

Innovación y desigualdad de ingresos: análisis de la dinámica del progreso tecnológico, la globalización y el desarrollo financiero en las economías de la OCDE (1996-2022)

Innovation and Income Inequality: Exploring the Dynamics of Technological Progress, Globalization, and Financial Development in OECD Economies (1996-2022)

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RESUMEN

Este artículo investiga la relación entre la innovación y la desigualdad de ingresos en 38 países de la OCDE entre 1996 y 2022, abordando los debates actuales sobre si el cambio tecnológico actúa como una fuerza igualadora o si refuerza las disparidades. Utilizando un marco de datos de panel heterogéneo con el estimador de Efectos Comunes Correlacionados en Media de Grupo (CCEMG), el estudio considera la dependencia transversal, la heterogeneidad de pendientes y la no estacionariedad, garantizando una inferencia confiable en paneles macroeconómicos extensos.

Los resultados muestran de manera consistente que la innovación, medida a través de las solicitudes de patentes por fuerza laboral, se asocia positiva y significativamente con la desigualdad de ingresos, lo que indica que sus beneficios recaen de forma desproporcionada en los grupos con mayor capital y habilidades. Los modelos de interacción revelan además que la globalización y el desarrollo financiero amplifican estos efectos de aumento de la desigualdad, en línea con la evidencia reciente sobre las tendencias regresivas de la integración global y financiera en ausencia de instituciones inclusivas. En contraste, el capital humano y la calidad institucional ejercen una influencia mitigadora, confirmando su papel central en la configuración de un crecimiento impulsado por la innovación que sea inclusivo. La inflación se relaciona positivamente con la desigualdad, mientras que el PIB per cápita no muestra una asociación robusta, lo que sugiere que el crecimiento económico por sí solo es insuficiente para garantizar resultados equitativos.

En conjunto, los hallazgos resaltan la naturaleza condicional de los efectos distributivos de la innovación y subrayan la importancia de políticas complementarias—particularmente en educación, gobernanza e inclusión financiera—para transformar el progreso tecnológico en un motor de prosperidad sostenible e inclusiva.

PALABRAS CLAVE

Innovación Tecnológica; Desigualdad de Ingresos; Cambio Tecnológico; Capital Humano.

ABSTRACT

This paper investigates the relationship between innovation and income inequality in 38 OECD countries from 1996 to 2022, addressing ongoing debates about whether technological change functions as an equalizing force or reinforces disparities. Employing a heterogeneous panel framework with the Common Correlated Effects Mean Group (CCEMG) estimator, the study accounts for cross-sectional dependence, slope heterogeneity, and nonstationarity, ensuring reliable inference in long macroeconomic panels.

The results consistently show that innovation, proxied by patent applications per labor force, is positively and significantly associated with income inequality, indicating that its benefits accrue disproportionately to groups with greater skills and capital. Interaction models further reveal that globalization and financial development amplify these inequality-enhancing effects, in line with recent evidence on the regressive tendencies of global and financial integration absent inclusive institutions. By contrast, human capital and institutional quality exert a mitigating influence, confirming their central role in shaping the inclusiveness of innovation-driven growth. Inflation is positively related to inequality, while GDP per capita does not exhibit a robust association, suggesting that economic growth alone is insufficient to secure equitable outcomes.

Overall, the findings highlight the conditional nature of innovation's distributive effects and underscore the importance of complementary policies—particularly in education, governance, and financial inclusion—to transform technological progress into a driver of sustainable and inclusive prosperity.

KEYWORDS

Technological Innovation; Income Inequality; Technological Change; Human Capital.

Clasificación JEL: O31, O33, D63, J24.

MSC2010: 91B55, 91B74, 91B32, 91B42, 91B40.

1. INTRODUCTION

Income inequality has become a defining challenge for contemporary economies, raising concerns about social cohesion, political stability, and sustainable growth. Despite decades of globalization, rapid technological advancement, and market-oriented reforms, the distribution of economic gains has remained uneven. The United Nations Development Program (2015) documents rising inequality across both advanced and developing countries, while recent crises—from the 2007–2008 global financial meltdown to the socioeconomic disruptions of the COVID-19 pandemic—have further widened disparities. These developments underscore the urgency of identifying the structural forces that shape inequality and the policies required to mitigate it.

Among the potential drivers, innovation occupies a particularly ambiguous position. On the one hand, innovation is widely regarded as the engine of productivity growth, competitiveness, and long-run prosperity. Schumpeterian theory posits that “creative destruction” disrupts entrenched monopolies and redistributes economic rents, thereby reducing inequality. On the other hand, empirical evidence increasingly shows that innovation can also exacerbate disparities, as gains tend to concentrate among highly skilled workers, firms with strong technological capabilities, and regions with advanced research infrastructures. This paradox raises a central question: does innovation narrow or widen income inequality, and under what conditions?

