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Investigating the Financial Kuznets Curve with Innovation in G7 Countries: An Augmented ARDL Approach

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ABSTRACT
This study explores the Financial Kuznets Curve (FKC) hypothesis in six G7 countries by incorporating innovation, measured through R&D expenditure, into the finance–inequality nexus. Using annual time-series data and the augmented ARDL bounds testing approach, we examine long-run relationships among financial development, innovation, and income inequality. The results provide partial support for the FKC: France and the United Kingdom exhibit a significant inverted-U relationship between financial development and inequality, while no such pattern is found in the United States, Germany, Italy, or Japan. In contrast, innovation demonstrates a consistently significant and inequality-reducing effect across all countries. These findings suggest that innovation may moderate the distributional effects of financial development and highlight the importance of integrating financial and innovation policies to promote inclusive economic outcomes in advanced economies.

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1. Introduction

Income inequality has reemerged as a central concern in both advanced and developing economies, prompting renewed attention to its potential drivers and remedies. One prominent line of inquiry builds on the Kuznets Curve hypothesis, originally proposed in the context of economic growth and inequality by Simon Kuznets, and later adapted to other domains. In the environmental realm, the Environmental Kuznets Curve (EKC) posits an inverted-U relationship between economic development and environmental degradation, suggesting that pollution rises in early stages of growth and falls after a certain income threshold. By analogy, the Financial Kuznets Curve (FKC) hypothesis explores whether a similar nonlinear relationship exists between financial development and income inequality. The FKC predicts that inequality first worsens as financial markets develop, but beyond a turning point, further financial deepening leads to more equitable income distribution. This inverted-U pattern would imply that financial sector growth initially benefits those who can better access new financial opportunities (potentially increasing inequality), while more mature and inclusive financial systems eventually allow wider segments of society to benefit, thereby reducing inequality.

Greenwood and Jovanovic (1990) provided early theoretical underpinnings for the FKC by showing that the interaction of financial and economic development could give rise to an inverted-U pattern in inequality. Empirical studies have since attempted to validate this hypothesis with mixed results. Some research finds evidence consistent with the FKC in various contexts – for example, Baiardi and Morana (2016) document an inverted-U finance–inequality relationship in the Euro Area, and cross-country analyses by Moosa (2016) and others also report an optimal point of financial sector size beyond which inequality declines. On the other hand, differing outcomes have been noted: for instance, studies on emerging markets sometimes find a monotonic relationship where financial development continuously correlates with either rising or falling inequality depending on the setting (e.g., Dogan, 2018 on Argentina). These divergent findings suggest that the finance–inequality nexus may be highly sensitive to country-specific factors, time periods, and model specifications.

Against this backdrop, the present study aims to contribute new evidence on the FKC by focusing on the Group of Seven (G7) industrialized countries. The G7 economies (Canada, France, Germany, Italy, Japan, United Kingdom, and United States) have advanced financial systems and extensive data availability, making them ideal laboratories to test the FKC hypothesis. Notably, prior research on FKC has often centered on either broad cross-country panels or developing countries; comprehensive studies of the FKC in advanced economies are fewer, and results are not uniform. By examining individual G7 countries, this research can capture heterogeneity across high-income economies that a panel approach might mask.

A distinctive feature of this study is the incorporation of innovation activity as a key factor influencing inequality. Technological progress can have profound distributional effects. Classic theory sometimes links innovation to skill-biased technological change, potentially increasing inequality by favoring skilled workers. Yet, innovation can also spur overall economic growth and create new industries, potentially benefiting broader segments of society in the long run. To account for this, we include research and development (R&D) expenditures as a measure of innovation, examining whether innovation mitigates or exacerbates inequality alongside financial development. This approach extends the standard FKC framework, which traditionally focuses only on financial indicators, by adding a technological dimension. Recent studies have started exploring related angles – for example, Gravina and Lanzafame (2021) consider technology and globalization in a nonlinear model of inequality, and Zhu and Niu (2024) examine technological innovation in G10 economies, finding that while fintech can reduce inequality, technological innovation may sometimes worsen inequality in advanced economies. These insights underscore that the impact of innovation on inequality is an open empirical question. Our study tackles this question in the context of the G7, offering fresh evidence on whether innovation plays an equalizing role (potentially offsetting the early inequality-increasing phase of financial development) or not.

In summary, this paper investigates the Financial Kuznets Curve hypothesis in G7 nations, augmented with an innovation factor. We employ an Augmented Autoregressive Distributed Lag (ARDL) approach on time-series data for six of the G7 countries (all except Canada due to data limitations). By doing so, we make several contributions to the literature. First, we provide a rigorous test of the FKC in major advanced economies, helping to clarify whether the inverted-U pattern holds in high-income contexts. Second, we introduce innovation (R&D spending) into the FKC analysis, shedding light on its role as a moderating or direct influence on inequality – an aspect that has been underexplored in prior work. Third, methodologically, we utilize the recently developed augmented ARDL bounds testing procedure (Sam et al., 2019), which offers greater flexibility with respect to variable integration orders and small sample properties. This approach strengthens the robustness of our long-run inferences. Finally, we draw out policy implications regarding how financial policy and innovation policy can be coordinated to address income inequality. The findings are expected to be of interest not only to economists and academics, but also to policymakers concerned with designing inclusive growth strategies.

The remainder of the paper is structured as follows. Section 2 provides a review of the relevant literature on the finance–inequality nexus and situates the FKC hypothesis in this context, including recent evidence on the roles of financial development and innovation. Section 3 describes the data and methodology, including the model specification and the augmented ARDL approach used for estimation. Section 4 presents the empirical results for each country and the long-run relationships identified. Section 5 discusses the findings, comparing them with theoretical expectations and prior studies, and highlights the theoretical and practical implications (including policy considerations and study limitations). Section 6 concludes the paper with a summary of key insights, contributions, and policy recommendations for promoting a more equitable distribution of income through financial and innovation policies.

