The rise of quantitative work in economics

by

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Declaration

I, Sbongakonke Sandisiwe Makhathini, declare that this thesis “The rise of quantitative work in economics" is my own work, that it has not been submitted before for any degree or assessment at any other university, and that all the sources I have used or quoted have been indicated and acknowledged by means of complete references. This thesis is submitted to the University of Cape Town for the Master of Philosophy in Financial Technology degree.

Signed: 05 October 2025

Signed by candidate

Sbongakonke Sandisiwe Makhathini

Abstract

The evolution of economic journals from 1940 to 2010 reflects a growing reliance on quantitative methods, driven by the increasing availability of data and the need for research to address complex economic challenges. This study analyses trends in the use of equations, figures, and tables across five leading economics journals—*American Economic Review*, *Econometrica*, *Journal of Political Economy*, *Quarterly Journal of Economics*, and *Review of Economic Studies*—to investigate the empirical turn in economics. Regression analysis reveals significant increases in the use of quantitative methods over time, with z-scores identifying critical periods of change. These shifts are influenced by editorial mandates, historical economic events, and technological advancements. The findings underscore the methodological transformation of economics and its implications for the discipline's engagement with empirical and policy-relevant questions.

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Above all, to God be the glory!

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1. Introduction

The nature of economic research has undergone a significant transformation over time. Quantitative methods have increasingly taken centre stage in response to growing demand for empirical approaches to complex economic challenges. The evolution of economic journals from 1940 to 2010 provides a rich field of study to investigate this empirical turn, as trends in publishing practices reveal broader methodological and disciplinary changes. The increased availability of data and advancements in computational tools have further facilitated the adoption of quantitative methods, enabling researchers to formalise theories and empirically test hypotheses with greater precision.

This paper explores the evolution of quantitative methods in economics by analysing the prevalence of equations, figures, and tables in five leading economics journals: *American Economic Review* (AER), *Econometrica* (ECTA), *Journal of Political Economy* (JPE), *Quarterly Journal of Economics* (QJE), and *Review of Economic Studies* (RES). These journals are selected for their influence in the economics discipline and their representation of diverse methodological traditions. By focusing on articles published between 1940 and 2010, this study captures key shifts in quantitative practices during a period that saw significant economic, publishing and technological advancements.

A key aspect of this study is identifying the change in quantitative work. The change of quantitative work is the use of algebra, mathematical analysis, statistical techniques, graphical methods, and data visualisations. The main driver for the changing use of quantitative work is the growing demand for research validation, particularly as policymakers increasingly require real-world data to inform economic models and decision-making. Hamermesh (2013) writes about the shift (increase) in quantitative methods in economics as the "empirical turn" and how it reshapes economic research. A growing emphasis on empirical methods has been placed in economics since the 1970s. This chapter outlines the research questions, methodology, and key results, providing a roadmap for the analysis that follows. This study contributes to ongoing discussions about the role of quantitative methods in economics and their implications for policy-relevant research. While the focus is on these five journals, the findings may have broader relevance in the field of economics. This offers insights into the evolution of economic publishing and its methodological approach.

1.1. Research questions

This paper seeks to answer the following questions; these questions then inform the methodology and analysis;

1. What are the trends of quantitative indicators (equations, figures and tables) over the chosen timeframe?
2. Are there any significant shifts, and what are the possible reasons for the shifts?

1.2. Research methodology

From past methodologies (Hamermesh, 2013: Togler & Piatti, 2013), what can be observed is that each paper adapts different, yet similar, methodologies. This paper defines quantitative indicators as equations, figures and tables whose prevalence is the source for the trend analysis used to investigate the empirical turn in economics. The null hypothesis is that there is no relationship between "year" and each quantitative indicator over time.

The occurrence of the quantitative indicators is manually collected. Following the normalisation of the data to ensure that the number and length of articles does not impact the results, I run Ordinary Least Squares (OLS) regression models for each of the quantitative indicators and journal to identify trends. In addition, I calculate z-scores to highlight significant periods of change.

1.3. Key results summary

Chapter 4 is the data analysis section of this study. The OLS regressions identify trends over time in each journal for each quantitative indicator, in order to answer the research question of this study. To show key results across the field, random samples of 35 articles per year from all five journals are selected. Table 1 below summarises key statistics that measure the null hypothesis. Results show statistically significant increases in the use of equations, figures and tables – each with a p-value less than 0.05 and high F-statistic values. Although the adjusted R-squares indicate that the variable year explains a modest variation for tables and a low variation for equations and figures.

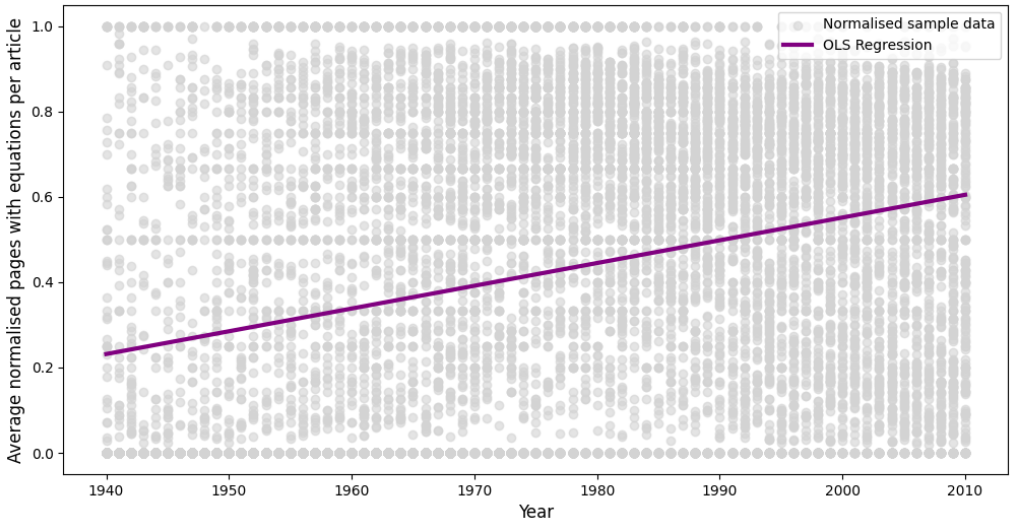
OLS regression results for each quantitative indicator across all five journals (AER, ECTA, JPE, QJE, and RES) from randomised sample data from 1940 to 2010

	F-STATISTIC	P-VALUE	ADJUSTED R-SQUARED	MSE
EQUATIONS	1225	<0.001	0.09	0.11
FIGURES	137	<0.001	0.28	0.22
TABLES	51	<0.001	0.12	0.54

Table 1: This table shows the statistical relationship between the year and the proportion of pages containing equations, figures, and tables. The regression is run on randomised sample data of 35 articles per year from all five journals. The data for all journals show positive co-efficients, indicating increasing mathematical content

Figure 1, 2 and 3 below shows the regression analysis for equations, figures and tables, respectively, for the period 1940 to 2010 for the top five journals. The proportion of pages with equations increases, reflecting the growing emphasis on quantitative and mathematical approaches to economic research. Similarly, the use of figures and tables increases steadily, likely driven by the increasing demand for readability of data results. The empirical turn is influenced by the growing availability of data, technology, advances in research methodologies over time, for example, that researchers have access to in order to support their research. In Chapter 5, this paper discusses some of the factors that affect the rise of quantitative methods in economics. While these trends are broadly consistent across journals, some variation exist, with certain journals adopting these quantitative indicators at different periods or to a greater extent than others.

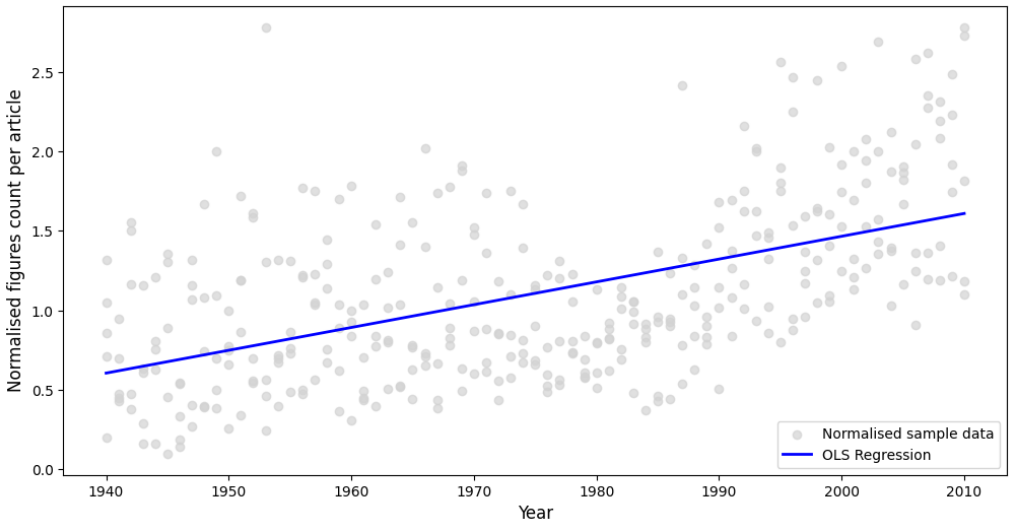
Trend in the proportion of pages containing equations across the top five journals (AER, ECTA, JPE, QJE, RES) from 1940 to 2010



$$y = 0.23 + 0.005x$$

Figure 1: The regression is run on randomised sample data of 35 articles per year for each of the five journals. Each point in the figure represents a page, and the fitted OLS line illustrates the long-term increase in the use of equations, signalling the rise of mathematical use in economics over the period of evaluation.