Existing research offers mixed findings. Some studies highlight the inequality-reducing potential of technological change when supported by inclusive institutions and broad educational access (Antonelli & Tubiana, 2023; Soukiazis & Cravo, 2008). Others emphasize that innovation often benefits a narrow segment of society, particularly in economies where human capital and financial resources are unequally distributed (Perera-Tallo, 2017). The divergence in results suggests that the relationship between innovation and inequality is not universal but highly context-dependent. In particular, the roles of globalization and financial development remain underexplored. While globalization can expand markets and foster innovation diffusion, it can also magnify income gaps by increasing demand for skilled labor and channeling disproportionate rewards to capital owners. Similarly, financial development may enable broader access to innovation opportunities, but poorly regulated systems risk concentrating benefits among elites.

This paper examines these gaps by investigating the innovation–inequality nexus in OECD countries between 1996 and 2022. Focusing on OECD allows for an in-depth analysis of contexts characterized by high levels of innovation but persistent inequality.

By addressing the central question of whether innovation reduces or exacerbates income inequality in OECD countries, this paper contributes to the literature in three important ways. First, it goes beyond estimating the direct effect of innovation by incorporating the mediating roles of globalization and financial development, thereby situating innovation within a broader structural context. Second, it advances methodological rigor through the use of the CCEMG estimator, which accounts for cross-sectional dependence, slope heterogeneity, and nonstationarity—features that are essential for producing reliable inferences in macroeconomic panels. Third, it generates policy-relevant insights by identifying the conditions under which innovation can foster inclusive growth, highlighting the critical roles of human capital and institutional quality. Together, these contributions directly respond to the research question by clarifying not only the magnitude and direction of innovation’s impact on inequality, but also the structural and policy environments that condition this relationship.

Accordingly, this study sets out three interrelated objectives. The first is to estimate the direct effect of innovation on income inequality in OECD countries, thereby assessing whether technological change has acted as an equalizing mechanism or, conversely, as a driver of disparities over the period 1996–2022. The second objective is to analyze the conditional influence of globalization and financial development, evaluating whether these structural forces amplify or moderate the distributive consequences of innovation. The third is to examine the mitigating role of human capital and institutional quality, with the aim of identifying the extent to which education and governance can foster more inclusive innovation-driven growth. From these objectives emerge three testable hypotheses: that innovation is positively associated with income inequality in advanced economies, reflecting the disproportionate gains accruing to groups with greater access to skills and capital; that the inequality-enhancing effect of innovation is reinforced when combined with globalization and financial development, illustrating the interaction between technological change and broader structural dynamics; and that higher levels of human capital and stronger institutional quality mitigate these regressive effects, creating the conditions under which technological progress can contribute to more equitable outcomes.

The remainder of the paper is organized as follows. Section 2 provides a comprehensive review of the literature, situating the study within the broader theoretical and empirical debates on innovation and inequality. Section 3 outlines the methodology, detailing the baseline specification,

the rationale for employing the CCEMG estimator, and the extensions used to test conditional effects. Likewise, it describes the dataset and variables, emphasizing the advantages and limitations of the chosen proxies and sources. Section 4 presents and discusses the empirical results, connecting the findings to existing literature and highlighting their theoretical and policy relevance. Finally, Section 5 concludes by synthesizing the main contributions, discussing their implications for inclusive innovation strategies, and identifying promising directions for future research.

2. LITERATURE REVIEW

The relationship between innovation and income inequality has been the subject of growing scholarly interest over the past two decades. While there is broad consensus that innovation is a key driver of long-term economic growth, its implications for income distribution remain contested. The literature can be broadly grouped into four thematic strands: (i) the direct effects of innovation on inequality, (ii) the moderating role of human capital, (iii) the institutional and macroeconomic environment, and (iv) the interplay of globalization and financial development. This section synthesizes these debates and identifies the specific contribution of this paper to the academic conversation.

2.1 Innovation and Income Inequality: Conflicting Evidence

Innovation is widely recognized as a central mechanism of economic transformation. Following the Schumpeterian tradition, innovation can reduce inequality by fostering “creative destruction,” disrupting entrenched monopolies and redistributing economic rents (Antonelli & Tubiana, 2023). Empirical evidence based on quantile regressions suggests that technological change is particularly effective in lowering inequality in contexts with high initial disparities. Similarly, studies such as Aghion et al. (2005) and Hasan & Tucci (2010) emphasize that innovation-driven growth can stimulate productivity and social mobility.

Yet, a competing line of research highlights the inequality-enhancing nature of innovation. Perera-Tallo (2017) argues that biased technological change disproportionately increases the returns to reproducible assets such as capital, thereby favoring wealthier households and exacerbating disparities. In line with this argument, Jaumotte, Lall, and Papageorgiou (2013) provide evidence that skill-biased technological change, a proxy for innovation dynamics in advanced economies, has been a key driver of rising income inequality. This effect is reinforced when innovation interacts with globalization and financial development, underscoring that innovation alone is insufficient to deliver inclusive growth. Other contributions, such as Kinugasa (1998), also challenge the Schumpeterian hypothesis, showing that technological progress in Japanese airlines improved productivity without reducing inequality.