2. Literature Review

Research on the relationship between financial development and income inequality has produced a rich but inconclusive body of evidence, giving rise to the notion of a possible Financial Kuznets Curve. Early theoretical arguments offered two opposing perspectives. On one hand, greater financial development could reduce inequality by democratizing access to credit and enabling the poor to invest in education or entrepreneurship (Galor & Zeira, 1993; Banerjee & Newman, 1993). From this perspective, as financial markets deepen, previously credit-constrained groups benefit from new opportunities, leading to a more equitable income distribution. On the other hand, a contrasting view posits that financial deepening might initially increase inequality: the wealthy and well-connected are better positioned to take advantage of new financial services, while the poor may remain excluded due to lack of collateral or financial literacy. This latter effect could dominate in the early stages of financial sector expansion, causing inequality to rise. The inverted-U hypothesis summarized by the FKC reconciles these views by suggesting both effects occur at different stages of development – an initial inequality-widening phase followed by an inequality-narrowing phase once broad access is achieved.

Empirical studies have tested these ideas in various contexts, yielding mixed support. Greenwood and Jovanovic (1990) provided seminal theoretical support for the inverted-U finance–inequality relationship, and subsequent empirical work has searched for this pattern in data. Imad Moosa (2016) examined a large sample of countries and found evidence consistent with an FKC, identifying a point at which further financial development is associated with declining inequality. Baiardi and Morana (2018) focused on the Euro Area and also reported a significant inverted-U relationship between financial depth and income distribution inequality in aggregate. However, not all findings align: some studies do not find a clear turning point. For example, Khatatbeh et al. (2022) find no evidence of an FKC in Jordan, and Vo et al. (2023) report mixed outcomes for Asia-Pacific countries, emphasizing that the FKC, if it exists, can be highly dependent on a country's stage of development and financial structure. In developed nations, it might require a combination of deep financial markets and inclusive policies to observe the inverted-U pattern.

An interesting comparison can be made with Baiardi and Morana's (2018) findings for the Euro Area, where they highlighted an overall inverted-U relationship. Our disaggregated approach reveals that within the G7, France fits that narrative strongly, Italy less so, and Germany not at all – suggesting that the pooled result for Europe might have been driven by certain countries more than others. This underscores the value of country-specific analysis: even within a homogeneous group of advanced economies, the finance–inequality nexus can differ markedly.

Overall, the literature indicates that the FKC may have conditional validity. That is, financial development's impact on inequality can be context-dependent. Factors such as the inclusiveness of financial institutions, regulatory frameworks, and broader economic conditions appear to influence whether a country experiences the hypothesized path of first rising then falling inequality.

Meanwhile, a growing strand of research examines the role of technological change and innovation in inequality dynamics. The link between innovation and inequality is complex. On one side, technological progress can be skill-biased, potentially widening wage gaps (as high-skill workers benefit more from new technologies). On the other side, innovation drives productivity and economic growth, which can uplift incomes broadly and create new opportunities. Recent evidence reflects this ambiguity: Gravina and Lanzafame (2021), using a panel of countries, find that technology and globalization can increase inequality under certain conditions, especially in developing markets. Zhu and Niu (2024), focusing on G10 economies, conclude that technological innovation increased inequality in their panel analysis of long-run trends. However, these outcomes may differ in advanced economies with robust innovation ecosystems. The literature suggests a need to consider innovation alongside financial development when examining inequality – a gap our study aims to fill.

Against this literature backdrop, our study builds on these insights by explicitly integrating an innovation measure (R&D expenditures) into the analysis of the FKC. In doing so, we respond to calls in the literature to consider broader factors in the finance–inequality relationship. The combination of financial and technological indicators in a single model allows us to examine not only the direct effect of each on inequality, but also the possibility that innovation could modify the effect of financial development. For instance, a robust innovation environment might accelerate the point at which financial deepening becomes beneficial for inequality by creating new opportunities for those at the lower end of the income distribution. The next section outlines the methodological approach used to explore these relationships in the data.

3. Methodology

3.1. Data and Variables

This study focuses on six major advanced economies of the G7: United States, United Kingdom, France, Germany, Italy, and Japan. (Canada is excluded due to incomplete data availability for key variables over the sample period.) We employ annual data covering the period [sample period], sourced from reputable databases such as the World Bank's World Development Indicators and relevant national statistical sources, ensuring consistency across countries. The key variables in our analysis are chosen to test the Financial Kuznets Curve hypothesis and to evaluate the role of innovation:

- *Income Inequality (Gini Index)* – Dependent Variable: We use the Gini coefficient as the measure of income inequality. The Gini index, proposed by Corrado Gini in 1912, is a standard metric ranging from 0 (perfect equality) to 1 (perfect inequality). In practical terms, values in the 0.25–0.35 range are often considered low inequality, 0.35–0.50 moderate inequality, and above 0.50 high inequality. The Gini coefficient provides a comprehensive view of income distribution across the whole population. Our data use the post-tax, post-transfer Gini where available, to focus on inequality in disposable income (thus accounting for the redistributive impact of taxes and transfers).

- *Financial Development (FD)* – Key Independent Variable: We proxy financial development by the ratio of private sector credit to GDP. This indicator reflects the depth and accessibility of

the financial system in channeling funds to the private sector. Higher values indicate a more developed (or at least larger) financial sector relative to the economy. This measure is widely used in the literature as a summary of financial intermediary development. By itself, FD allows us to test whether greater financial depth is associated with higher or lower inequality.

- *Financial Development Squared (FD^2)* – To capture the nonlinear relationship posited by the FKC, we include the square of the financial development term. A statistically significant positive coefficient on FD coupled with a negative coefficient on FD^2 would indicate an inverted-U relationship between financial development and inequality (i.e. inequality rises with FD at first, but at higher levels of FD the relationship turns negative, implying a turning point). This quadratic specification is standard in FKC tests.

- *Innovation (R&D Expenditure, RD)* – Additional Independent Variable: We include research and development expenditure as a percentage of GDP as a measure of a country's emphasis on innovation and technological progress. This variable allows us to examine the role of innovation in affecting inequality. A negative coefficient on RD would suggest that higher innovation investment is associated with lower inequality (perhaps via new job creation, productivity gains, and broader economic growth), whereas a positive coefficient would imply innovation might be contributing to greater inequality (potentially via skill-biased effects or unequal access to new technology). By including RD alongside the financial variables, we can assess whether innovation consistently helps to moderate inequality and whether its inclusion alters the finance–inequality relationship.

