European Agricultural Fund for Rural Development (EAFRD)		298	0.09	0.12
Regional characteristics				
LTU disparities (SD)	Authors calculations based on regional LTU and Education attainment data retrieved from OECD - Regional Statistics	402	1.31	1.31
Human capital disparities (SD)		402	4.48	1.90

Table A2. Descriptive statistics on regional inequality and economic downturns by country

Country	Average	Min	Max	Ranking	Downturns years (1990-2014)
Belgium	22658	20105	24415	1	2001, 2002, 2012
Mexico	17992	14810	21850	2	-
United States	17319	13013	20261	3	2001, 2002, 2008, 2013
Slovak Republic	14797	8489	21273	4	1998, 1999, 2008
Canada	14078	8615	18581	5	1991, 1995, 2001, 2002, 2008
Ireland	12301	6884	14767	6	1998, 2001, 2002, 2008, 2011, 2012
Germany	10998	10283	11659	7	2002, 2003, 2004, 2012
Norway	9783	9312	10090	8	2009
Italy	9284	8870	9473	9	1996, 1998, 2002, 2012
United Kingdom	8441	6683	9693	10	-
Finland	8259	5284	9548	11	2001, 2002, 2012, 2013
Austria	7858	7324	8256	12	1996, 2001, 2002, 2013
Denmark	7056	5052	8759	13	1995, 2001, 2002, 2007, 2008, 2012, 2013
Australia	6995	4296	13004	14	1991, 1995, 2000, 2009, 2010, 2013
Sweden	6901	4439	8284	15	1996, 2001, 2002, 2008, 2012
Greece	6892	5253	8037	16	2001, 2009, 2010, 2011
Netherlands	6635	4655	8038	17	2001, 2002, 2003, 2004, 2012
Slovenia	6292	4511	8006	18	2001, 2002, 2003, 2004, 2012
Switzerland	6243	5870	6915	19	-
Spain	5856	4624	6256	20	1996, 2001, 2002, 2003, 2012
France	5671	4558	6816	21	1996, 2001, 2002, 2012
Portugal	5496	4815	5796	22	2002, 2011, 2012
Japan	4073	3612	4704	23	-
Poland	3347	1577	5016	24	2001, 2002, 2012
New Zealand	1971	130	3113	25	2001, 2008, 2012

Note:. Columns 2-4 refer to standard deviation values of regional (NUTS 2) GDP per-capita in the period 1990-2014. Columns 6 refers to the list of downturns years.

Table A3. Severe vs moderate downturns

	k=0	k=1	k=2	k=3	k=4
a) Severe					
Downturn dummy$_{i,t}$	-1.638	-3.247**	-3.919*	-4.284***	-3.939**
	(-1.216)	(-2.101)	(-1.992)	(-2.888)	(-2.278)
b) Moderate					
Downturn dummy$_{i,t}$	0.624	-1.627*	0.086	-0.838	0.225
	(0.768)	(-1.818)	(0.109)	(-0.730)	(0.213)

Note: severe downturns are identified as those downturns with annual growth rates below to the first quartile of the distribution of annual growth rates; moderate downturns are identified as all the other downturns. Note: k=0 is the year of the downturn. k=1,2,3,4 are the years after the downturn. Estimations based on equation (1). Controls included but not reported. Robust t-statistics in parentheses. We apply Driscoll-Kraay (1988) standard errors to account for cross-sectional and time dependence in the error term $\varepsilon_{i,t}^{k}$. *** p<0.01, ** p<0.05, * p<0.1.

Table A4. Persistence of regional disparities

	(1)
$\sigma_{i,t-1}$	0.832***
	(9.017)
$\sigma_{i,t-2}$	-0.004
	(-0.049)
Observations	236
within R-squared	0.850

Estimates based on $\sigma_{i,t} = \alpha_i + \varphi_t + \sum_{j=1}^{2} \gamma_i \sigma_{i,t-j} + \varepsilon_{i,t}$ where $\sigma_{i,t}$ is the logarithm of the standard deviation of regional (NUTS-2) per-capita GDP. Robust t-statistics in parentheses. We apply Driscoll-Kraay (1988) standard errors to account for cross-sectional and time dependence in the error term $\varepsilon_{i,t}^{k}$. *** p<0.01, ** p<0.05, * p<0.1.