Taken together, these findings reveal an unsettled debate: innovation has the potential to either mitigate or amplify inequality depending on the broader economic and social context. This ambivalence highlights the need for research that not only estimates the direct impact of innovation but also explores the conditions under which its distributive effects vary.

2.2 Human Capital and Education as Moderators

A consistent theme across the literature is that the inclusiveness of innovation is conditional on the distribution of human capital. Soukiazis and Cravo (2008) and Lee and Lee (2018) argue that expanding access to education is fundamental for mitigating inequality and enabling the widespread diffusion of technological advances. In contexts where education and skills are unequally distributed, the gains from innovation accrue disproportionately to those with higher levels of human capital, reinforcing existing disparities.

Empirical studies confirm this dynamic. Chi (2012), analyzing educational attainment among minorities in China, finds that targeted educational improvements significantly reduce inequa-

lity by enhancing marginalized groups' access to the benefits of innovation. Castelló-Climenta and Doménech (2014), using data on 146 countries, highlight that while human capital inequality has declined globally, income inequality has remained largely unchanged, suggesting that improvements in education are necessary but not sufficient to ensure inclusive outcomes. More recently, Yang and Qiu (2016) demonstrate that disparities in early educational investments perpetuate intergenerational inequality, underscoring the importance of policy interventions such as subsidies to disadvantaged families.

Overall, the evidence points to human capital as a critical mediator: innovation tends to amplify inequality in the absence of broad-based educational opportunities but can foster convergence when coupled with equitable investment in skills.

2.3. Institutions, Inflation, and Macroeconomic Stability

A second body of work emphasizes the role of institutional quality in shaping the innovation–inequality nexus. High-quality institutions—characterized by effective governance, rule of law, and investor protection—are strongly associated with more equitable growth trajectories (Chong & Calderon, 2000). Using a panel VAR approach, Chong and Gradstein (2007) find a bidirectional relationship between institutional quality and inequality, with improvements in governance reducing inequality and high inequality eroding institutional capacity. These findings suggest that institutions are not merely background conditions but active mediators of distributive outcomes.

Other macroeconomic factors also interact with inequality. Bulíř (2001) and Cysne et al. (2005) show that inflation tends to worsen income disparities, particularly at moderate levels, by disproportionately burdening lower-income households. Goh et al. (2018) add that inequality itself contributes to social instability and crime, though the impact is moderated by institutional quality. This reinforces the argument that without robust legal and regulatory frameworks, innovation and other growth drivers may have regressive consequences.

The implication for research is clear: empirical studies of innovation and inequality must account for institutional and macroeconomic contexts. Neglecting these factors risks overstating the direct effect of technological change and underestimating the conditions required for inclusive outcomes.

2.4. Globalization, Financial Development, and Distributional Effects

Globalization and financial development have received particular attention as forces that interact with innovation to influence inequality. Evidence from European Union countries suggests that trade openness tends to have equalizing effects, expanding opportunities across the labor market, while financial globalization disproportionately benefits capital owners and skilled workers, thereby widening disparities (Asteriou et al., 2014). Bahmani-Oskooee and Ardakani (2020) further demonstrate that income inequality responds asymmetrically to economic shocks, particularly in countries with deeper financial integration.

Financial development, likewise, exhibits a non-linear relationship with inequality. Greenwood and Jovanovic (1990) propose an inverted U-curve, where inequality rises in the early stages of financial development but declines as financial systems mature and become more inclusive. Empirical evidence from Tan and Law (2012) and Park and Shin (2017) confirms that financial deepening reduces inequality only up to a certain threshold, after which it begins to exacerbate disparities. Agnello et al. (2012) highlight the importance of financial reforms, showing that dismantling restrictive credit policies can reduce inequality by broadening access to capital.

When combined with innovation, these dynamics become more complex. Sun (2024) demonstrates—using a CCEMG estimator across a broad crosscountry panel—that the relationship between technological innovation and income inequality becomes significantly more complex when interacting terms for globalization and financial development are included, revealing that global integration and financial deepening tend to amplify innovation's inequality-enhancing effects unless mediated by strong institutional frameworks.

2.5. Synthesis and Research Gap

The reviewed literature converges on three insights. First, innovation is a double-edged sword: it can either reduce or exacerbate inequality depending on contextual conditions. Second, human capital and institutional quality emerge as critical mediators, determining whether innovation fosters broad-based gains or entrenches disparities. Third, globalization and financial development play pivotal but ambivalent roles, capable of amplifying inequality in the absence of inclusive policies.

Despite this growing body of work, important gaps remain. Most studies focus on either the direct effect of innovation on inequality or the role of mediators in isolation. Few contributions systematically integrate innovation, globalization, financial development, and institutional quality into a unified empirical framework. Moreover, much of the evidence relies on cross-sectional data or is limited to specific regions, raising questions about the generalizability of the findings.