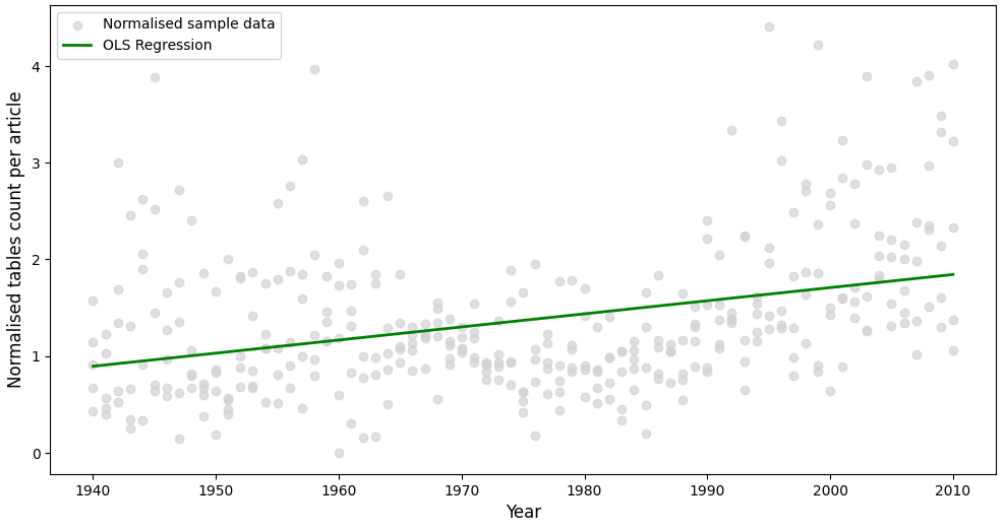
Trend in the proportion of figures per page across the top five journals (AER, ECTA, JPE, QJE, and RES), 1940–2010



$$y = 0.61 + 0.01x$$

Figure 2: Each point in the figure represents normalised distribution of sample data points of the number of figures per page within the data for all five journals. The OLS regression line and its equation demonstrates the increasing use of data visualisations to convey empirical content in economic research.

Trend in the proportion of tables per page across the top five journals (AER, ECTA, JPE, QJE, and RES), 1940–2010



$$y = 0.89 + 0.01x$$

Figure 3: Each point in the figure represents normalised distribution of sample data points of the number of tables per page with the data for all five journals. The OLS regression line and its equation indicates growth in the use of tabular data to summarise empirical findings

This study investigates the rise of quantitative methods in economics by analysing trends in equations, figures, and tables across five top journals in economics from 1940 to 2010. These quantitative indicators highlight the broader methodological transformation within the discipline, driven by advancements in data availability, computational tools, and shifts in research priorities. While the findings of this study contribute to understanding the empirical turn in economics, they also raise questions about the factors shaping these trends.

To contextualise this evolution, it is necessary to examine the foundational structures and influences that guide the discipline over time. Chapter 2 provides an overview of the historical background and the roles of the top five journals in establishing the methodological norms of economics. By exploring the mandates of these journals, significant economic events, and the distinction between theoretical and empirical approaches, the chapter lays the groundwork for understanding the broader context of this study's findings.

2. Background

The historical and institutional context of economic publishing is critical to understanding the rise of quantitative methods. The increasing prominence of equations, figures, and tables in economics did not occur in isolation but was influenced by broader historical developments, including significant economic events, technological advancements, and the mandates of leading journals. These factors collectively shaped the discipline's transition from a predominantly theoretical approach to one increasingly driven by quantitative methods.

This chapter situates the study within this broader context by examining the historical trajectory of economics from the 1940s to the 2010s. It begins with an overview of the establishment and mandates of the five selected journals and their influence on research practices. The chapter then explores significant economic events that potentially influenced the trends in publishing, as well as the evolving relationship between theoretical and quantitative work. This contextual foundation is essential for interpreting the empirical findings presented in later chapters.

2.1. The top five journals

The top five journals are mainly based in top Universities with prestigious economics departments. The oldest of the five are QJE and JPE, founded in 1886 and 1892, respectively. Followed by AER (1911) and lastly, ECTA and RES which were both established in 1933.

Journal Mandates and Focus

Each of the top five journals has specific mandates and areas of focus that influence the type of research they publish:

- **AER:** AER shows an increasing emphasis on empirical evidence and quantitative methodologies – in accordance with its mandate (Togler and Piatti, 2013).
- **ECTA:** From its establishment, ECTA's mandate places significant emphasis on econometrics and the integration of theoretical and empirical approaches to economic problems (Bjerkhott, 2014).

- **JPE:** Focuses on widely cited research topics and publishes diverse research, including analytical, interpretive, and empirical studies (University of Chicago Press, 2024).
- **QJE:** Edited by Harvard University's Department of Economics, QJE covers both empirical and theoretical micro- and macroeconomics.
- **RES:** Particularly focuses on supporting emerging scholars and research in both theoretical and applied economics.

In section 3.5, this paper also briefly discusses the influence of these journals and how they set the standard within the field.

2.2. Distinction between quantitative and theoretical work

Classifying empirical work often involves subjective judgement. Figlio (1994) defines this standard as whether some degree of actual data analysis is central to the research, without necessarily requiring the empirical aspect to be the primary or a significant secondary focus. Articles that incorporate both theoretical and empirical elements are empirical under this approach. Angrist et al (2017) categorise articles into three styles: theoretical, empirical or econometrics. Articles are "empirical" if they use data to estimate economically meaningful parameters and covering methodological issues while providing meaningful estimates. Determining the level of technique used in an article can be challenging, as a single piece of work may employ a blend of advanced and basic mathematical methods and economic theory. Even in the absence of clear algebraic expressions, mathematical symbols, tables, or figures - qualitative analysis can still rely on regression techniques or econometric methods without them being present in an article (Stigler et al., 1995). While the distinction between quantitative and theoretical work may seem clear cut, it can be subjective in practice. However, the subjectivity in classification and identifying quantitative indicators does not diminish the occurrence of the quantitative shift in economic publishing. For the articles in this study, the number of times these quantitative indicators occur (defined as equations, figures and tables) are counted.

2.3. Significant economic events from 1940 to 2010

Major economic events potentially influence economic publishing trends. While a definitive causal link is not established in this study, some significant events within the analysed timeframe include:

- **Post-World War II reconstruction (post-1945):** The need to rebuild weakened economies and address high inflation influenced economists to build new economic models to combat the post-war crisis (Biddle & Hamermesh, 2016).
- **The oil crisis and stagflation (1978-1981):** These events prompted the re-evaluation of existing economic models and the exploration of new approaches. This accelerated the adoption of applied economic research (Backhouse & Cherrier, 2017).
- **Advancements in computational techniques (1990s):** The technological advancements facilitated the ease of creation of analytical models and quantitative experiments, enhancing the formalisation of economic research and literature (Einav & Levin, 2014).
- **The dotcom bubble (late 1990s - early 2000s):** Led to re-evaluation of economic policies aimed at managing speculative investments and inflationary pressures (Cockburn, et al., 2019).
- **The global financial crisis (GFC) (2007-2008):** The GFC emphasised the need for robust economic models capable of predicting and mitigating systemic risks. It also reinforced the shift toward empirical, data-driven research in macroeconomics (Christiano, et al., 2015).

These and other similar events often provide real and practical data for evaluating existing models, developing new theories, and informing policy decisions. In chapter 6, this study will discuss whether the trend analysis results in Chapter 5 align with some of the economic events.

The historical context and institutional landscape of economic publishing provides a crucial foundation for understanding the rise of quantitative methods in economics. By examining the establishment of the top five journals, the distinction between theoretical and quantitative work, and key historical events, this chapter introduced factors that affect the empirical turn and definitions. This foundation sets the stage for Chapter 3, which looks into the

methodological evolution of economics and evaluates the increasing prominence of quantitative approaches in shaping academic research and publishing trends.

3. Quantitative Work in Economics

Building upon the historical and institutional context set in the previous chapter, this chapter focuses on the rise of quantitative work in economics and its impact on the discipline. This chapter examines the methodological evolution of economics, with a particular emphasis on the increasing use of empirical methods to address complex research questions and inform policy decisions. By analysing the role of quantitative methods, the changes in their application over time, and their evaluation in academic literature, this chapter provides a comprehensive overview of the empirical turn in economics. Additionally, it explores the influence of top journals in shaping research trends and reinforcing methodological preferences.

The chapter begins by highlighting the growing importance of quantitative methods in economics. It then traces the historical progression of these methods, identifying critical periods of change and their broader implications. Lastly, this chapter reviews studies on the evaluation of quantitative approaches and discusses how the top five journals play a pivotal role in guiding the direction of economic research. This discussion serves as a bridge to the methodology in chapter 4.

3.1. Role of quantitative methods in economics

The increasing prominence of quantitative methods in economics is largely due to the need for validation in academic work. Policymakers are putting more pressure on academics to conduct research that uses real-world data to validate theories. As a result, policy often mirrors the results from quantitative data and models (Moed & Halevi, 2015). This shift towards empirical work is also present in the broader science system, where quantitative methods of research evaluation complement qualitative assessments. This emphasis on accountability leads to a greater focus on quantitative methods in economics (Fourcade et al., 2015).

Quantitative methods provide a structured framework for analysing complex economic phenomena. This enables economists to test hypotheses and develop policy recommendations. These methods enhance the robustness of economic research by ensuring

replicability and precision in empirical analyses. Since the 1980s, the use of equations, tables, and figures in economic journals has grown significantly, reflecting a shift towards methodological formalism (Stigler et al., 1995). Computational advancements enable economists to process large datasets and perform complex analyses, facilitating the adoption of econometric and experimental methods. Techniques like Randomised Controlled Trials (RCTs) and natural experiments represent methodological evolution, allowing researchers to identify causal relationships and inform evidence-based policymaking (Athey & Imbens, 2017).