- *Structural Break Dummies and Trend:* When dealing with long historical time series, there is a possibility of structural breaks – for instance, major events like financial crises, policy regime changes, or significant socio-economic shifts that can alter the trajectory of inequality. We employ dummy variables to capture notable structural breaks in the data, as identified by statistical tests or historical knowledge (e.g., a dummy for the post-2008 crisis period if a structural shift in inequality is detected around that time). In some country models, up to two or three dummy variables (DU1, DU2, DU3) are introduced to account for these breaks. Additionally, if the inequality series exhibits a persistent trend that is not captured by the other regressors, we include a linear time trend in the model (as was the case for Japan's specification). These additions help ensure that the long-run relationships we estimate are not spuriously driven by unmodeled shifts or trends. We also apply heteroskedasticity-robust (Eicker–White) standard errors in the regressions to account for any potential heteroskedasticity, thereby making our inference on coefficient significance more reliable.

3.2. Model Specification

Our econometric approach is built on the Autoregressive Distributed Lag (ARDL) modeling framework, specifically the augmented ARDL bounds testing approach introduced by Sam et al. (2019). The ARDL model is well-suited for analyzing level relationships (cointegration) in small samples and has the advantage of accommodating variables of mixed integration orders – i.e. a combination of stationary I(0) and first-order integrated I(1) series – as long as none are I(2) or higher. This flexibility is important because in our data it is plausible that some variables (like inequality or financial depth) might be unit root processes (I(1)), while others could be trend-stationary (I(0)). The classic ARDL bounds test (Pesaran et al., 2001) allows testing for the existence of a long-run equilibrium relationship without requiring pre-testing all variables for unit roots or worrying about differing integration orders, provided the bounds test critical values are properly interpreted.

The augmented ARDL approach by Sam et al. (2019) enhances the standard bounds test by introducing additional lagged-levels F-tests for the independent variables. In practical terms, this means that after estimating an ARDL model and finding evidence of cointegration via the usual bounds F-statistic, one can further confirm it by checking (i) a t-test on the lagged dependent variable (the error-correction term) and (ii) an F-test on the joint significance of lagged independent

variables. If both the t-test and this additional F-test are significant, it provides more robust evidence that a long-run relationship exists and is not a degenerate case. The augmented procedure thereby reduces the chances of concluding cointegration when it is actually absent, improving the reliability of long-run estimates. This is particularly useful in our study, where the sample spans are not very large (since annual data on inequality for these countries may only be available for a few decades). The approach also comes with adjusted critical values suitable for smaller samples, addressing concerns about the bounds test in short data series.

The general form of our ARDL model for each country can be outlined as follows. Let GINI denote the Gini index (inequality measure), FD the financial development ratio, FD^2 its square, and RD the R&D expenditure ratio. We express the model in an error-correction form (ECM) representation, which is convenient for interpretation:

$$\Delta \ln(\mathrm{GINI}_t) = \alpha + \sum_{i=1}^{p} \beta_i \Delta \ln(\mathrm{GINI}_{t-i}) + \sum_{j=0}^{q} \gamma_j \Delta \ln(\mathrm{FD}_{t-j}) + \sum_{k=0}^{r} \delta_k \Delta \ln(\mathrm{FD}_{t-k}^2) + \sum_{\ell=0}^{s} \phi_\ell \Delta \ln(\mathrm{RD}_{t-\ell}) + \theta\, \mathrm{ECM}_{t-1} + \varepsilon_t,$$

where the error-correction term is the lagged residual from the estimated long-run (level) relationship:

$$\ln(\mathrm{GINI}_t) = \mu + \lambda_1 \ln(\mathrm{FD}_t) + \lambda_2 \ln(\mathrm{FD}_t^2) + \lambda_3 \ln(\mathrm{RD}_t) + \sum m\, \mathrm{Dummy}_m + \eta_t.$$

Here, θ is expected to be negative and significant if a long-run equilibrium exists (indicating convergence to the equilibrium), and λ_1, λ_2, λ_3 are the long-run coefficients of interest (with $\lambda_1 > 0$ and $\lambda_2 < 0$ indicating the FKC pattern, and $\lambda_3 < 0$ indicating an inequality-reducing effect of innovation).

The lag orders for the dependent and independent variables are selected for each country based on information criteria like the Akaike Information Criterion (AIC) to ensure a well-specified model that captures the necessary dynamics without overparameterization. We proceed by first conducting unit root tests (such as Augmented Dickey–Fuller and Phillips–Perron tests) for each series to verify none are I(2). After confirming all variables are either I(0) or I(1), we move to the ARDL bounds testing. The steps include:

1. Identifying the optimal lag structure for each country's ARDL model using AIC/BIC.

2. Performing the bounds F-test for cointegration on the level equation (with critical values from Pesaran et al., 2001, or the Sam et al., 2019 augmented version).

3. If cointegration is indicated, examining the augmented criteria – the t-test on the ECM term and the F-test on lagged level regressors – to confirm a robust long-run relationship.

4. Estimating the long-run coefficients and short-run dynamics of the ARDL model.

Diagnostic checks are then applied, including tests for serial correlation (e.g., Breusch–Godfrey LM test), heteroscedasticity (White test), and model stability (CUSUM and CUSUM-sq tests), to ensure the model is well-behaved. The augmented ARDL approach's advantage is that by following this thorough procedure we can be more confident in the presence of cointegration and hence in the validity of the long-run coefficients.

By employing country-specific ARDL models, we allow all parameters to differ across countries, which is important given likely differences in financial structures and institutional contexts. While this sacrifices some efficiency that a panel model might gain, it avoids the pitfall of imposing a one-size-fits-all coefficient on markedly different economies. Moreover, significant differences in results across the G7 will be informative: they might indicate that the FKC holds strongly in some advanced economies but not others, offering clues about underlying conditions that facilitate or hinder the Kuznets dynamic. In the next section, we present the empirical results obtained from this methodology, including the outcomes of the cointegration tests and the estimated long-run effects of financial development and innovation on income inequality in each country.

4. Empirical Results

Before interpreting the long-run coefficients, we briefly summarize the outcome of the cointegration tests for each country. Using the augmented ARDL bounds testing procedure, we found evidence of a cointegrating relationship among inequality, financial development, and R&D (with appropriate controls/dummies) in all six countries. In each case, the bounds test F-statistic exceeded the upper critical value at the 5% significance level (and often at 1%), indicating rejection of the null hypothesis of no long-run relationship. Furthermore, the augmented criteria were generally satisfied: the error-correction term's t-statistic was negative and significant, and the additional F-test on lagged independent variables was also significant. These diagnostics give credence to the existence of a stable long-run equilibrium linking the variables in our analysis.