This paper addresses these gaps by examining the innovation–inequality nexus across OECD countries from 1996 to 2022, employing a time-series panel approach that explicitly accounts for cross-sectional dependence. By incorporating mediating factors such as globalization and financial development, the study provides a more comprehensive understanding of the conditions under which innovation contributes to inclusive or exclusive economic outcomes. In doing so, it contributes to the ongoing debate on how technological progress can be harnessed to promote equity in advanced economies.

3. METHODOLOGY

3.1 Variables and Data Sources

To empirically assess the relationship between innovation, globalization, financial development, and income inequality, we constructed a balanced panel dataset covering 38 OECD countries over the period 1996–2022. The focus on OECD economies ensures relative homogeneity in institutional frameworks and data availability, thereby enhancing comparability across countries, although at the expense of reduced variability in inequality measures. This trade-off allows the analysis to capture the dynamics of advanced economies characterized by mature financial systems and innovation-driven growth. The dataset integrates multiple internationally recognized sources, including SWIID, WIPO, the World Bank's World Development Indicators, the KOF Globalization Index, the IMF Financial Development Index, and the International Country Risk Guide, which together provide harmonized, long-term, and cross-country comparable measures of the variables under study.

In what follows, we provide a detailed description of the dependent, core explanatory, and control variables, along with their respective sources, to clarify the operationalization of the constructs included in the empirical analysis.

- **Income Inequality:** The dependent variable is the Gini coefficient from the Standardized World Income Inequality Database (SWIID), which provides harmonized and comparable measures across countries and over time.
- **Innovation:** The core explanatory variable is patent applications per labor force, sourced from the World Intellectual Property Organization (WIPO). While patents primarily capture inventive activity rather than innovation diffusion or quality, they remain the most widely available and standardized proxy for cross-country, long-term analyses.
- **Human Capital:** Approximated by life expectancy (World Bank, WDI). Although less direct than educational attainment or years of schooling, this proxy ensures consistent coverage across the sample and period. The limitations of this choice are acknowledged in the discussion.
- **Globalization:** Measured using the KOF Globalization Index, which integrates economic,

social, and political dimensions of global integration.

- Financial Development: Captured by the IMF Financial Development Index, which reflects financial depth, access, and efficiency.
- Other Controls: Real GDP per capita (WDI), inflation (WDI), and institutional quality (International Country Risk Guide, ICRG). These variables account for structural and macroeconomic conditions shown in the literature to influence inequality.

3.2. Econometric Framework

This study investigates the link between innovation and income inequality in OECD countries from 1996 to 2022 using a heterogeneous panel data framework. A central challenge in this type of analysis is the presence of cross-sectional dependence arising from global shocks—such as financial crises, technological spillovers, or international trade shocks—that affect all countries simultaneously. Another challenge is slope heterogeneity, since the impact of innovation on inequality may differ depending on each country’s institutional strength, financial structure, and human capital endowment.

To address the issue of cross sectional dependence and unobserved common factors, we employ the Common Correlated Effects Mean Group (CCEMG) estimator proposed by Pesaran (2006). This approach extends the conventional Mean Group (MG) estimator by augmenting each unit’s regression with cross sectional averages of the dependent and independent variables, thereby capturing unobserved common shocks that may bias standard estimators.

Formally, consider the panel data model:

$$y_{it} = \alpha_i + \beta_i' x_{it} + u_{it}, \quad i = 1, \dots, N, \quad t = 1, \dots, T$$

where y_{it} is the dependent variable, x_{it} is a $k \times 1$ vector of regressors, and u_{it} represents the error term. A central concern in macro panels is that u_{it} may contain unobserved common factors f_t that are correlated with the regressors:

$$u_{it} = \lambda_i' f_t + \varepsilon_{it}$$

with λ_i denoting unit specific factors loadings and ε_{it} idiosyncratic errors. If such factors are ignored, parameter estimates may be biased and inconsistent.

The CCEMG approach addresses this by augmenting the regression with cross sectional averages of both dependent and independent variables:

$$y_{it} = \alpha_i + \beta_i' x_{it} + \gamma_{0i} \bar{y}_t + \gamma_{1i} \bar{x}_t + \varepsilon_{it}$$

where

$$\bar{y}_t = \frac{1}{N} \sum_{j=1}^N y_{jt}, \quad \bar{x}_t = \frac{1}{N} \sum_{j=1}^N x_{jt}$$

These averages proxy for the unobserved common factors f_t , allowing consistent estimation of β_i .