One explanation for the empirical turn in economics is the rise of new and diverse techniques to build models with data. These techniques can be due to either technological advancements or advancements in research – also including broader science as economic models can borrow for other science fields. Economists often conduct experiments to test and validate their theories. For example, using models to show the functioning of the markets. The design of models is to show how specific mechanisms work by isolating them from others, while setting specific environment. Models show the most likely outcome in an event, in turn helping policymakers support decisions with data (Rodrik, 2015). Economists play a crucial role in policymaking by translating theoretical insights into practical applications. From the mid-20th century, empirical models increasingly inform decisions on fiscal policy, labour markets, and macroeconomic stabilisation (Oliveira & Da'vila-Fernández, 2020). This growing reliance on quantitative methods reflects their utility in addressing complex societal challenges.

3.2. Changes in the use of quantitative methods over time

The mid-20th century marks a critical shift in economic publishing, as policymakers increasingly rely on empirical models to address real-world challenges. From the 1940s to 1960s, economic modelling evolved into a central tool for policy formulation, driven by the need to translate theoretical insights into actionable solutions (Oliveira & Da'vila-Fernández, 2020). This era also witnessed the institutionalisation of empirical methods, with quantitative techniques gaining prominence as economists formalise their analyses. From the 1970s onwards, economics experienced an empirical turn, driven by advancements in data availability and methodological tools. There was a decline in purely theoretical research, with

empirical studies increasingly dominating journal publications. This shift towards empirical work represents a significant transformation in economics, reflecting the growing importance of quantitative methods in addressing real-world economic challenges.

Before 1970, theory enjoyed a privileged status in the economics publishing space. Between the World Wars, Economists started focusing on empirical work, giving character to the rise of empirical work. This was the period when statistical transformation was occurring to understand the economy and the business cycle. Economists had to respond to the Great Depression by using data and empirical analysis of the market structures to understand what was happening (Backhouse & Cherrier, 2017). The 1970s marked a turning point, with empirical research surpassing theoretical work in journals such as AER and ECTA, indicating prioritising quantitative methods. This was mostly due to the increasing availability of data and advanced econometric tools, enabling economists to explore complex work through robust empirical frameworks (Angrist & Pischke, 2010). This trend continues into the 2000s, with experimental methods and causal inference gaining prominence.

While the emphasis on rigorous quantitative methods contributes to the advancement of economic knowledge, it raises concerns about the potential marginalisation of qualitative approaches. Qualitative research plays a crucial role in economics. It provides rich insights into issues that are not easily quantifiable, such as the role of institutions, social norms, and power dynamics in shaping economic outcomes. Akerlof (2020) discusses the hardness bias – where quantitative work is seen as harder than qualitative work. In his work he notes that the excessive demand of quantitative work on researchers can lead to omission of vital research. Their work might conform to the "hard" instead of research that is of importance to the field. This can negatively affect innovation and limit the scope of economic inquiry. It is therefore important for journals to strike a balance between quantitative and qualitative research, recognising the strengths of each approach. Encouraging a diverse range of provable methodologies can foster a more diverse and inclusive field of economics, capable of addressing a wider range of economic and societal challenges.

3.3. Studies evaluating quantitative methods in economics

Several influential studies laid the groundwork for this paper's methodology. Stigler et al. (1995) explore the relationship between economic theory and empirical work, highlighting the increasing reliance on econometric analysis. Similarly, Card and DellaVigna (2013) conduct a meta-analysis of economic publications, demonstrating a trend toward empirical research, particularly in labour economics. Labour economics is a subfield within economics, this study however, does not focus on subfields but it is important to highlight how the empirical turn differs even with different fields. Hamermesh (2013) emphasises the growing trend in empirical work by categorising articles as either theoretical or empirical across several decades. Figlio (1994) samples articles published between 1960 and 1992 in ten economic journals, (including the five journals in this study) and calculates the percentage of articles with empirical content. Oliveira and Dávila-Fernández (2020) investigate the rise of mathematical and quantitative methods in three journals (AER, JPE, and QJE) from 1940 to 2010. Their findings highlight a significant increase in the use of mathematical techniques, particularly in the latter half of the 20th century. They say this change is mainly driven by the institutionalisation of econometrics and the growing emphasis on formalism in economic research. They attribute these trends to shifts in academic incentives, technological advancements, and the increasing integration of quantitative methods into policy analysis.

Angrist et al. (2017) looks at 134,892 articles published in 80 economics journals between 1980 and 2015. They classify articles in three categories: empirical, theoretical and econometric. From their research they find that the share of publications devoted to empirical work, is roughly one-third in the 1980s. Around 1985, there is a steady increase, and the empirical share starts exceeding 55 percent. By 2015, this increases to over 60 percent. Of the three categories, the share for econometrics was basically unchanged. Therefore, the share of theoretical articles had decreased and gone to the share of empirical papers. Data from Hamermesh (2013) does not conclude that theoretic work is dying. Making such a claim would mean that no theory is present in quantitative articles. This increase in quantitative work can also be due to the influence of Economists who work in government, central banks, and global financial organisations that make use of economics to inform policy. This is a drastic contrast in comparison to the 1960s when economists complained about the high

propensity of economists developing elaborate economic theories, with no thought to the research's real-world application.

3.4. Influence of top journals in shaping research

Publishing in the top five journals is highly sought after. The top journals are known to set the standard for economic research, driving trends in methodology and subject focus. These journals emphasise rigorous quantitative methods, often prioritising empirical work over theoretical contributions. Articles in these journals increasingly incorporate quantitative methods, reflecting their influence in shaping the field. The top journals, particularly AER and ECTA, play a pivotal role in reinforcing methodological trends. AER frequently publishes policy-relevant empirical research, while ECTA emphasises econometric contributions (Togler & Piatti, 2013).

Publishing in the top journals is not only a measure of productivity but is considered as a proxy for the likelihood that an author publishes a highly influential article. For many young economists the perception is that if an article on any topic within the field is not published in these journals, the topic is not worth pursuing. With high rejection rates, publishing in these journals has become the professional standard for authors and researchers. As a result, this pursuit contributes to the present and future research agendas within the field. However, the reliance on journal rankings as proxies for research quality may limit innovation, as authors align their work with the perceived preferences of these journals (Heckman & Moktan, 2020). Card and DellaVigna (2013) report on how of the five journals, QJE is the most selective, with a 3 percent acceptance rate, followed by JPE and RES with that of 5 percent each. The least selective being AER and ECTA with a rate of 8 percent each.

Fourcade et al. (2015) writes about how the top five are highly cited journals in economics and have a higher concentration of papers coming from elite departments in economics. This is also in line with the fact that these journals are founded and based in elite institutions, as mentioned in section 2.1. above. In comparison to other social sciences departments and related journals, economists regard citation statistics, journal ranking and University economics departments as indicators of intellectual strength. This results in institutionalised

hierarchies that lead to high competitiveness for status, including publishing in the top five journals. Such biases, including the mandates of journals, shapes the direction of research.

3.5. Chapter summary

This chapter traced the historical development and increasing reliance on empirical approaches, highlighting how these methods have become integral in validating theories and informing policy decisions. By exploring the changes in the use of quantitative methods over time, key studies evaluating their prevalence, and the role of leading journals in shaping research trends, this chapter's aim was to provide a comprehensive understanding of the empirical turn in economics. These insights lay the groundwork for the empirical analysis in Chapter 4. This study's analysis builds on the methodological foundation this chapter discussed, seeing whether trends that will be observed in the analysis are linked to other factors.

4. Methodology

This chapter outlines the methodology framework this study uses to investigate the trends in the use of quantitative methods in economics. Focusing on the five top economics journals: AER, ECTA, JPE, QJE, and RES over the period 1940 to 2010 - provides a robust dataset. These journals cover a broad range of economic topics and have significant influence in the field of economics. The design of the methodology enables this study to analyse how the quantitative indicators (equations, figures and tables) evolve over time, providing insights into the empirical turn.

The chapter begins by detailing the data sources and justification for the chosen timeframe. The study uses full-length articles and excludes non-research material (such as notes and corrections). Following this, the analytical framework details the key quantitative indicators used and how they are measured. The data analysis approach outlines the normalisation process, regression modelling and calculation of the z-scores. The primary goal of this study is to track the trends of quantitative methods through these indicators and to assess the implications of changing reliance on quantitative methods in the field. Lastly, this chapter will discuss ethical considerations and limitations of the study.

4.1. Data

4.1.1. Data collection

The data in this study is extensive, covering articles published in the top five economics journals between 1940 and 2010. These journals cover a broad range of topics in economics. They have significant influence and breadth in economic publishing, as highlighted in chapter 3. The data required for the analysis includes articles from these five journals.

4.1.2. Data acquisition

To ensure efficiency in data collection, the Selenium Python scraper is used, which automates the downloading of 41,981 articles from JSOR. After filtering for non-articles, such as editorials, notes and reviews, the final dataset decreases to 25,613 articles. Each article is split into pages. Figure 4 shows the number of articles per decade for each journal. A sharp increase in the number of articles published in the 1970s across all journals, except for QJE is

observed. While AER is the only journal that continues this upward trend, the rest of the journals decrease number of articles published post-1980.