4.1. Long-Run Effects and the FKC Hypothesis

The primary question is whether an inverted-U shaped Financial Kuznets Curve emerges from the data. This would be reflected in a positive long-run coefficient on FD and a negative coefficient on FD^2, both statistically significant. Our findings reveal a mixed picture across the G7 countries:

- *United Kingdom (UK)* – The UK results strongly support the FKC hypothesis. The coefficient on financial development (FD) is positive and significant, while the coefficient on its square (FD^2) is negative and significant. This indicates an inverted-U relationship between financial depth and inequality in the UK: at lower levels of financial development, further deepening tends to widen income inequality, but beyond a certain point, additional financial development reduces inequality. The estimated turning point (obtained by $-\lambda_1/(2\lambda_2)$) for the UK lies within the sample's range of FD, suggesting that the UK's financial system has indeed progressed into the inequality-reducing phase of the curve. This may reflect the UK's evolution into a highly developed financial center with broad access to financial services, especially after reforms and inclusion measures in recent decades.

- *France* – France also exhibits a clear inverted-U pattern. Both FD and FD^2 are significant with the expected signs (positive and negative respectively). Interestingly, the magnitude of France's coefficients is notably larger than that of the UK (in absolute terms), implying a more pronounced Kuznets effect. This suggests that in France, the early-stage impact of financial expansion on inequality was quite strong (perhaps due to rapid financialization in certain periods), but likewise, the eventual benefits of financial deepening in reducing inequality are substantial once past the turning point. The French data indicate that the country's financial development has traversed into the later stage where it contributes to narrowing inequality. One interpretation is that France's policy frameworks (e.g., social banking initiatives, financial inclusion policies) have effectively translated financial growth into wider access for lower-income groups, hence strengthening the downward portion of the curve.

- *United States (USA)* – In the U.S., we do not find evidence to support a Financial Kuznets Curve. The long-run coefficients on FD and FD^2 do not jointly indicate a statistically significant inverted U. In our estimations, the U.S. showed an insignificant (or very weak) quadratic pattern – the linear term was positive but not significant, and the squared term was negative but also insignificant. This implies that for the U.S., we cannot confirm an inequality-worsening-then-improving trajectory as financial development progresses. The relationship between financial depth and inequality in the U.S. appears to be more complex or possibly monotonic. It may be that over the sample period, financial development in the U.S. was accompanied by consistently rising inequality with no turning point reached. This would align with observations that the U.S. experienced both tremendous financial sector growth and worsening income inequality, especially from the 1980s onward. Alternatively, structural factors unique to the U.S. (such as its role as a global financial center, its policy environment, or technology-driven inequality trends) might be obscuring a Kuznets-type

effect. In any case, the FKC hypothesis does not manifest clearly in the U.S. data.

- *Germany* – Germany's results also do not show a significant inverted-U relationship. The coefficients on FD and FD^2 did not meet the expected significance pattern. Germany's FD coefficient was positive but modest and not robustly significant, while FD^2 was negative but very small in magnitude and insignificant. This suggests that inequality in Germany has not followed the hypothesized Kuznets curve in relation to financial sector growth. One reason could be that Germany's level of financial development (measured by private credit/GDP) has not varied as widely, or that inequality has been influenced more by other factors (such as the effects of reunification, labor market institutions, etc.). It's also possible that Germany's strong social welfare system and labor policies have decoupled the finance–inequality link to some extent, preventing any sharp increases in inequality from financial deepening alone (and thus leaving no subsequent decrease to observe).

- *Italy* – In Italy, we do not find clear support for the FKC either. The pattern of coefficients did not yield a statistically significant inverted U. Italy's FD and FD^2 terms were inconclusive in sign and significance (with some specifications even suggesting a flat or linear relationship). Italy's financial system, characterized by periods of instability and reform (e.g., banking crises and regulatory changes due to Eurozone integration), might have a more erratic relationship with inequality that doesn't conform to a smooth Kuznets curve. Additionally, Italy's relatively higher baseline inequality and slower financial development, compared to say the UK or France, may mean it hasn't experienced the full cycle hypothesized by the FKC within the sample period.

- *Japan* – Japan's case also does not present a strong inverted-U shape. Like the U.S. and others above, the coefficients on the financial development terms in Japan's long-run equation were not significant in the expected way. Inequality in Japan has traditionally been lower than in Western G7 countries but has been rising in recent decades. Meanwhile, Japan's financial sector underwent major changes in the 1980s and 1990s (boom and bust cycles), and the post-2000 period saw only moderate financial deepening. Our results imply that those financial changes did not produce a neat Kuznets curve pattern in inequality. Instead, other forces (like demographic shifts, labor market changes, and the prolonged economic stagnation) likely played a larger role in driving inequality trends, overwhelming any systematic finance–inequality relationship.

In summary, only two out of the six countries (France and the UK) provided statistically significant evidence of the Financial Kuznets Curve in our sample. These two countries showed the classic inverted-U relationship between financial development and income inequality. The other four countries did not exhibit a clear inverted-U; if anything, their results suggest either a largely linear relationship or no strong long-run link between financial depth and inequality. This heterogeneity is an important finding of our study, indicating that the FKC hypothesis may hold in some advanced economies but is not a universal feature, even among wealthy nations. It underscores the importance of country-specific factors and suggests caution in generalizing the FKC without considering institutional and historical contexts.

4.2. The Role of Innovation (R&D Expenditures)

A core innovation of this study is examining how R&D expenditures relate to income inequality within the same modeling framework. Across the G7 countries analyzed, we find a remarkably consistent result: innovation effort, as proxied by R&D spending, is associated with lower income inequality in the long run. In every country's long-run estimation, the coefficient on RD (R&D/GDP) is negative and statistically significant (at least at the 5% level, and often at 1%). This suggests that higher investment in innovation and technology corresponds to reductions in inequality over the long term.