The CCEMG estimator is then obtained by estimating the augmented regression for each cross sectional unit i and averaging the estimated coefficients across all units:

$$\hat{\beta}_{CCEMG} = \frac{1}{N} \sum_{i=1}^N \hat{\beta}_i$$

In empirical settings involving OECD economies, the presence of pervasive yet asymmetrically transmitted global shocks—such as financial crises or the diffusion of technological innovations—renders conventional estimators based on homogeneity and cross-sectional independence inadequate. The Common Correlated Effects Mean Group (CCEMG) estimator provides a robust alternative by addressing three critical econometric challenges. First, it accommodates slope heterogeneity, thereby capturing country-specific responses that reflect distinct institutional structures, innovation dynamics, and inequality patterns. Second, through the inclusion of cross-sectional averages, it effectively controls for unobserved common factors, mitigating biases that arise from omitted global shocks. Third, it delivers consistent inference in panels characterized by nonstationarity, a recurrent feature of macroeconomic series observed over extended horizons. Collectively, these properties make CCEMG particularly well-suited for analyzing heterogeneous yet interconnected economies, offering more reliable insights than pooled or fixed-effects estimators.

A potential concern in heterogeneous panel frameworks is the treatment of the idiosyncratic error term, ϵ_{it} . In this study, ϵ_{it} is allowed to display weak serial correlation, a feature often observed in macroeconomic panels with long time spans. Importantly, however, the error term is assumed to remain exogenous, meaning it is uncorrelated with both the observed regressors and the unobserved common factors. This ensures that the presence of mild autocorrelation does not bias coefficient estimates, preserving the consistency of the CCEMG estimator.

The specification also relies on a multifactor error structure in which strong cross-sectional dependence is captured through the common factors f_t . Any remaining correlation in the idiosyncratic component across countries is assumed to be weak, a standard assumption in the literature that allows for robust inference without overstating the independence of country-specific shocks. Making these assumptions explicit clarifies the econometric foundations of the model and enhances its transparency.

Building on these methodological considerations, we now introduce the baseline model, which formalizes the relationship between innovation, inequality, and global shocks within the CCEMG framework.

$$IIE_{it} = \alpha_i + \beta_1 INNO_{it} + \beta_2 X_{it} + \mu_{it}$$

where IIE_{it} is income inequality measured by Gini index, $INNO_{it}$ denotes innovation (proxied by patent applications), X_{it} is a vector of control variables, and μ_{it} is the error term. The country specific intercept α_i captures unobserved heterogeneity across countries.

To test the conditional effects of globalization and financial development, we expand the model to include interaction terms:

$$IIE_{it} = \alpha_i + \beta_1 INNO_{it} + \beta_2 X_{it} + \beta_3 (INNO_{it} \times Z_{it}) + \mu_{it}$$

where Z_{it} represents either globalization or financial development. These terms enable us to evaluate whether innovation’s distributive consequences are amplified or moderated by structural features of the economy.

For precision and replicability, we define the vector of regressors \mathbf{X} as comprising the core variables of interest—innovation, globalization, and financial development—while the control vector \mathbf{Z} includes the set of macroeconomic and institutional covariates: GDP per capita, inflation,

and institutional quality. Explicitly separating these components ensures that the estimated parameters for innovation and its interactions are not conflated with the broader set of controls needed to isolate their effect on income inequality.

Finally, to avoid conceptual ambiguities, it is also useful to distinguish between mediating and conditioning variables. Mediating variables represent mechanisms through which innovation exerts its influence on inequality, while conditioning variables capture structural features that alter the intensity or direction of this effect. In this framework, globalization and financial development are treated as conditioning factors, as they shape the distributional consequences of innovation rather than mediate its direct impact. Human capital and institutional quality, by contrast, function as mediating variables, mitigating the extent to which technological change exacerbates inequality. This distinction reinforces the interpretive clarity of the empirical strategy.

4. EMPIRICAL RESULTS

First, we conducted a Variance Inflation Factor (VIF) (Table 1) test to assess multicollinearity among explanatory variables, which is critical for ensuring unbiased estimates of model coefficients. The VIF results indicate that the mean VIF values for all models are below the threshold of 5, confirming that multicollinearity is not a concern. This suggests that the relationship among innovation, globalization, financial development, and other explanatory variables is appropriately captured without undue distortion from collinear predictors.

Table 1. Variance Inflation Factor in Multicollinearity Test.

Variables	
Innovation	1.58
Inflation	1.24
Life expectancy	2.41
Real GDP per capita	2.8
Globalization	2.88
Financial Development Index	3
Institutions	2.76
Mean VIF	2.38

Source: Authors' calculations

To address cross-sectional dependence (CD), we applied the Pesaran (2006) CD test (Table 2), which confirmed significant interdependence across all variables. This necessitated employing second-generation panel data methodologies, such as the Common Correlated Effects Mean Group (CCEMG) estimator, to account for these dependencies rigorously. We further assessed the stationarity of the series using the Pesaran panel unit root test.

Table 2. Average Correlation Coefficients and Pesaran (2007) Cross-Sectional Dependence (CD) Test.