Table A5. Economic Downturns and Regional Inequality – Controlling for initial disparities in income

	k=0	k=1	k=2	k=3	k=4
Downturn dummy$_{i,t}$	0.987	-1.589*	-0.666*	-2.157***	-1.824**
	(1.348)	(-2.068)	(-1.867)	(-2.949)	(-2.408)
Downturn dummy$_{i,t-1}$	-1.872	-0.266	-1.936***	-1.678***	-2.992**
	(-1.696)	(-0.804)	(-3.591)	(-3.094)	(-2.268)
Downturn dummy$_{i,t-2}$	0.889	-1.084	-0.479	-1.584	0.524
	(1.426)	(-1.445)	(-0.368)	(-0.852)	(0.342)
D$\sigma_{i,t-1}$	-0.043	0.007	0.115	-0.066	-0.159
	(-0.341)	(0.097)	(0.861)	(-0.986)	(-1.196)
D$\sigma_{i,t-2}$	-0.009	0.153	-0.004	0.016	-0.025
	(-0.107)	(1.595)	(-0.044)	(0.105)	(-0.120)
Average per-capita GDP$_{i,t-1}$	0.000	0.001**	0.002**	0.002***	0.001
	(1.133)	(2.538)	(2.651)	(2.923)	(1.527)
Regional disparities in income$_{t-1}$	-22.38***	-49.92***	-69.52***	-90.83***	-88.11***
	(-3.370)	(-3.439)	(-4.210)	(-5.414)	(-7.292)
Observations	213	190	167	145	123
Within R-squared	0.227	0.345	0.430	0.546	0.626

Note: k=0 is the year of the downturn. k=1,2,3,4 are the years after the downturn. Estimates based on equation (1). Robust t-statistics in parentheses. We apply Driscoll-Kraay (1988) standard errors to account for cross-sectional and time dependence in the error term $\varepsilon_{i,t}^{k}$. *** p<0.01, ** p<0.05, * p<0.1.

Table A6. Economic Downturns and Regional Inequality – Controlling for initial disparities in human capital

	k=0	k=1	k=2	k=3	k=4
Downturn dummy$_{i,t}$	0.481	-0.734*	-0.265	-1.510**	-1.372**
	(1.550)	(-1.783)	(-0.530)	(-2.293)	(-2.326)
Downturn dummy$_{i,t-1}$	-0.929*	-0.150	-1.197***	-0.626**	-1.683***
	(-1.941)	(-0.268)	(-4.480)	(-2.140)	(-2.951)
Downturn dummy$_{i,t-2}$	-0.056	-1.474***	-0.824	-1.553**	0.067
	(-0.111)	(-3.058)	(-0.937)	(-2.594)	(0.080)
Dσ$_{i,t-1}$	-0.187*	-0.333***	-0.313***	-0.582***	-0.695***
	(-1.961)	(-4.669)	(-3.304)	(-6.346)	(-3.001)
Dσ$_{i,t-2}$	-0.154	-0.101	-0.330**	-0.418*	-0.463***
	(-1.623)	(-0.985)	(-2.635)	(-1.729)	(-3.807)
Average per-capita GDP$_{i,t-1}$	-0.001**	-0.001***	-0.001*	-0.002*	-0.002*
	(-2.186)	(-3.540)	(-1.939)	(-1.971)	(-1.780)
Regional disparities in	0.363	-1.226	-4.507***	0.098	-6.026**
human capital$_{t-1}$	(0.269)	(-0.817)	(-4.347)	(0.051)	(-2.525)
Observations	198	176	154	133	112
Within R-squared	0.155	0.163	0.201	0.284	0.472

Note: k=0 is the year of the downturn. k=1,2,3,4 are the years after the downturn. Estimates based on equation (1). Robust t-statistics in parentheses. We apply Driscoll-Kraay (1988) standard errors to account for cross-sectional and time dependence in the error term $\varepsilon_{i,t}^{k}$. *** p<0.01, ** p<0.05, * p<0.1.

Table A7. Economic Downturns and Regional Inequality – Controlling for initial disparities in long term unemployment rates