Total number of published articles per journal by decade from 1940 to 2010

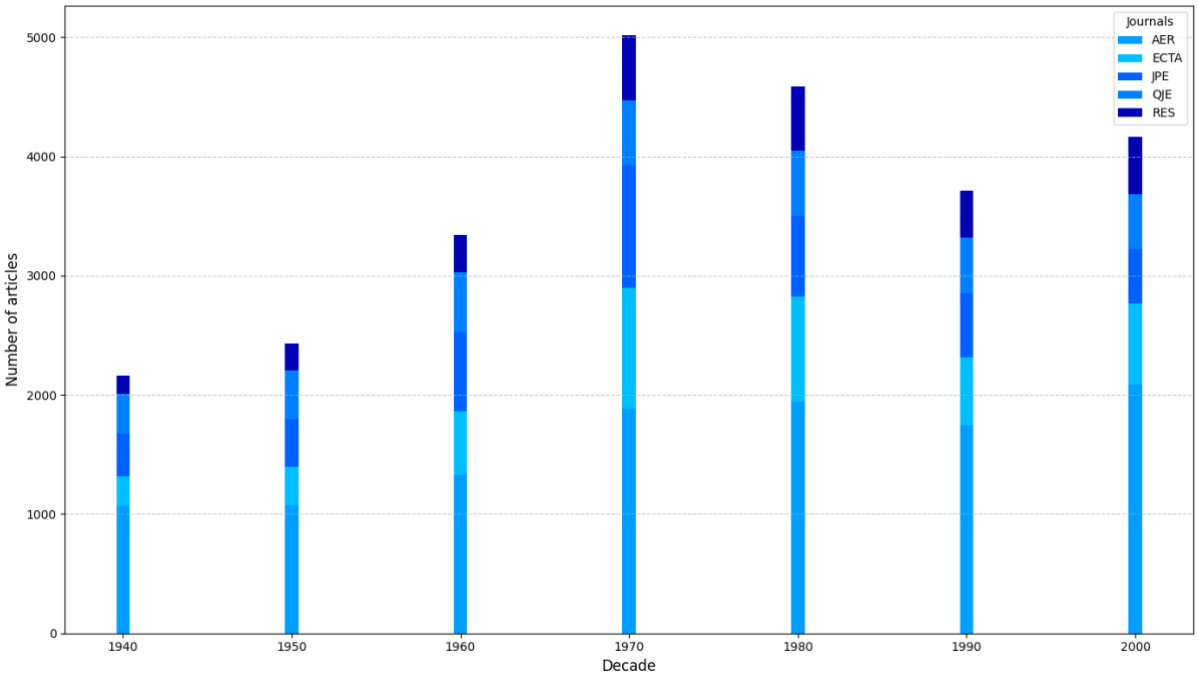


Figure 4: This figure shows the number of articles published in each decade, highlighting the shifts in publication volume. This includes a significant increase in the number of articles published in the 1970s, with subsequent declines but remaining higher than pre-1970s numbers.

Note: The figure represents articles published within a range of years with a decade, i.e. for the 1940-decade category, all articles published between 1940 and 1949 are included in the 1940 category.

4.1.3. Justification for selecting the period from 1940 to 2010

The mid-20th century marks the emergence of empirical models, which have since become central to economic research. By focusing on this period, this study aims to reveal long-term trends and shifts in the use of quantitative methods. The 1950s and 1960s are classified as the age of economic theory, with the significant increase in empirical work from the 1970s. The theory provides structure to the way economists thought about economic problems. Some researchers (Hamermesh, 2013; Togler and Piatti, 2013) record significant changes between years 1970 and 1990. Therefore, seeing the changes across all a longer period would give a better picture of the trends in quantitative methods over time. Technology enables for use of advanced techniques and new sources of data. This made it possible to derive results that economists consider more robust and useful in evaluating real-life events (Backhouse & Cherrier, 2017). Reason for not going beyond 2010 is the delay in data access of articles

published in recent years on JSTOR. The match between articles published in each journal and being available on JSTOR is far more accurate for older articles, hence articles published post 2010 are not considered.

4.2. Analytical framework

4.2.1. Previous study as validation for the methodology

In chapter 3 above, several authors who explore this topic are discussed. One that has a similar approach to the methodology of this study, is Togler and Piatti (2013). They evaluate the movement of use of mathematical techniques. They focus on mainly AER and analyse how often equations, figures and tables appear, like this study's approach but they look at periods 1984-88 and 2004-08. The use of equations serves as a proxy for mathematical tools, and the number of figures and tables for the application and visualisation of statistical and econometric tools. In their findings by 1989-90, 53% of AER articles included mathematics techniques (65% for JPE and 44% for QJE). Their analysis involves classifying whether an article makes use of mathematics. From their analysis of equations, figures and tables in AER, they find that by 2004-08, an article on average has 12 equations in the main text. Figures increased to 15 in the main text and 3.30 for tables. Even when adjusted for varying article length, the increase they observe between the two periods is statistically significant. This paper draws from their study, as well as those discussed in Chapter 3, to quantify the use of equations, figures and tables in articles published in the top five from 1940 to 2010.

4.2.2. Quantitative methods classification

Quantitative methods are defined as the use of algebra, mathematics, statistical analysis, graphical analysis, tables, and/or mathematical figures. An article is empirical if it features significant use of quantitative methods listed above, even if it also contains theoretical components (Figlio, 1994**).** Since the dataset for this study is relatively large, I do not briefly read through the articles for the quantitative methods classification. Like Togler and Piatti (2013), I use the occurrence of equations, figures and tables. The three main quantitative indicators in this study are:

- **Equations**: Binary data of the presence of an equation or inequality on a page.
- **Figures**: Count of visual representations of data such as graphs and charts.
- **Tables**: Count of tabular representations of statistical outputs or summarised findings.

Measuring and analysing the changes in equations suggest the increasing technical sophistication and formalisation of mathematically and empirical models. Figures and tables indicate the importance of presenting and visualising statistical and econometric results that require extensive data analysis.

The collection of these quantitative indicators is done manually. As a team with Research Assistants, the quantitative indicators are classified by one team first, and then checked by another. This is to ensure quality check of accuracy of the data classification. Similar to the approach by Stigler et al. (1995), this study considers the complexity of the quantitative methods, acknowledging that a single article may mix advanced and simpler methods. This paper does not make an absolute distinction of whether an article is theoretical or quantitative but rather considers the entire trend of the extensive use of these quantitative indicators. The use of indicators covers the range in which the quantitative methods can fall under - from algebra, econometric methods, mathematical analysis and calculus for example.

4.3. Data analysis approach

4.3.1. Preliminary data exploration

In this section, the descriptive statistics reveal the proportion of the length of articles containing equations, figures, and tables. Figure 5 shows the number of pages with equations over time, revealing a growth in the presence of equations, although it does not account for the density of the equations in the pages. Figures 6 and 7 show the number of figures and tables, respectively, from 1940 to 2010 in the articles used for this study. From these preliminary data graphs, it shows that there is an increase in all quantitative indicators for all five journals of the evaluation.

Total number of articles containing at least one equation from 1940 to 2010 across the top five journals

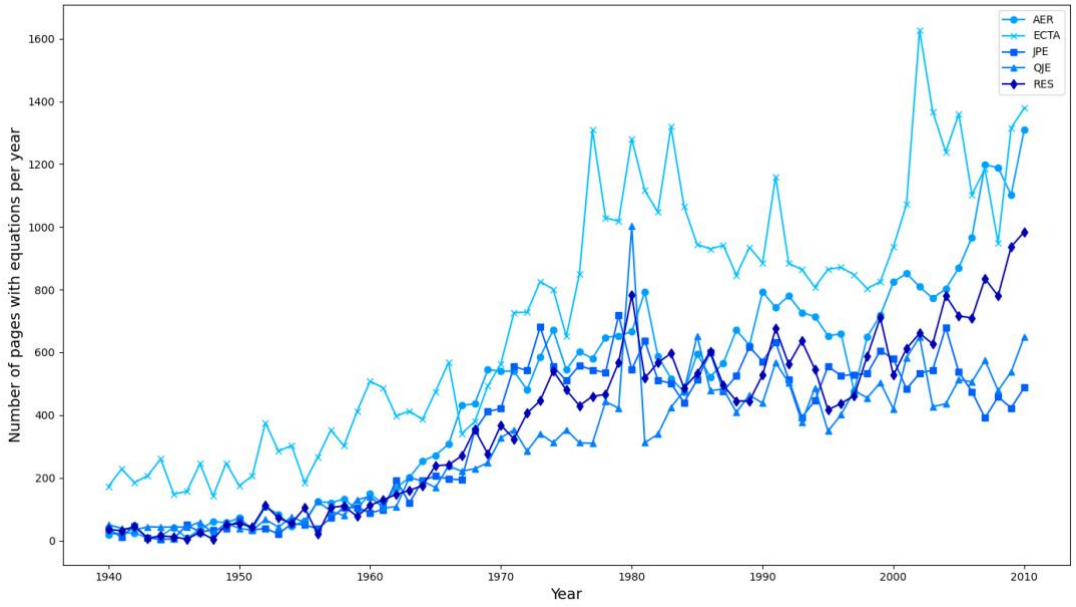


Figure 5: Each point represents the total number of pages containing at least one equation per year. This provides insights into the increasing mathematical formalisation in published research.