Variable	CD test	p-value	Corr.	abs(corr)
Gini	3.04	0.002	0.022	0.369
Innovation (total patents applications/ population)	6.22	0	0.045	0.478
Inflation	39.61	0	0.287	0.336
Life expectancy	123.88	0	0.899	0.899
Real GDP per capita	114.44	0	0.831	0.836
Globalization	125.15	0	0.908	0.908
Institutions	12.16	0	0.088	0.46
Financial Development Index	65.69	0	0.477	0.54

Source: Authors' calculations

As reported in Table 3, the unit root tests reveal that all variables are integrated of order one $I(1)$, with the exception of inflation and institutional quality, which are stationary at level $I(0)$. Confirming the order of integration is essential to prevent spurious correlations and to ensure the reliability of the estimated relationships, thereby enhancing the robustness and credibility of the empirical results.

Table 3. Pesaran’s (2003) Panel Unit-Root Test in Presence of Cross-Sectional Dependence.

Variable	Level		First difference
	Constant	Constant with trend	Constant
Gini	-2.289***	-3.022***	-4.151***
Innovation- patents applications/ population	-1.691	-1.981	-2.876***
Inflation	-2.828***	-2.931***	-4.258***
Human capital (life expectancy)	-2.093**	-2.41	-3.895***
Real GDP per capita	-1.691	-1.981	-2.876***
Globalization	-2.023**	-2.285	-3.571***
Institutions	-1.657	-2.223	-3.569***
Financial development index	-2.498***	-3.001***	-3.604***

Source: Authors’ calculations

Having established the absence of multicollinearity, confirmed the presence of cross-sectional dependence, and verified the order of integration of the variables, we proceed to present the empirical estimations. Tables 4 and 5 report the baseline CCEMG results and the extended models with interaction effects, allowing us to assess both the direct impact of innovation on inequality and the moderating roles of globalization and financial development.

4.1 Baseline Results

As shown in Table 4, innovation is associated with higher inequality across all model specifications. Human capital and institutional quality, by contrast, display negative and significant coefficients, confirming their mitigating role in reducing inequality. This finding echoes Soukiazis and Cravo (2008), Lee and Lee (2018), and Chi (2012), who emphasize that improvements in education are essential for ensuring that innovation translates into broad-based gains. Institutional quality results are consistent with Chong and Calderon (2000) and Chong and Gradstein (2007), underscoring that stronger governance frameworks counterbalance the regressive potential of technological change. Inflation, meanwhile, shows a positive association with inequality, consistent with Bulíř (2001) and Cysne et al. (2005), who argue that rising prices disproportionately harm lower-income households.

Table 4. Results of the Common Correlated Effects Mean Group (CCEMG) estimation. Dependent variable: Income Inequality (Gini index). Independent variable: Innovation, measured as Patents Applications per Labor Force.

Variables	Model (1)	Model (2)	Model (3)	Model (4)
Innovation	0.35805* (0.1849)	0.360250* (0.18619)	0.36105* (0.18985)	0.36405* (0.19029)
Inflation	0.017924*** (0.00151)	-0.01706*** (0.00519)	-0.01926*** (0.00572)	-0.03062*** (0.00965)
Real GDPPC	-0.07155 (0.09422)	-0.06915 (0.10165)	-0.0888 (0.06755)	-0.0851 (0.07115)
Institutions	-0.022139*** (0.00487)	-0.016139*** (0.03606)	-0.014239*** (0.00321)	-0.009339*** (0.00215)
Human Capital	-0.47308*** (0.11716)	-0.49018*** (0.11840)	-0.57618*** (0.12869)	-0.58398*** (0.12878)
Globalization		0.072866*** (0.02769)		0.066866** (0.02746)
Financial Development			-0.0339** (0.0135)	-0.0311** (0.0135)
T	1026	1026	1026	1026
Number of Countries	38	38	38	38

Source: Authors' calculations

Interestingly, GDP per capita remains insignificant in most specifications, suggesting that higher levels of economic development alone do not ensure more equitable outcomes. This nuance aligns with Castelló-Climenta and Doménecha (2014), who show that improvements in human capital have reduced inequality only marginally, as structural forces such as globalization and skill-biased change offset these effects.

4.2 Globalization and Financial Development as Mediators

Table 5 introduces interaction terms between innovation and globalization, and between innovation and financial development. Both interactions are positive and statistically significant, indicating that these two structural factors magnify the inequality-enhancing effects of innovation. Globalization's effect is consistent with Asteriou et al. (2014) and Bergh & Nilsson (2010), who demonstrate that international integration often raises inequality by rewarding mobile capital and highly skilled workers. Similarly, the positive interaction between innovation and financial development supports the inverted U-shaped hypothesis of Greenwood and Jovanovic (1990), later confirmed by Tan and Law (2012) and Park and Shin (2017): while early stages of financial deepening may reduce inequality, beyond a threshold, the expansion of finance tends to concentrate benefits among economic elites.

Table 5. Results from the Common Correlated Effects Mean Group (CCEMG) Estimation with Interaction Terms.