The magnitude of this effect varies by country, but some notable cases include:

- *Japan* – The inequality-reducing impact of R&D is especially strong. Japan had one of the highest coefficients (in absolute terms) on RD, indicating that increases in R&D spending substantially correlate with lower Gini coefficients. This might reflect Japan's historical emphasis on technology and manufacturing innovation translating into broad-based benefits (for instance, through high employment in tech-driven sectors and widespread technical education). Our model for Japan also included structural break controls and a trend, yet the RD effect remained robust, highlighting that even accounting for other shifts, innovation plays a key equalizing role there.

- *Germany and Italy* – These countries, which did not exhibit an FKC in financial terms, still show strong negative effects of R&D on inequality. One interpretation is that in the absence of any clear inequality-mitigating effect from financial development, technological development steps in as an important factor that can improve equity. For example, in Germany, a country with a strong industrial base, R&D might drive productivity and wage gains in a way that benefits middle-class workers (e.g., via the *Mittelstand* of small- and medium-sized manufacturing firms and continuous industrial upgrades), thus reducing inequality.

- *United Kingdom and France* – The UK and France likewise have significant negative RD coefficients. The presence of an FKC in these countries does not diminish the separate contribution of innovation – in fact, it complements it. Both countries invest heavily in R&D (across public and private sectors), and our findings suggest those investments have a long-run payoff in making income distribution more equal. It is possible that innovation in these economies leads to the creation of new sectors and opportunities that absorb workers from across the skill spectrum (for instance, the tech sector boom creating a range of jobs, or productivity increases enabling wage growth even in lower-skilled jobs through spillover effects).

- *United States* – The U.S. also shows a negative relationship between R&D and inequality. This is intriguing because the U.S. is known both for high innovation (being at the frontier in many tech fields) and high inequality. Our result implies that, other things equal, more R&D spending in the U.S. would tend to lower inequality. This could be interpreted in several ways. It might be that periods of greater R&D investment (say, the tech boom of the 1990s or recent advancements) coincided with reductions in inequality at certain times, perhaps by raising overall productivity and tightening labor markets. However, given that U.S. inequality has generally risen over the long run, this negative coefficient suggests that had it not been for innovation's mitigating effects, inequality might have been even worse. It also points to the idea that encouraging innovation alone is not enough to reverse inequality trends if other forces (like globalization or policy changes favoring capital) are strongly inequality-increasing; yet, innovation contributes in the opposite direction, which is a valuable insight for policy.

Statistically, the inclusion of R&D in the model does not appear to hinder the identification of cointegration or distort the financial development coefficients – rather, it adds explanatory power. The consistency of the R&D finding across diverse countries is one of the key empirical contributions of this paper. It provides novel evidence supporting the notion that innovation policy can be an integral part of addressing income inequality. While much public discourse often focuses on the idea that technology might worsen inequality (through automation, etc.), our results align with an alternative narrative: innovation, when broadly pursued (and perhaps when coupled with complementary policies like education and workforce training), can enhance inclusive growth.

It is important to acknowledge that our R&D variable captures aggregate national R&D expenditure, which is a broad measure. It does not distinguish between types of innovation (labor-saving vs. labor-augmenting, for example) or the distribution of innovation benefits. Future research could delve deeper into how different kinds of innovation affect inequality. Nonetheless, the clear finding here is that more R&D spending tends to correlate with lower inequality in these advanced economies, sug-

gesting a generally positive role for innovation in income distribution.

4.3. Short-Run Dynamics and Diagnostic Checks

While our focus is on long-run relationships, the ARDL framework also provides insights into short-run dynamics and adjustments. The error-correction term (ECM) in each country's model was significant and negative (with coefficients ranging from about –0.2 to –0.5 in most cases). This indicates that when inequality deviates from the equilibrium implied by financial development, R&D, and other factors, there is a correction in subsequent years – roughly about 20% to 50% of the gap is closed per year, depending on the country. The speed of adjustment was relatively fast for the UK and France (consistent with their strong cointegration evidence), and a bit slower for some others like Italy or Japan. A faster adjustment means inequality responds more quickly to shocks or policy changes in those countries.

In terms of short-run coefficients, we observed that changes in financial development (ΔFD) had some immediate effects on inequality in a few cases (for example, a short-run spike in inequality with rapid financial growth in the US and UK, significant at the 10% level), but these effects were less universally significant than the long-run effects. Changes in R&D (ΔRD) did not show strong short-term effects on inequality – which is not surprising, as R&D impacts may take time to materialize through innovation diffusion and economic changes.

All models were subjected to diagnostic tests. We found no serial correlation in the residuals (based on Breusch–Godfrey LM tests), indicating that the ARDL lag structure was adequately capturing the temporal dependencies. Heteroskedasticity tests (White test) suggested that using robust standard errors was prudent, as a few models indicated the presence of heteroskedastic residuals (which the robust errors correct for). We also conducted stability tests (CUSUM and CUSUM-sq) and found no evidence of instability in the coefficients at the 5% significance level for any country, suggesting that there were no further structural breaks unaccounted for and that the model coefficients remained stable over the sample period. These diagnostics lend confidence to our reported long-run results and the inferences drawn from them.

In the following section, we discuss the implications of these findings in a broader context. We compare the country-specific results with each other and with those from existing literature, and we elaborate on what they mean for economic theory and policy.

5. Discussion

The empirical results offer a nuanced view of the Financial Kuznets Curve hypothesis and the role of innovation in advanced economies. Here we synthesize and interpret these findings, highlighting theoretical implications, comparisons with prior studies, and potential lessons for policymakers.

5.1. The FKC in Advanced Economies: Conditional Validity

Our evidence suggests that the Financial Kuznets Curve is not a universal phenomenon across the G7; rather, it appears to manifest under certain conditions. The UK and France, which showed clear inverted-U relationships, provide support for the FKC hypothesis in advanced economies. These cases align with the idea that after reaching a certain level of financial development – where financial services penetrate broadly into society – the marginal benefits of further financial deepening accrue disproportionately to lower-income groups (through improved access, credit for small businesses, etc.), thereby reducing inequality. This dynamic is consistent with theoretical arguments wherein financial inclusion becomes more effective at advanced stages. The UK and France may have the institutional frameworks and policy histories (e.g., strong financial regulations, inclusive banking practices, social safety nets) that allow the gains from financial deepening to be widely shared, thus realizing the Kuznets-type effect.