Total number of figures appearing in articles across the top five journals for from 1940 to 2010

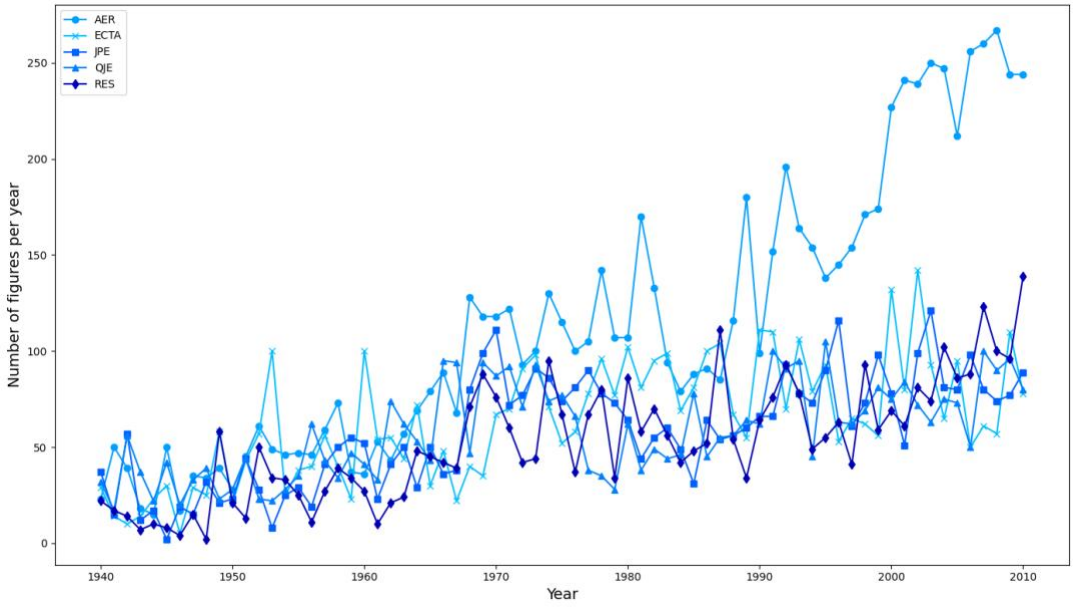


Figure 6: Each point on the line graph represents the total number of figures appearing in the articles per year, illustrating the rising use of visual representations in economic publications, particularly for AER.

Total number of tables in published articles across journals from 1940 to 2010

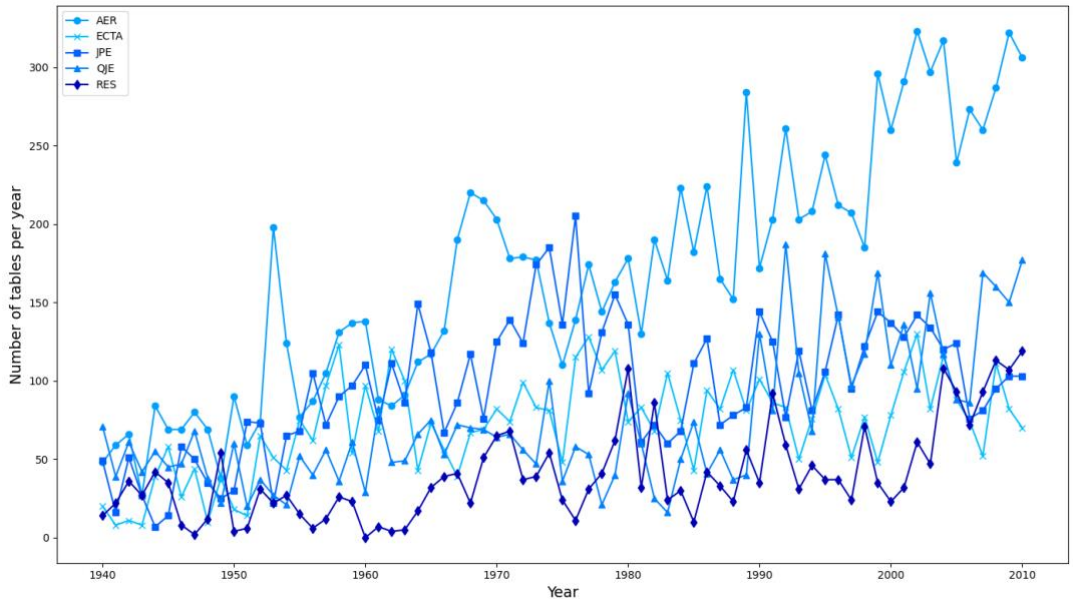


Figure 7: Each point on the line graph represents the total number of tables appearing in the articles per year. The graph reflects the increasing preference for tabular presentation of quantitative results.

Averaging the number of articles published and number of pages, presents evidence on the average length of the articles and how that changes over the years, which is summarised in Figure 8. All journals except RES show significant increase in the average length of articles. The format of the pages differs from journal to journal and even within each journal (Card & DellaVigna, 2013). As the occurrence of quantitative indicators can be influenced by varying article length, the number of pages as a unit of normalisation provides a foundation for analysing trends in quantitative methods over time as the article length varies. Following normalisation, in Chapter 4 regression models show whether the increase in quantitative indicators is present even with the normalisation of the article length and number of articles.

Average number of pages per article across the top five journals from 1940 to 2010

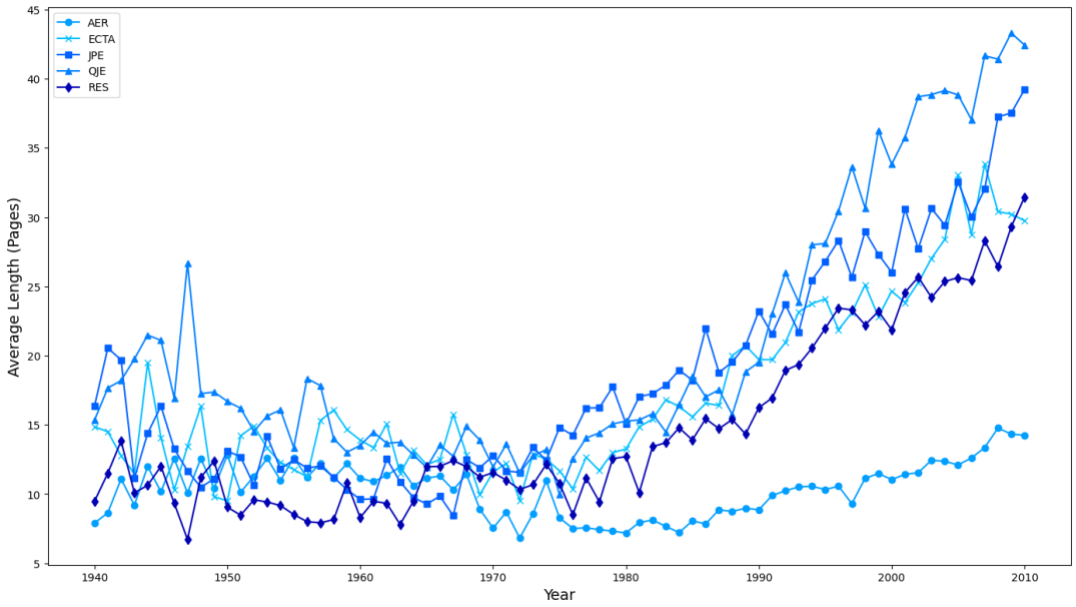


Figure 8: This figure shows how the length of the articles has changed over the period of evaluation. This also accounts for format variations and later supports the normalisation of quantitative indicators by article length since the length of the articles has increases over time.

4.3.2. Normalisation and length analysis

To control for varying number of articles published and article length, the study normalises the number of quantitative indicators by the total number of pages by calculating the proportional data. This approach ensures that the increasing length of articles over time does not artificially adjust the quantitative indicators in the analysis. Card and DellaVigna (2013) find that the average number of articles published per year from 1970-75 is 341 articles. This number increases to 398 articles from 1976-80 and then afterwards declines to around 250 per year. This number starts to recover to around 275 articles per year between 2001 and 2010. They also renormalise the length of the standard manuscript format to get the formats of all journals to match as closely as possible. From their findings, they conclude that the average length for all five journals increases from an average of 16 pages in the early 1970s to 46 pages in 2011-12, showing nearly a 300% increase. Since the equations data in this study is binary, after normalising for article length and number of articles, the data becomes proportions that are any number between 0 and 1. Therefore, after normalisation, equations data becomes continuous data instead of being binary and discrete data.

4.3.3. Trend analysis

The study employs time series-based analysis to observe trends in the use of the quantitative indicators over time. By looking at the proportion of each indicator over time, I highlight periods of significant change using the calculation of the z-score. The z-score measures how many standard deviations a data point is from the mean. For this analysis, it highlights where significant deviations in use of each quantitative indicator occurs relative to the average level between two periods, highlighting key periods of change. The formula for the z-score is $z = \frac{X-\mu}{\sigma}$, where X is an observed value, μ is the mean, and σ is the standard deviation of the dataset. I calculate the z-score to measure the periods of significant change in the use of quantitative indicators. Significant change helps to understand whether these moments match with economic events. Torgler and Piatti (2013) calculate z-scores to analyse statistically significant changes in publishing trends within AER between two periods: 1984–88 and 2004–08. Their analysis adjusts for article length and focuses on the prevalence of equations, figures, and tables per page. Their calculated z-scores are -0.03 for equations, 10 for figures, and 4 for tables. These results indicate significant positive changes in the use of figures and tables, while the change in the use of equations is negligible and slightly negative over the two periods.