	k=0	k=1	k=2	k=3	k=4
Downturn dummy$_{i,t}$	1.126	-1.215	-0.285	-2.232***	-2.355***
	(1.723)	(-1.719)	(-0.497)	(-3.399)	(-2.987)
Downturn dummy$_{i,t-1}$	-1.936*	-0.411	-2.297***	-2.042***	-3.426***
	(-1.868)	(-0.875)	(-3.499)	(-3.350)	(-7.204)
Downturn dummy$_{i,t-2}$	0.653	-1.648***	-0.951	-2.351*	-0.642
	(0.906)	(-4.697)	(-1.248)	(-1.986)	(-0.763)
Dσ$_{i,t-1}$	-0.183*	-0.289***	-0.294***	-0.529***	-0.578***
	(-1.845)	(-4.179)	(-2.849)	(-5.631)	(-3.059)
Dσ$_{i,t-2}$	-0.092	-0.037	-0.228	-0.204	-0.247
	(-1.098)	(-0.447)	(-1.703)	(-0.854)	(-1.085)
Average per-capita GDP$_{i,t-1}$	-0.001**	-0.001**	-0.001	-0.002*	-0.002**
	(-2.454)	(-2.130)	(-1.213)	(-1.960)	(-2.724)
Regional disparities in	-0.982	-1.682	-3.023*	-4.492*	-6.606**
LTU$_{t-1}$	(-1.377)	(-1.356)	(-1.838)	(-1.937)	(-2.306)
Observations	207	186	165	144	123
Within R-squared	0.164	0.182	0.221	0.294	0.398

Note: k=0 is the year of the downturn. k=1,2,3,4 are the years after the downturn. Estimates based on equation (1). Robust t-statistics in parentheses. We apply Driscoll-Kraay (1988) standard errors to account for cross-sectional and time dependence in the error term $\varepsilon_{i,t}^{k}$. *** p<0.01, ** p<0.05, * p<0.1.

Table A8. Robustness checks - outliers

	k=0	k=1	k=2	k=3	k=4	Country excluded
Downturn dummy$_{i,t}$	0.352	-2.991**	-1.629	-1.871**	-1.885***	NZL - BEL
	(0.345)	(-2.432)	(-1.535)	(-2.469)	(-3.204)	
Downturn dummy$_{i,t}$	-0.473	-2.724***	-1.548*	-1.369	-0.889*	AUS
	(-0.687)	(-3.752)	(-1.767)	(-1.334)	(-2.043)	
Downturn dummy$_{i,t}$	-0.108	-3.516***	-1.686	-2.125**	-1.863**	AUT
	(-0.110)	(-3.432)	(-1.503)	(-2.261)	(-2.732)	
Downturn dummy$_{i,t}$	-0.048	-3.411***	-1.733	-2.437**	-1.937**	BEL
	(-0.050)	(-3.289)	(-1.664)	(-2.653)	(-2.821)	
Downturn dummy$_{i,t}$	-0.167	-3.270**	-2.117**	-3.100***	-2.161***	CAN
	(-0.195)	(-2.235)	(-2.397)	(-7.510)	(-3.795)	
Downturn dummy$_{i,t}$	0.062	-3.192***	-1.592	-2.234**	-1.814**	CHE
	(0.065)	(-2.985)	(-1.481)	(-2.549)	(-2.722)	
Downturn dummy$_{i,t}$	0.338	-2.745*	-1.081	-1.615*	-1.410**	DEU
	(0.272)	(-2.064)	(-0.839)	(-1.968)	(-2.252)	
Downturn dummy$_{i,t}$	0.440	-2.793**	-1.047	-1.998*	-1.739**	DNK
	(0.438)	(-2.386)	(-0.872)	(-2.066)	(-2.119)	
Downturn dummy$_{i,t}$	0.238	-3.118**	-1.067	-2.129**	-1.519**	ESP
	(0.233)	(-2.682)	(-0.948)	(-2.368)	(-2.505)	
Downturn dummy$_{i,t}$	-0.404	-3.459***	-1.762	-2.456**	-2.136**	FIN
	(-0.441)	(-3.196)	(-1.437)	(-2.087)	(-2.107)	
Downturn dummy$_{i,t}$	0.042	-3.280***	-1.618	-2.205**	-1.673**	FRA
	(0.042)	(-3.275)	(-1.515)	(-2.409)	(-2.555)	
Downturn dummy$_{i,t}$	-0.248	-3.562***	-1.941*	-2.471**	-2.004**	GBR
	(-0.262)	(-3.269)	(-1.829)	(-2.758)	(-2.805)	
Downturn dummy$_{i,t}$	0.126	-3.302***	-1.505	-2.261**	-1.814**	GRC
	(0.130)	(-3.238)	(-1.382)	(-2.487)	(-2.722)	
Downturn dummy$_{i,t}$	0.045	-3.474***	-2.027*	-2.620***	-2.022***	IRL
	(0.048)	(-3.364)	(-1.833)	(-3.457)	(-2.919)	
Downturn dummy$_{i,t}$	0.482	-3.141**	-1.485	-2.209*	-1.827***	ITA
	(0.442)	(-2.690)	(-1.263)	(-2.086)	(-3.140)	
Downturn dummy$_{i,t}$	0.069	-3.186***	-1.557	-2.234**	-1.814**	JPN
	(0.071)	(-2.965)	(-1.442)	(-2.549)	(-2.722)	
Downturn dummy$_{i,t}$	0.075	-3.192***	-1.592	-2.234**	-1.814**	MEX
	(0.078)	(-2.985)	(-1.481)	(-2.549)	(-2.722)	
Downturn dummy$_{i,t}$	0.104	-3.582***	-1.578	-2.209**	-1.598**	NLD
	(0.104)	(-3.209)	(-1.321)	(-2.373)	(-2.153)	
Downturn dummy$_{i,t}$	0.062	-3.192***	-1.592	-2.234**	-1.814**	NOR
	(0.065)	(-2.985)	(-1.481)	(-2.549)	(-2.722)	
Downturn dummy$_{i,t}$	0.448	-2.780**	-1.508	-1.682**	-1.770***	NZL
	(0.436)	(-2.212)	(-1.380)	(-2.255)	(-2.987)	
Downturn dummy$_{i,t}$	0.246	-2.834**	-1.221	-1.814*	-1.356*	POL
	(0.243)	(-2.745)	(-1.134)	(-1.916)	(-1.840)	
Downturn dummy$_{i,t}$	0.099	-3.171***	-1.654	-2.160**	-1.823**	PRT
	(0.098)	(-2.865)	(-1.512)	(-2.219)	(-2.612)	
Downturn dummy$_{i,t}$	0.459	-2.721***	-0.952	-1.559*	-1.056	SVK
	(0.581)	(-3.299)	(-1.582)	(-2.058)	(-1.540)	
Downturn dummy$_{i,t}$	-0.649	-3.893***	-2.576*	-3.638***	-2.875***	SVN
	(-0.573)	(-3.346)	(-1.916)	(-3.110)	(-3.057)	
Downturn dummy$_{i,t}$	0.248	-2.894**	-1.309	-2.109**	-1.702**	SWE
	(0.238)	(-2.531)	(-1.171)	(-2.521)	(-2.698)	
Downturn dummy$_{i,t}$	0.017	-3.361***	-1.842*	-2.434**	-1.932**	USA
	(0.018)	(-3.144)	(-1.790)	(-2.745)	(-2.832)	