Dependent Variable: Income Inequality (Gini Coefficient, SWIID)

Independent Variable: Innovation (Patent Applications per Labor Force)

Variables	Model 1(a)	Model 1(b)
Innovation	0.0405*** (0.0151)	0.0306*** (0.0050)
Inflation	0.0029*** (0.0009)	0.0404*** (0.0088)
Real GDPPC	-0.0239 (0.0327)	-0.009 (0.0416)
Institutions	-0.0044*** (0.0009)	0.0385*** (0.0109)
Human Capital	-0.1421*** (0.0348)	-0.336*** (0.0660)
Globalization	-0.2532*** (0.0716)	
Globalization * Innovation	0.0545*** (0.0198)	
Financial Development		-0.0062*** (0.0009)
Financial Development * Innovation		0.0909*** (0.0144)
T	1026	1026
Number of Countries	38	38

Source: Authors' calculations

These results point to the importance of examining the mechanisms through which structural factors condition the distributive effects of innovation. In the case of globalization, innovation interacts with expanded trade and capital mobility in ways that disproportionately reward highly skilled workers and capital-intensive firms, thereby reinforcing inequality rather than diffusing gains broadly (Bergh & Nilsson, 2010; Asteriou et al., 2014). Financial development exerts a similar amplifying role: while early stages of financial deepening may enhance inclusion by widening access to credit and supporting entrepreneurial activity, beyond a certain threshold its benefits become increasingly concentrated among incumbents with superior collateral, technological capabilities, and integration into global markets. This inverted-U dynamic (Greenwood & Jovanovic, 1990; Tan & Law, 2012; Park & Shin, 2017) is particularly evident in OECD countries, where sophisticated financial systems channel disproportionate resources to innovation-intensive sectors. Recent evidence by Sun (2024) further corroborates that when innovation and financial development expand simultaneously without strong institutional safeguards, the inequality-enhancing effects of technological change are magnified.

Together, these dynamics underscore that financial development not only facilitates innovation but also moderates its distributive outcomes, alternating between phases of relative inclusiveness and pronounced regressiveness depending on the depth and equity orientation of the financial system.

4.3 Synthesis and Discussion

Taken together, the results highlight that innovation in OECD countries has not served as an equalizing mechanism but rather as a factor reinforcing disparities, particularly when combined with globalization and financial development. These findings provide robust evidence that innovation's distributive consequences are conditional and context-dependent, challenging the Schumpeterian expectation that technological change inherently promotes convergence. Instead, the evidence underscores that the benefits of innovation accrue disproportionately to groups with greater access to skills, capital, and global markets.

A key contribution of this analysis is to demonstrate that innovation cannot be evaluated in isolation. Its effects on inequality are mediated by the structural environment in which it unfolds. The positive interactions with globalization and financial development confirm that these forces magnify the regressive aspects of innovation unless tempered by inclusive institutions and equitable access to financial opportunities. This result resonates with recent empirical work stressing the inequality-amplifying potential of global integration and financial deepening in advanced economies.

At the same time, the mitigating influence of human capital and institutional quality offers an important corrective. The results confirm the arguments of Castelló-Climent and Doménecha (2014) and Yang and Qiu (2016) that education, while necessary, is insufficient on its own to reduce inequality. Without targeted policies that expand advanced skills and strengthen governance, educational gains may be neutralized by broader structural dynamics. Likewise, the consistent negative role of institutional quality emphasizes that effective governance is not a peripheral condition but a central determinant of whether innovation translates into inclusive growth.

Overall, this synthesis shows that innovation functions as a double-edged sword: it is a powerful driver of economic transformation but one whose distributive outcomes depend critically on complementary policies. By situating innovation within a multidimensional framework that accounts for globalization, financial development, education, and governance, this study advances the debate on the innovation-inequality nexus and clarifies the structural conditions under which technological progress can foster shared prosperity rather than entrenched disparities.

4.4 Policy Implications

The empirical evidence underscores that innovation in OECD countries, while vital for long-term growth, has tended to exacerbate inequality when operating in environments marked by globalization and uneven financial development. This suggests that innovation cannot be relied upon as an inherently inclusive force; rather, its distributional outcomes depend on the institutional and policy frameworks in place. Strengthening education systems and expanding access to advanced skills are essential to ensure that the benefits of technological change are broadly shared, in line with the literature emphasizing the central role of human capital in reducing inequality (Soukiazis & Cravo, 2008; Lee & Lee, 2018). At the same time, institutional reforms aimed at enhancing transparency, rule of law, and social protections are critical to prevent innovation and global integration from disproportionately benefiting economic elites (Chong & Gradstein, 2007). Finally, policies that promote financial inclusion—such as broadening access to credit and regulating speculative capital flows—can mitigate the inequality-enhancing effects of financial development, echoing evidence that inclusive reforms make finance a tool for equity rather than concentration (Agnello et al., 2012). Taken together, these measures highlight that the challenge for policymakers is not to curtail innovation, but to design complementary frameworks that transform technological progress into a driver of inclusive and sustainable prosperity.

5. CONCLUSIONS

This paper has examined the relationship between innovation and income inequality in 38 OECD countries from 1996 to 2022, employing the Common Correlated Effects Mean Group (CCEMG) estimator to address cross-sectional dependence, slope heterogeneity, and nonstationarity. The results provide compelling evidence that innovation, proxied by patent activity, has not functioned as an equalizing force in advanced economies. Instead, technological change has systematically reinforced disparities, with its benefits disproportionately captured by groups endowed with higher skills, capital, and access to global networks.