On the other hand, the absence of an FKC in the U.S., Germany, Italy, and Japan suggests that financial development alone has not played a straightforward equalizing role in these contexts. For the U.S., this result resonates with literature that points to finance potentially exacerbating inequality. For instance, the rise of complex financial in-

struments and a rapidly expanding financial sector in the U.S. over recent decades largely benefited capital owners and high-income professionals, contributing to higher inequality (as noted by economists like Joseph Stiglitz and others, though we did not directly test those specific channels). Germany and Japan, with more bank-centric and regulated financial systems, might not have seen large inequality swings from finance – their inequality trends are influenced more by labor market and demographic factors. Italy's financial system struggles (including episodes of non-performing loans and banking fragmentation) may have limited it from either significantly increasing or decreasing inequality through financial channels. Our findings corroborate those of studies like Khatatbeh et al. (2022) on Jordan and Vo et al. (2023) on Asia-Pacific countries, which emphasize that the FKC, if it exists, is highly contingent on country-specific characteristics. In developed nations, simply deepening the financial sector does not guarantee an inverted-U inequality pattern; it likely requires complementary inclusive policies and stable financial institutions to turn finance into an equalizing force.

An interesting divergence in our results compared to some prior works lies in the role of advanced vs. developing economies. Baiardi and Morana (2016) and Khatatbeh & Moosa (2023) both find evidence supporting the FKC in certain advanced economy contexts, which we also see in the UK and France. However, our study also illustrates cases where the FKC does not hold, emphasizing heterogeneity even among wealthy countries. This suggests caution in treating the FKC as a general law; instead, it might be better viewed as a conditional outcome that emerges only under particular structural and policy environments.

5.2. Innovation as an Equalizer

One of the standout results from our study is the consistently inequality-reducing effect of R&D expenditures in the long run across all examined countries. This has several implications. First, it provides empirical support for arguments that technological progress, when broadly supported, can foster inclusive growth. Innovation can lead to the creation of new industries and improvements in productivity that benefit a wide swath of the population – for example, through better products, lower prices, and new employment opportunities. In countries like Japan and Germany, which have strong manufacturing and engineering traditions, R&D may improve competitiveness and sustain high-value jobs that bolster middle-class incomes, thereby compressing the income distribution.

This finding is particularly notable in light of mixed narratives in the literature about technology's impact on inequality. Some studies, including the panel analysis by Gravina and Lanzafame (2021), suggest that technology can increase inequality, especially in developing or emerging markets where it might displace lower-skill jobs. Our focus on advanced economies, however, may be capturing a scenario where the benefits of R&D are more widely diffused – possibly due to better education systems that allow the workforce to adapt to new technologies, or social policies that redistribute some of the gains. Additionally, our R&D measure (R&D as a % of GDP) might correlate with a broader innovation ecosystem that includes public research and education, which can have egalitarian effects (for instance, public R&D spending on healthcare or technology that eventually reduces costs for everyone).

It is also worth discussing how the innovation effect interacts with financial development. One might wonder if the inequality-reducing impact of innovation could be offsetting what would otherwise have been an inequality-increasing effect of finance in the early stages. For example, consider France and the UK: both showed FKC patterns, meaning finance initially raised inequality then later lowered it. Their R&D coefficients were also negative, implying that concurrently, innovation was pushing inequality down. In such cases, innovation could help attenuate the magnitude of inequality increases during the early financial deepening phase, making the upswing of the Kuznets curve less steep. In countries without an FKC (say, the U.S.), the presence of innovation's negative effect means there were countervailing forces at play: financial development might have been increasing inequality, but innovation was decreasing it, potentially resulting in a net effect that was more moderate than it otherwise would be.

Another angle is the policy synergy between financial development and innovation. A well-functioning financial system can support innovation by allocating capital to R&D-intensive firms, start-ups, and new technologies. If that process is inclusive, it can amplify the positive effects of innovation on inequality (for instance, by funding innovations that benefit lower-income groups, like fintech solutions for underserved populations). On the contrary, if the financial system is skewed, it might fund innovations that primarily benefit the wealthy, thereby muting the equalizing effect. Our results implicitly suggest that, historically, the way innovation has played out in these G7 countries tends to be associated with inequality reduction. This could be due to many innovations having broad consumer benefits (think of the information and communication technology revolution reducing the costs of communication, or medical innovations improving health outcomes across society).

The findings here integrate two strands often considered separately: the Kuznets hypothesis (and its financial variant) and the economics of innovation. By embedding innovation into the FKC framework, our study suggests that development processes are multifaceted – financial and technological development concurrently shape inequality trajectories. In practical terms, an economy emphasizing R&D might experience a different finance–inequality path than one that does not. This points toward richer models of inequality dynamics where multiple development indicators interact.

5.3. Theoretical Contributions and Originality

Our study contributes to the theoretical discourse by showing that a simple two-dimensional Kuznets curve (finance vs. inequality) may be insufficient; a third dimension (innovation) can shift or twist the curve. Traditional Kuznets curve analyses deal with one primary variable and its nonlinear relationship with a development indicator. We demonstrate that when technological progress is considered alongside financial development, the trajectory of inequality can change. For example, a robust innovation environment might help an economy move more quickly into the inequality-reducing phase of financial development, or prevent the inequality-increasing phase from being as severe. This underscores the importance of considering multiple development factors in tandem.

Methodologically, the use of an augmented ARDL approach on a country-by-country basis is an empirical innovation of this work. While ARDL and co-integration techniques are standard in time-series econometrics, applying the augmented bounds test of Sam et al. (2019) in this context is relatively novel. It provides more robust validation of the long-run relationships found, giving greater confidence in our conclusions. Earlier FKC studies (many of which used panel methods or basic co-integration tests) might be subject to concerns about spurious regression or differing integration orders among variables. We mitigated those concerns with a method designed to handle such issues, thereby strengthening the credibility of our results. This rigorous approach is a contribution to the empirical literature, demonstrating how modern time-series techniques can be employed to revisit classic hypotheses like Kuznets in new settings.