Note: k=0 is the year of the downturn. k=1,2,3,4 are the years after the downturn. Estimations based on equation (1). Controls included but not reported. Robust t-statistics in parentheses. We apply Driscoll-Kraay (1988) standard errors to account for cross-sectional and time dependence in the error term $\varepsilon_{i,t}^{k}$. *** p<0.01, ** p<0.05, * p<0.1.

Table A9. Robustness checks – additional control variables

	k=0	k=1	k=2	k=3	k=4	Additional Control Variables	source
Downturn dummy$_{i,t}$	0.351	-3.019***	-1.485	-2.702*	-1.896*	Share of employed	OECD
	(0.306)	(-3.110)	(-1.146)	(-1.890)	(-1.869)	in Agriculture	
Downturn dummy$_{i,t}$	0.335	-2.939***	-1.762	-3.289***	-2.761**	Share of employed	OECD
	(0.308)	(-3.075)	(-1.464)	(-2.970)	(-2.151)	in Industry	
Downturn dummy$_{i,t}$	-0.356	-3.634***	-1.591	-2.829*	-1.584	Share of national population	OECD
	(-0.303)	(-3.119)	(-1.190)	(-2.083)	(-1.440)	under 15 years old	
Downturn dummy$_{i,t}$	0.154	-2.999***	-1.490	-2.118**	-1.794**	Share of national population	OECD
	(0.141)	(-2.859)	(-1.438)	(-2.507)	(-2.653)	65 years old and over	
Downturn dummy$_{i,t}$	-0.919	-2.465**	-2.783***	-3.268***	-1.901***	Foreign population	OECD
	(-1.165)	(-2.443)	(-4.270)	(-6.422)	(-4.410)	(% of total population)	

Note: k=0 is the year of the downturn. k=1,2,3,4 are the years after the downturn. Estimations based on equation (1). Controls included but not reported. Robust t-statistics in parentheses. We apply Driscoll-Kraay (1988) standard errors to account for cross-sectional and time dependence in the error term $\varepsilon_{i,t}^{k}$. *** p<0.01, ** p<0.05, * p<0.1.