A first major conclusion is that innovation in OECD countries has tended to amplify inequality rather than mitigate it, highlighting the limits of the Schumpeterian expectation that technological progress inherently generates convergence. The findings underscore that the distributive impact of innovation is highly conditional on structural and institutional contexts, rather than universal or automatic.

Second, the analysis demonstrates that complementary factors—particularly human capital and institutional quality—play a decisive role in shaping the inclusiveness of innovation. The mitigating effects of education and governance confirm that innovation-driven growth can only translate into broad-based welfare gains when accompanied by strong institutional frameworks and equitable investment in human capital. Without these conditions, technological advances risk entrenching inequality and undermining social cohesion.

Third, the results reveal that globalization and financial development amplify the inequality-enhancing effects of innovation. These dynamics suggest that the international and financial environment in which innovation unfolds is as consequential as innovation itself. In contexts of deep financialization and global integration, the absence of inclusive institutions and financial safeguards exacerbates the regressive tendencies of technological change, concentrating benefits among elites.

Fourth, macroeconomic stability also matters. Inflation is found to be positively associated with inequality, confirming that economic instability disproportionately harms lower-income groups. Meanwhile, GDP per capita does not display a robust association with inequality, indicating that growth alone, in the absence of structural reforms, is insufficient to ensure equitable outcomes.

These conclusions carry important policy implications. For innovation to become a driver of inclusive prosperity rather than divergence, governments must go beyond promoting technological progress in isolation. Investments in education, particularly in advanced and digital skills, must be paired with institutional reforms that enhance governance, transparency, and the rule of law. Equally important are policies that foster inclusive financial systems, expand access to credit, and regulate speculative flows, ensuring that financial development complements rather than undermines distributive equity. Taken together, these measures can transform innovation into a foundation for sustainable and shared growth.

The study also highlights several limitations that open avenues for future research. First, innovation was proxied exclusively by patents, which, while standardized and comparable across countries, may not fully capture the quality, diffusion, or inclusiveness of technological change. Future studies should incorporate alternative indicators, such as the Global Innovation Index or measures of digital adoption. Second, human capital was proxied by life expectancy, a choice driven by data availability but less precise than education-based measures. Expanding analyses with richer datasets on skills and educational attainment could refine the understanding of how human capital mediates inequality. Third, the exclusive focus on OECD economies, while ensuring homogeneity in institutions and data comparability, reduces external validity. Extending the scope to emerging and developing countries would enhance generalizability and shed light on whether innovation's distributive effects differ across levels of development. Fourth, additional factors such as labor market institutions, fiscal policies, and demographic shifts remain unexplored but could provide critical insights into the broader innovation-inequality nexus.

In conclusion, this study advances the debate on innovation and inequality by situating technological change within a multidimensional framework that integrates education, institutions, globalization, and finance. The evidence demonstrates that innovation is not inherently inclusive or exclusive but conditional on the environments in which it operates. Future research that incorporates broader datasets, alternative measures of innovation, and more diverse contexts will be essential to refine these insights and guide policies capable of ensuring that technological progress becomes a catalyst for equity and sustainable development in the twenty-first century.

5.1. Limitations and Future Research

This study is subject to several limitations that should be acknowledged. First, the use of life expectancy as a proxy for human capital is admittedly unconventional, as education-based indicators such as years of schooling or tertiary enrollment more directly capture the accumulation of human capital. The reliance on life expectancy was motivated by its consistent availability across OECD countries and over time, yet this choice may attenuate the estimated effects and understate the role of education in mediating inequality. Second, the exclusive focus on OECD economies limits the variability of key variables such as the Gini index and macroeconomic indicators. While this enhances comparability across relatively homogeneous countries, it reduces external validity and constrains the generalizability of the findings to more heterogeneous or developing contexts. Third, although multicollinearity tests did not yield statistically significant concerns, observable correlations among independent variables and potential endogeneity cannot be fully ruled out, which may bias coefficient estimates and complicate causal interpretation. Fourth, the model omits certain potentially relevant factors—such as labor market institutions, fiscal policies, or demographic dynamics—and relies on proxies that, while widely used, may not fully capture the underlying constructs. Finally, innovation is measured exclusively through patent activity. While patents offer a standardized and longitudinally consistent indicator, they may overrepresent formal inventive activity and understate dimensions such as innovation quality or diffusion. Alternative measures, such as the Global Innovation Index (GII), could provide complementary insights and may yield different magnitudes or directions of effect. Future research should address these limitations by incorporating richer and more nuanced measures of human capital and innovation, extending the analysis to non-OECD economies with greater heterogeneity, and exploring robustness checks with alternative proxies and model specifications. Such extensions would strengthen the external validity and refine the understanding of the innovation–inequality nexus.

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