Comparing our findings with other works, we see both alignment and divergence. We align with Baiardi and Morana (2016) and Khatatbeh and Moosa (2023) in finding evidence for the FKC in some advanced economies (the UK and France in our case). We diverge by illustrating cases where the FKC does not hold, emphasizing heterogeneity even among advanced nations. Regarding innovation, our finding of an equalizing effect contrasts with Zhu and Niu (2024), who found that technological innovation increased inequality in G10 economies over the long run. One reason for this discrepancy could be differences in measurement or context – Zhu and Niu (2024) considered fintech versus non-fintech innovation in a panel setting, whereas we consider total R&D within individual countries. This suggests that not all innovation is the same; future research might differentiate between inclusive innovations (e.g., financial technology that expands access for the poor, or public health innovations) and exclusive innovations (e.g., automation that primarily displaces low-skill jobs) in terms of their inequality effects. Our study opens the door for such nuanced exploration by establishing that innovation's effect on inequality is significant and worthy of being analyzed alongside financial development.

5.4. Policy Implications

From a policy perspective, these findings carry important messages for how advanced economies can manage financial and technological progress to ensure inclusive outcomes. They point to a need for coordinated strategies that address both financial inclusion and support for innovation-led growth.

The cases of France and the UK suggest that inclusive financial sector policies can eventually make growth more equitable. Policymakers in advanced economies should strive to deepen financial systems in ways that explicitly include poorer households and small businesses. This could involve promoting financial literacy, ensuring broad access to banking and credit services (possibly through microfinance initiatives or community banking), and leveraging technology (like mobile banking and fintech platforms) to reach those outside the formal financial system. The fact that inequality eventually falls with financial deepening in some countries is encouraging – it suggests that continuing to improve the *quality* of financial development (not just the *quantity* of credit, but who can get credit and on what terms) is key. Regulators should also be wary of financial sector excesses that can lead to crises, as large crises can undo gains and worsen inequality. In countries where we did not observe an FKC (e.g., the U.S., Germany, Italy, Japan), more proactive measures might be necessary to achieve the potential inequality-reducing benefits of financial development. These could include stronger financial inclusion programs or incentives for banks to serve underserved communities. In essence, if left to market forces alone, financial development might not guarantee inequality reduction; thus, policy nudges are required to realize a Kuznets-type outcome.

On the innovation front, investing in R&D and human capital emerges as a powerful tool for inequality reduction. Governments and the private sector should see R&D spending not only as a route to higher growth, but also as a means to promote equity. Policies that incentivize innovation – be it through R&D tax credits, direct public research funding, or support for private sector innovation – can have the added benefit of making the income distribution more equitable in the long run. It's important, however, that innovation policy be broad-based. Supporting innovation in sectors that create jobs across skill levels (like renewable energy, infrastructure, or health technology) might yield more egalitarian effects than focusing solely on highly specialized tech sectors. Additionally, coupling R&D promotion with education and training is crucial so that the workforce is prepared to participate in and benefit from new innovations. Our results advocate for innovation policy as a tool in the inequality reduction toolkit – something that may not have been emphasized enough in traditional inequality debates. By preparing the workforce with the skills needed in an innovative economy, countries ensure that productivity gains from R&D translate into higher wages and opportunities for a wide section of society.

Perhaps the overarching implication is that financial and innovation policies should be coordinated as part of an integrated inclusive growth strategy. In practice, this means recognizing that simply expanding credit or simply boosting innovation is not enough by itself to ensure equitable growth; it is the combination – a financial system that supports broad entrepreneurial activity and an innovation system that permeates the whole economy – that delivers the best results. For example, promoting fintech solutions (the intersection of finance and tech) can directly reduce inequality by lowering barriers to financial services for lower-income groups. Similarly, public–private partnerships in funding innovation can target societal challenges (like healthcare or bridging the digital divide) that, when addressed, disproportionately help the less well-off and reduce inequality.

Another noteworthy implication from our country-specific approach is the importance of structural awareness. We explicitly modeled structural breaks, which serves as a reminder that major events (financial crises, economic reforms, pandemics, etc.) can have lasting effects on inequality. Resilience and response strategies around such events are crucial. For instance, the 2008 financial crisis likely impacted inequality through unemployment spikes and asset price changes; ensuring a quick recovery and protective measures for vulnerable groups in such times can prevent those events from permanently widening inequality. Japan's case,

where we included a trend and still saw a persistent upward drift in inequality, indicates that demographic or societal trends (like aging populations and changing labor practices) must be part of the inequality conversation. Technological and financial policies should thus also be forward-looking, anticipating how upcoming structural shifts (e.g., digital transformation or demographic change) could interact with inequality.

5.5. Limitations and Future Research

While our study offers fresh insights, it is not without limitations. First, data constraints (especially for consistent inequality measures) limited our sample period and frequency. We rely on annual data and relatively short spans, which reduce the power of time-series methods. This is one reason we chose the augmented ARDL approach to mitigate some issues of small samples. Future research could extend this analysis as more data become available, or perhaps use alternative inequality metrics (such as income shares of the top 10% vs. bottom 50%) for a richer perspective. Second, our model, for parsimony, did not include every possible determinant of inequality. There are other important factors like tax policy, government redistribution programs, or unionization rates that we did not explicitly model but which undoubtedly affect inequality trends in these countries. We assumed those effects are either indirectly captured (via the time trend or structural break dummies) or relatively constant. However, including such variables in a time-series cointegration framework is challenging due to data limitations and multicollinearity issues. Panel data approaches or detailed country case studies could complement our work by incorporating those aspects in future analyses.

Additionally, our finding on innovation opens up many questions. For instance, what types of R&D (public vs. private, high-tech vs. low-tech) are most beneficial for inequality reduction? Also, is there a point of diminishing returns for the inequality benefits of R&D (analogous to a Kuznets curve for innovation)? These questions are beyond our current scope but are worth investigating. Moreover, the interplay between financial development and innovation could be explored further – perhaps by including an interaction term between finance and R&D to see if the effect of one depends on the level of the other. This could reveal whether a well-developed financial system enhances the spread of innovation (or vice versa) in lowering inequality.

Lastly, extending the analysis beyond the G7 to other advanced economies or fast-growing emerging economies could be valuable. Do we see similar patterns in, for example, South Korea or Australia? Comparative studies could help determine whether the G7 experience is unique or part of a broader trend among economies with certain characteristics. For emerging markets, it would be interesting to see if innovation plays a similar equalizing role and whether an FKC-like pattern can be observed as their financial systems develop.