4.3.4. Statistical modelling

This study makes use of regression models to explore the relationship between time and the inclusion of each quantitative indicators for each journal. The OLS regression models the relationship between each normalised quantitative indicator and time (year). OLS regression provides a straightforward yet robust approach for capturing linear trends and evaluating the changes of quantitative indicators over time. By focusing on the linear trend, this approach ensures simplicity while retaining interpretability. The formula for the OLS regression model is:

$$y = \beta_0 + \beta_1 x + \epsilon$$

Where y represents the dependent variable (normalised quantitative indicator), x is the independent variable (year), β_0 is the intercept and β_1 is the rate of change, and ϵ is the error term. This approach is particularly suitable for capturing long-term trends and provides insights into how the inclusion of equations, figures, and tables evolves over the evaluation period. The use of OLS regression aligns with prior studies examining trends in economic

publishing, such as Hamermesh (2013) and Stigler et al. (1995), who also adopted regression-based methodologies to assess changes in quantitative methods in economics.

To assess model fit, I calculate the Adjusted R-squared and Mean Squared Error (MSE). The Adjusted R-squared measures the proportion of variance explained by the model, accounting for the number of predictors. The MSE reflects the average squared difference between observed and predicted values. These metrics provide insights into the explanatory power and the accuracy of the model. Additionally, the F-statistic and p-value test the overall significance of the regression, determining whether the relationship between the dependent variable and time is meaningful. The F-statistic compares the fit of the regression model to a null model, with a higher value indicating a significant amount of variance explained. A p-value below 0.05 rejects the null hypothesis, confirming the model's significance. The Likelihood Ratio (LR) tests is also conducted to compare the dependent variable as a function of year baseline model with models that include lagged dependent variables. The LR test evaluates whether adding y_{t-1} materially improves the fit ($\rho = 0$ against $\rho \neq 0$); it does not itself speak to the direction or magnitude of the persistence of quantitative indicators. Therefore, the LR test evaluates whether including a lag significantly improves model fit, addressing concerns about persistence and autocorrelation in time-series data. This complements the OLS analysis by testing robustness to temporal dependence.

In addition to journal-specific OLS time trends, I estimate pooled regressions with journal fixed effects and interactions between journal dummies and year to test whether trends differ statistically across journals. Standard errors are clustered by year to account for cross-journal correlation each year. Joint Wald tests assess whether slopes differ across journals. I estimate the following:

$$y_{jt} = \alpha + \sum_{J \neq AER} \delta_J 1\{j = J\} + \beta year_t + \sum_{J \neq AER} \gamma_J 1\{j = J\} \,.\, year_t + \mathcal{E}_{jt}$$

Where y_{jt} is the indicator (normalised equation count) for journal j in year t , with the journal fixed effects baseline being AER and the interactions of the other journals are based on this baseline. This approach follows best practices in econometrics as outlined in Wooldridge (2016), ensuring the robustness and interpretability of the results. However, the model's reliance on a single independent variable may lead to potential limitations, such as

omitted variable bias. In Chapter 5, this study considers additional factors that may influence the rise of quantitative methods in economics.

4.4. Ethical considerations and limitations

4.4.1. Data handling and privacy

All data is collected ethically through the university's subscription to JSTOR. The articles are purely for research purposes and are not for redistribution. Additionally, the handling of large datasets necessitates careful attention to data privacy and the ethical use of journal content.

4.4.2. Limitations of the study

This study acknowledges several limitations, including potential biases in publication practices and the manual collection of data. While the manual collection method ensures accuracy, it is prone to human error. Future research could explore the use of automated tools that would result in high accuracy rates, such as natural language processing and machine learning (ML) algorithms. Manual data collection provides this study with better accuracy then Optical Character Recognition technology such as layoutparser API as initially tested. With increased technological and data management capacity, further research studies can explore such tools. These would not only reduce the risk of human error but also enhance the scalability of the research, allowing for the analysis of larger datasets and the examination of trends across a wider range of publications.

Additionally, the study's focus on articles published in English may introduce a bias towards English-language journals. Future research could consider incorporating non-English journals to provide a more global perspective on the empirical turn. The analysis also assumes that the presence of equations, figures, and tables is a sufficient proxy for identifying quantitative methods, which may overlook subtler forms of quantitative reasoning, such as qualitative discussions of econometric results. The reliance on top journals may not fully capture trends occurring in the wider economic publishing discipline.

4.5. Chapter summary

This methodology outlines the process of data collection, classification, and analysis approach for this study. By analysing the evolution of quantitative methods in economics, the aim is to shed light on when the empirical turn occurs. The study draws from previous influential studies on the empirical turn and adopts a systematic approach to quantifying these changes. By leveraging a robust dataset from five leading journals, this framework enables a systematic exploration of how quantitative indicators evolve over time. The focus on normalisation and regression modelling ensures that the analysis accounts for variations in article length and publication practices, thereby providing reliable insights into the trends observed.

While this study contributes to the broader literature on the empirical turn in economics, it differs from prior works like Hamermesh (2013), Stigler et al. (1995), and Torgler and Piatti (2013). This study utilises a larger dataset over a longer time frame and focusing exclusively on quantitative indicators. By normalising the data by article length and controlling for shifts in editorial policies, this study provides a nuanced understanding of how quantitative methods have become central to the field of economics. The analysis presented in the next chapter builds on this foundation, revealing trends in the use of quantitative methods and their implications for the evolution of economic publishing.

5. The quantitative work in the top 5 journals

This chapter builds upon the methodological framework in Chapter 4 to analyse trends in the use of equations, figures, and tables across the five journals. These quantitative indicators serve as proxies for the methodological evolution within the discipline, shedding light on the empirical turn that shapes economics over time. The analysis is conducted at both the individual journey level and finally, ending with a general discussion of the results across all five journals. Each indicator is examined independently within each journal to identify trends that may reflect editorial mandates, journal-specific focus, or broader methodological shifts.

By focusing on these trends, this chapter aims to uncover whether the observed changes in quantitative indicators is driven by journal-specific editorial practices, broader disciplinary transformations, or external factors such as historical economic events. The chapter concludes with a comparative analysis, exploring patterns across journals to provide a comprehensive understanding of how quantitative methods have influenced and been shaped by the evolution of economics as a field.

5.1. Equations

The proportion of equations across the five journals reveals an overarching trend toward increasing mathematical rigour in economics. This trend is evident in the steady rise in the proportion of pages containing equations across the journals from the mid-20th century onwards (as seen in Figure 5 above). However, the magnitude and timing of these changes vary by journal, suggesting distinct additional influence such as editorial policies or audience preferences for example.

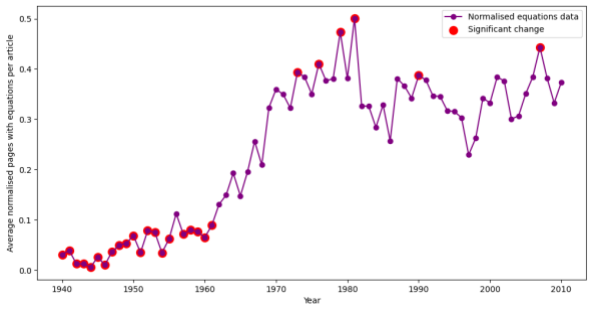
5.1.1. Timing of significant changes

Figures 9 below - representing AER, ECTA, JPE, QJE, and RES - highlights the variation in the use of equations over time. The red markers indicate statistically significant changes based on z-scores, pointing to key moments when statistically significant shifts in mathematical formalism occur. Each journal experiences periods of significant growth in mathematical content, though to different extents. In

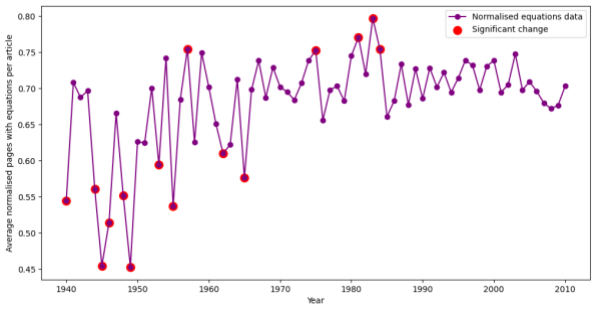
AER, the steady increase from the 1940s to the early 1980s, followed by stagnating changes, suggests a sustained rise in mathematical content. JPE and RES follow similar trajectories, while QJE shows an initial increase followed by a dip in the late 1980s before reaching a stable phase. ECTA exhibits a unique pattern of volatility, reflecting its focus, from inception, on econometrics and advanced mathematical methods (Bjerkholt, 2014). Each graph underscores distinct editorial policies, shaping the journals' approaches to mathematical content.

Z-score for normalised proportion of pages with equations in each journal publication from 1940 to 2010

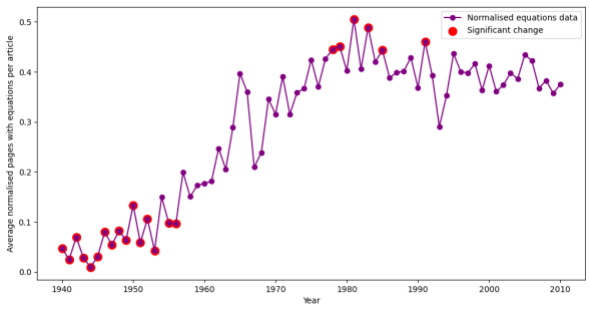
AER



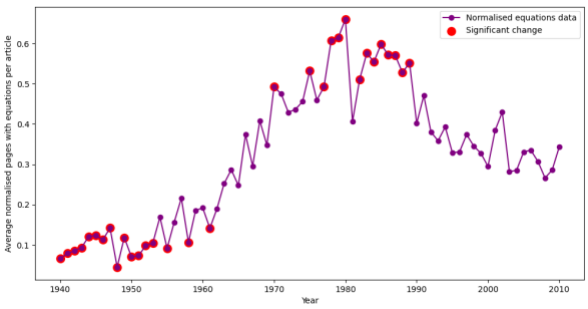
ECTA



JPE



QJE



RES

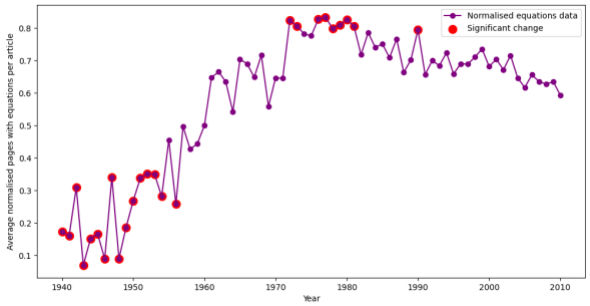


Figure 9: The red markers indicate years of statistically significant changes of the normalisation proportion of pages with equations in each journal using the z-score calculation. Notable shifts in the 1940s and early 1980s align with the increased mathematical usage in economic research.