Table A10. Validity of IV: effect of the instrument on regional inequality

	k=0	k=1	k=2	k=3	k=4
Instrument	-2.897	0.811	10.992	16.803	12.799
	(-0.726)	(0.092)	(1.008)	(1.531)	(1.392)
Downturn dummy$_{i,t}$	1.213	-2.072	-1.163	-2.262**	-2.530**
	(1.019)	(-1.203)	(-0.820)	(-2.196)	(-2.224)
Downturn dummy$_{i,t-1}$	-3.108**	-1.543**	-3.323**	-4.310***	-6.009***
	(-2.454)	(-2.177)	(-2.565)	(-4.014)	(-5.437)
Downturn dummy$_{i,t-2}$	0.542	-1.510**	-1.095	-2.055	-0.184
	(0.905)	(-2.744)	(-0.692)	(-1.109)	(-0.139)
$\mathbf{D\sigma}_{i,t-1}$	-0.129	-0.220*	-0.229***	-0.487***	-0.636**
	(-1.123)	(-1.896)	(-3.062)	(-3.590)	(-2.647)
$\mathbf{D\sigma}_{i,t-2}$	-0.060	0.061	-0.084	-0.078	-0.184
	(-0.627)	(0.510)	(-0.556)	(-0.342)	(-0.730)
Average per-capita GDP$_{i,t-1}$	-0.001**	-0.002***	-0.002**	-0.003***	-0.004***
	(-2.105)	(-2.901)	(-2.529)	(-4.094)	(-5.917)
Observations	185	165	145	126	107
within R-squared	0.148	0.210	0.274	0.369	0.478

Note: k=0 is the year of the downturn. k=1,2,3,4 are the years after the downturn. Estimates based on equation (1) with the instrument as additional control. Robust t-statistics in parentheses. We apply Driscoll-Kraay (1988) standard errors to account for cross-sectional and time dependence in the error term $\varepsilon_{i,t}^{k}$. *** p<0.01, ** p<0.05, * p<0.1.

Table A11. Validity of IV: effect of the instrument on residuals of regional inequality

	k=0	k=1	k=2	k=3	k=4
Instrument	-2.483	0.879	9.548	14.274	10.381
	(-0.992)	(0.162)	(1.375)	(1.176)	(1.093)
Observations	185	165	145	126	107
within R-squared	0.602	0.771	0.736	0.873	0.937

Note: k=0 is the year of the downturn. k=1,2,3,4 are the years after the downturn. The outcome variables are the residuals from Table 1 based on equation (1). We regress these residuals on the instrument. Country and time fixed effects included but not reported. Robust t-statistics in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Table A12. Robustness checks – Instrumental variable – lagged instrument

	k=0	k=1	k=2	k=3	k=4
Downturn dummy$_{i,t}$	-10.424*	-17.174**	-18.062**	-18.748	-27.417
	(-1.663)	(-2.485)	(-2.107)	(-1.306)	(-1.566)
Downturn dummy$_{i,t-1}$	-0.014	1.621	1.009	0.559	-0.588
	(-0.005)	(0.572)	(0.322)	(0.106)	(-0.130)
Downturn dummy$_{i,t-2}$	-1.223	-4.229***	-4.206**	-5.160**	-4.845***
	(-1.123)	(-3.661)	(-2.078)	(-2.410)	(-4.146)
Dσ$_{i,t-1}$	-0.018	-0.161	-0.193***	-0.451***	-0.672***
	(-0.295)	(-0.833)	(-2.735)	(-2.633)	(-3.461)
Dσ$_{i,t-2}$	-0.077	-0.013	-0.212	-0.230	-0.293
	(-0.710)	(-0.113)	(-1.141)	(-0.782)	(-0.893)
Average per-capita GDP$_{i,t-1}$	-0.000	-0.001*	-0.001	-0.002*	-0.002
	(-1.186)	(-1.652)	(-1.126)	(-1.723)	(-0.627)
Observations	176	156	136	117	100
R-squared (centered)	0.010	0.219	0.316	0.458	0.452
Kleibergen-Paap_rk_LM_statistic	1.571	1.614	1.707	1.563	1.316
Kleibergen-Paap_rk_Wald_F_statistic	11.11	11.49	21.14	17.40	15.58

Note: k=0 is the year of the downturn. k=1,2,3,4 are the years after the downturn. Robust t-statistics in parentheses. We apply Driscoll-Kraay (1988) standard errors to account for cross-sectional and time dependence in the error term $\varepsilon_{i,t}^{k}$. *** p<0.01, ** p<0.05, * p<0.1.