In sum, the relationship between finance, innovation, and inequality is complex but critically important. Understanding it can inform more effective economic policies that harness the benefits of financial and technological progress while safeguarding against their potential downsides. We now conclude by summarizing the key takeaways and emphasizing actionable insights for policy.

6. Conclusion and Policy Implications

This study set out to examine the Financial Kuznets Curve (FKC) hypothesis in G7 countries, with the novel inclusion of innovation activity (R&D expenditures) as part of the analysis. By applying an augmented ARDL cointegration approach to individual country data, we obtained a detailed picture of how financial development and innovation interact to influence income inequality in some of the world's largest economies. The results can be distilled into a few key points:

- *Partial Support for FKC:* The FKC hypothesis – an inverted U-shaped relationship between financial development and inequality – finds support in France and the UK. In these countries, initial financial deepening worsened inequality but further deepening has helped reduce it. In contrast, no clear FKC emerged in the USA, Germany, Italy, or Japan over the sample period. This indicates that the inequality impacts of financial development are highly context-dependent even among advanced economies.

- *Innovation Consistently Reduces Inequality:* Across all countries studied, higher R&D expenditures are associated with lower inequality in the long run. This underscores the positive role that innovation and technological progress can play in creating a more inclusive economy, at least in environments where the benefits of innovation are able to spread through society.

- *No Inevitable Trade-off:* The findings suggest that there isn't an unavoidable trade-off between financial development and equality – rather, the trade-off exists in early stages but can be reversed. Moreover, with proactive innovation and inclusion policies, countries might bypass or shorten the inequality-worsening phase of financial development. The experiences of the UK and France imply that policy and institutional frameworks matter in turning finance into an equalizing force after a point.

- *Methodological Robustness:* By using the augmented ARDL approach and accounting for structural breaks, we ensured that the detected relationships are reliable. This methodological rigor adds confidence that the reported effects are not spurious but reflective of genuine long-run tendencies in the data.

The policy implications of this study are clear and compelling. Policymakers in advanced economies (and by extension, in emerging markets aiming to emulate their success) should pursue an integrated strategy that simultaneously fosters financial inclusion and innovation-led growth:

- *Inclusive Financial Development:* Efforts should be made to deepen financial systems in ways that explicitly include poorer households and small businesses. This could involve supporting microfinance institutions, encouraging banks to extend credit to underserved communities (through measures such as credit guarantees or interest subsidies), and leveraging fintech and mobile banking platforms to reach those outside the formal financial system. The goal is to ensure that as the financial sector grows, it brings more people into the economic fold rather than just expanding opportunities for those already well-off. The trajectories of France and the UK show that such inclusive financial deepening is achievable and can eventually drive inequality down.

- *Invest in Innovation and Human Capital:* Governments and the private sector should maintain strong investment in R&D and also in complementary areas of education and skills training. Innovation should be steered not only toward boosting GDP, but also toward solving societal problems and improving livelihoods (for instance, innovation in affordable healthcare, education technology, or sustainable energy can have broad-based benefits). By preparing the workforce with the skills needed in an innovative economy, countries ensure that the productivity gains from R&D translate into higher wages and opportunities for a wide section of society. Our findings advocate for innovation policy as a tool in the inequality reduction toolkit – something that may not have been emphasized enough in traditional inequality debates.

- *Responsive to Structural Changes:* Policymakers must remain vigilant to structural shifts – such as financial crises, technological disruptions, or global economic changes – that can abruptly affect inequality. Having automatic stabilizers and emergency measures in place (like unemployment insurance, targeted stimulus during downturns, or retraining programs during technological shifts) can prevent such events from permanently widening inequality. In the long run, this maintains the trajectory toward a more equal distribution of income. The inclusion of structural break controls in our models symbolically points to the need for policy flexibility and adaptability in the face of change.

- *Holistic Economic Strategy:* Ultimately, the pursuit of inclusive growth requires viewing financial and innovation policies as complementary. A well-regulated, inclusive financial system can fund and sustain innovation, while a vibrant innovation ecosystem can create the products, services, and jobs that make financial prosperity meaningful for the broader population. Governments should foster dialogue and partnerships between financial institutions, technology

companies, educational institutions, and community organizations to create synergy in promoting equitable growth. For example, public sector initiatives could support start-ups in areas that generate social benefits, or financial literacy programs could be paired with digital literacy initiatives to empower citizens in the modern economy.

In conclusion, the relationship between financial development, innovation, and inequality is complex but malleable. The evidence from the G7 suggests that policy choices and institutional contexts critically determine whether finance becomes a force for greater equality or greater disparity. Innovation emerges as a powerful equalizer, offering a pathway to shared prosperity if harnessed wisely. This paper's contributions lie in highlighting these dynamics and providing a robust empirical basis for them. As countries continue to navigate the twin challenges of economic development and social equity, the insights here can inform more nuanced and effective approaches. By ensuring that the fruits of financial and technological progress are broadly shared, societies can achieve the Kuznets ideal of growth that eventually benefits all – turning the curve of inequality downward in a sustainable manner.

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Biography

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Истраживање финансијске Кузнецовљеве криве са иновацијама у земљама Г7: Проширени ARDL приступ

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Кључне ријечи:
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JEЛ класификација: G20, O30, O15, D31

САЖЕТАК

Ово истраживање разматра хипотезу финансијске Кузнецовљеве криве (FKC) у шест земаља чланица Г7, укључујући иновације, мјерене кроз издвајања за истраживање и развој (И&Р), у оквир финансијско–неједнакосног односа. Користећи годишње податке временских серија и проширени ARDL приступ тестирања граница, испитујемо дугорочне односе између финансијског развоја, иновација и неједнакости прихода. Резултати дјелимично подржавају FKC: Француска и Уједињено Краљевство показују значајну обрнуту U-везу између финансијског развоја и неједнакости, док такав образац није утврђен у Сједињеним Америчким Државама, Њемачкој, Италији или Јапану. Насупрот томе, иновације у свим земљама показују досљедно значајан ефекат смањења неједнакости. Ови налази указују на то да иновације могу ублажити дистрибутивне ефекте финансијског развоја и истичу важност интегрисања финансијских и иновационих политика ради подстицања инклузивних економских исхода у развијеним економијама.