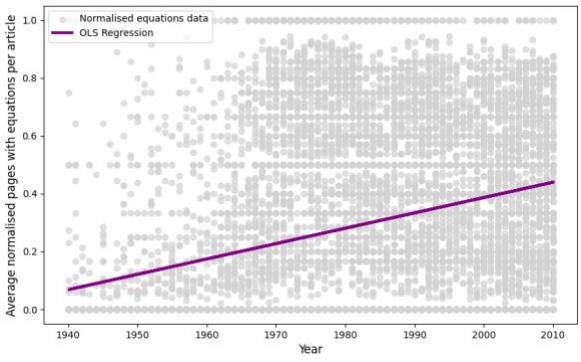
These trends reflect the broader empirical turn, aligning with technological advancements and shifting expectations within the field of economics. The common periods of significant change across journals, particularly between the 1940s and the early 1980s, highlight a coordinated shift towards empirical methods and quantitative rigour.

5.1.2. Regression analysis

To examine changes in the usage of equations over time, I model OLS regression to explore the linear relationship between the normalised proportion of equations and publication year. This method reveals trends in the occurrence of equations across the years, reflecting shifts in the mathematical rigour of economic research. Figure 10 shows the OLS regression for equations, showing all individual data points, and shows these trends with fitted regression lines and best-fit equations. Table 2 summarises the key statistical metrics. The intercepts in 1940 vary among journals, highlighting differences in their initial use of equations. ECTA has the highest intercept (0.64), demonstrating a strong early emphasis on the use of equations. By contrast, AER exhibits the lowest intercept (0.07), indicating a more modest use of equations at the start of the period. These initial differences reflect the journals' diverse editorial policies and disciplinary orientations at the time.

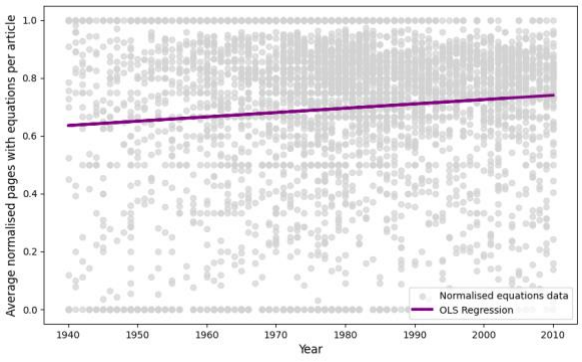
OLS regression lines for the proportion of pages containing equations for each of the top five journals from 1940 to 2010

AER



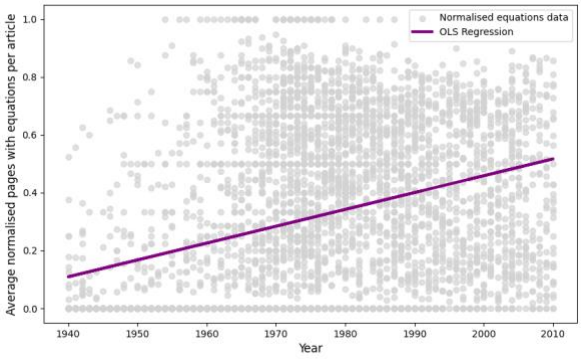
$y = 0.07 + 0.005x$

ECTA



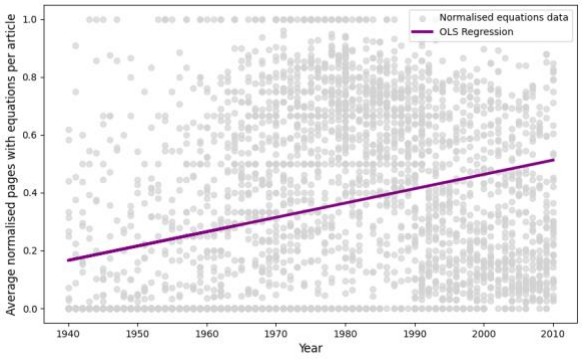
$y = 0.64 + 0.001x$

JPE



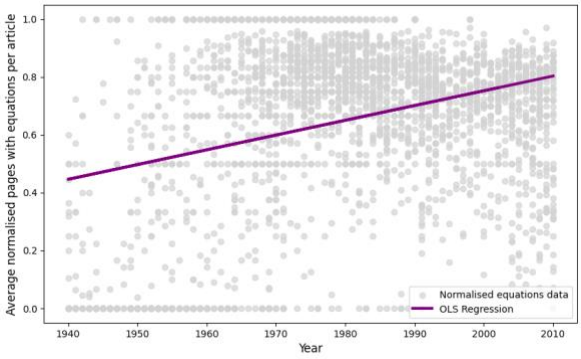
$y = 0.11 + 0.006x$

QJE



$y = 0.17 + 0.005x$

RES



$y = 0.45 + 0.005x$

Figure 10: Each point represents a page in an article. While all journals exhibit update trends, ECTA begins at a higher mathematical baseline, and JPE and QJE show steeper growth trajectories.

The results in Table 2 show statistically significant upward trends in the use of equations for all five journals (F-statistics and p-values < 0.001). Although the adjusted R-squared values are low, especially for ECTA (0.01), this indicates that year alone explains a limited share of variation. The significant F-statistics confirm the presence of a linear time trend. AER and JPE has the highest F-statistic, adjusted R-squares and a steep slope, relative to the other slopes, this reflects the growing incorporation of formal mathematical models in the particularly after the 1950s. These significant results, with p-values lower than 0.05, confirming the significance of the trend and gradual adoption of mathematical response to evolving research practices in economics.

The **unit-root diagnostics** indicate heterogeneity across journals: the ADF test rejects a unit root only for **ECTA** (p = 0.031), while for AER, JPE, QJE, and RES the null cannot be rejected, consistent with

trending (non-stationary) behaviour in levels. Residual **autocorrelation** is evident in several journal, Durbin–Watson statistics well below 2 for AER (0.385), JPE (0.519), QJE (0.259), and RES (0.381), which motivates a dynamic specification. LR tests below, show that adding a lagged dependent variable significantly improves fit, confirming **persistence** in equation use over time.

OLS regression, with unit-root and autocorrelation diagnostics, results for equation presence across AER, ECTA, JPE, QJE, and RES (1940 – 2010)

	ADJUSTED R-SQUARED	F-STATISTIC	P-VALUE	ADF STAT	P-VALUE	DURBIN-WATSON
AER	0.11	1337	<0.001	-1.337	0.612	0.385
ECTA	0.01	39	<0.001	-3.042	0.031	1.578
JPE	0.12	554	<0.001	-1.866	0.348	0.519
QJE	0.09	322	<0.001	-1.524	0.522	0.259
RES	0.10	301	<0.001	-2.203	0.205	0.381

Table 2: All journals show statistically significant upward trends, indicating increasing reliance on mathematical techniques in economic publishing.

For each journal, I compare a baseline linear trend model to a dynamic specification that adds a one-period lag of the dependent variable. The LR statistic, $\chi^2(1)$, as shown in Table 3, strongly rejects the null that the lag adds no explanatory power in all five journals ($p < 0.001$). This indicates persistence in the use of equations from year to year. Conditional on the time trend, equation intensity exhibits serial correlation consistent with editorial or disciplinary inertia.

Likelihood ratio results for equation presence across AER, ECTA, JPE, QJE, and RES (1940 – 2010)

	LR STAT ($\boldsymbol{\chi 2}$)	$\boldsymbol{\Delta df}$	P-VALUE
AER	1581.80	1.00	<0.001
ECTA	55.28	1.00	<0.001
JPE	63.13	1.00	<0.001
QJE	284.66	1.00	<0.001
RES	217.65	1.00	<0.001

Table 3: The LR stat shows that all five journals show persistence in equation use over time, with p-values < 0.001

5.1.3. Summary of results

The analysis results show the evolving role of mathematical formalism across the five journals. The timing of significant changes, as highlighted by z-scores in Figure 9, demonstrates key periods of transformation in the inclusion of equations, particularly during the 1940s to early 1980s. This period marks a coordinated shift towards empirical methods. Each journal follows a unique path: ECTA's volatility reflects its early emphasis on econometrics and advanced mathematical methods, while AER, JPE, and RES exhibit more gradual and steady growth in mathematical content. QJE's trajectory includes an initial rise, a dip in the late 1980s, and subsequent stabilisation, further reflecting the influence of distinct editorial priorities. The regression analysis complements these findings, confirming the overall trend of increasing mathematical rigour and the varying rates of change across journals. The varying intercepts and slopes reinforce the role of editorial policies in shaping each journal's methodological transformation.

5.2. Figures

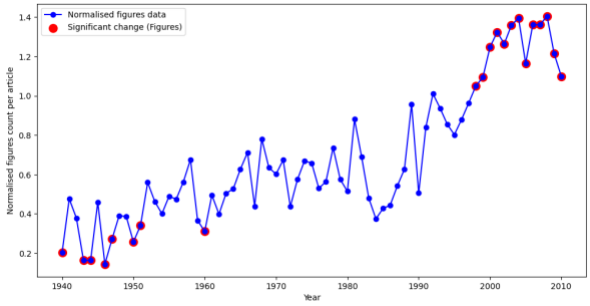
The proportion of figures across the five journals reveals a consistent increasing trend of the use of visual data representation in economics. This aligns with the broader empirical shift noted in studies that analyse economic publishing (Togler & Piatti, 2013).

5.2.1. Timing of significant changes

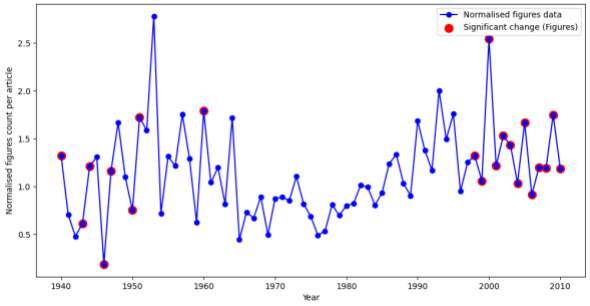
The use of figures varies in terms of timing and intensity across journals. Figure 11 illustrate these variations for the five journals, showing the proportion of figures per article and highlights periods of significant change. Notably, AER, JPE, and QJE show an upward trend starting in the 1940s. For all three journals, there is a peak around the 1980s. Thereafter, there are slight declines, potentially indicating a balanced integration of visual aid in quantitative methods. In contrast, RES displays volatile and gradual increase, possibly signalling a flexible adoption of visual data methods. ECTA, with its econometric focus, exhibits the most volatility. After the 1980s, ECTA's figure usage stabilises, suggesting a consistent approach. Years of significant change vary across journals but are pronounced across all journals in the 1940s, 1950s and 2000s.

Z-score trends in the proportion of figures per article across all five journals from 1940 to 2010

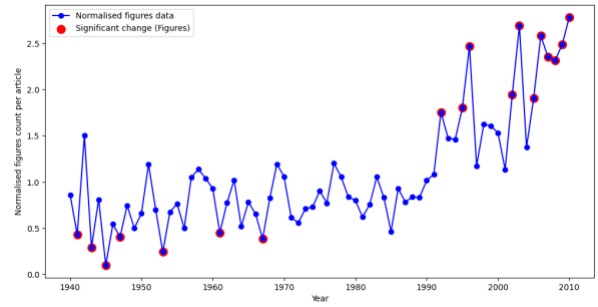
AER



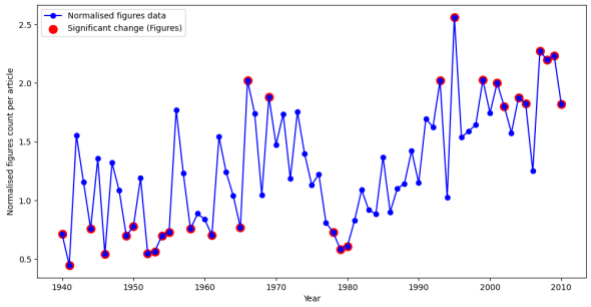
ECTA



JPE



QJE



RES

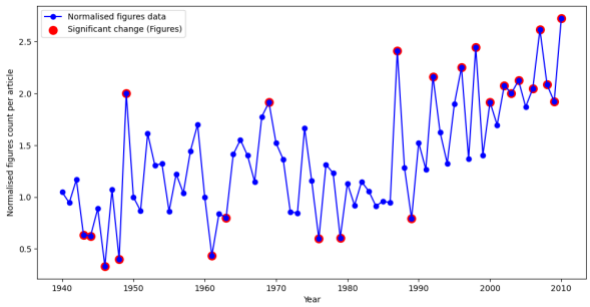


Figure 11: The figures above show the proportion of figures per article for each of the five journals evaluated, identifying years with significant changes in figure usage. High z-scores reflect pivotal shifts in the visual presentation of quantitative findings, which is concentrated in the earlier years and later years of the evaluation.

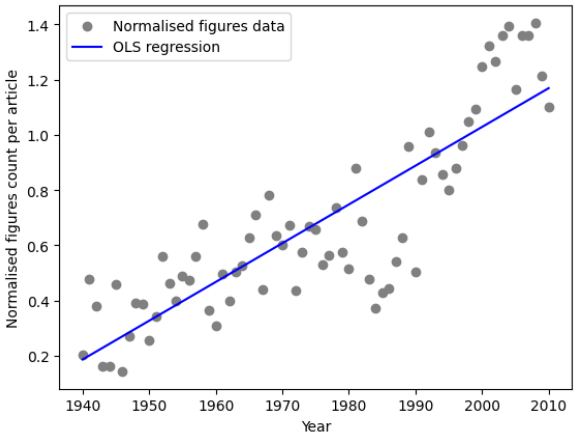
5.2.2. Regression analysis

To quantify changes in the usage of figures over time, I apply OLS regression, which enables a linear interpretation of the relationship between the normalised proportion of figures and the publication year. This approach highlights the general trends in figure usage across years. Figure 12 illustrate the trends for figures data with fitted OLS regression lines, displaying the aggregated yearly averages, and best-fit equations. Table 3 provides the key statistics for the models. The intercepts in 1940 vary across journals,

reflecting initial differences in figure usage. ECTA demonstrates the highest intercept (0.98). This indicates an early emphasis on figures, while AER shows the lowest intercept (0.19). These initial values highlight the variability in figure usage across journals, potentially influenced by differing methodological preferences. JPE and RES have the steepest of the five slopes (0.02), which indicates the meticulous change of use of data visualisation in the form of figures.

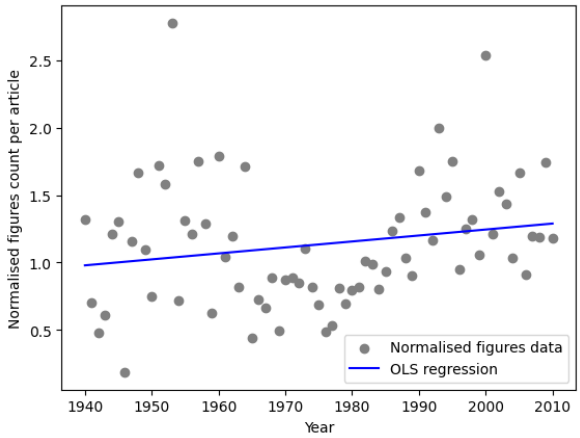
OLS regression plots for average proportion of figures per page in each journal (1940 – 2010)

AER



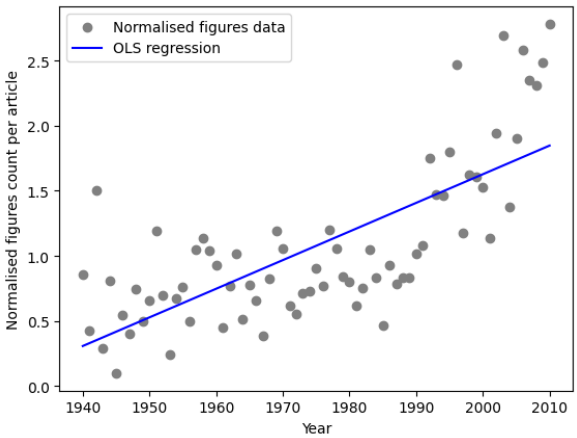
$y = 0.19 + 0.01x$

ECTA



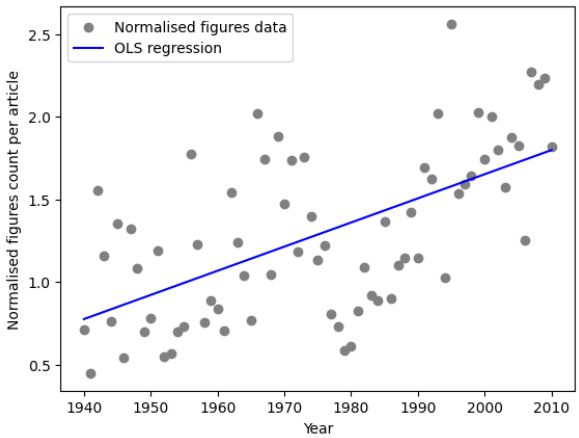
$y = 0.98 + 0.004x$

JPE



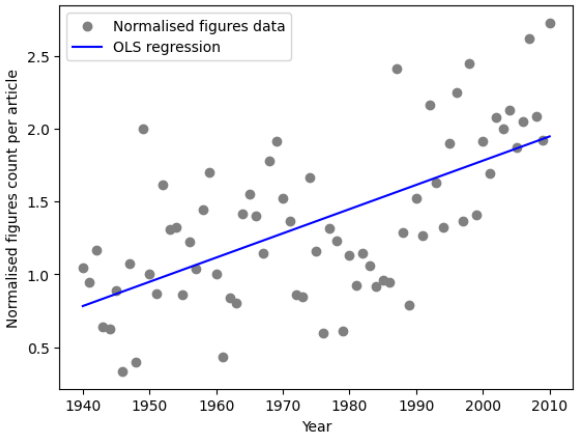
$y = 0.31 + 0.02x$

QJE



$y = 0.77 + 0.01$

RES



$$y = 0.78 + 0.02x$$

Figure 12: Each dot represents a yearly average. The fitted OLS lines show positive relationship between time and the normalised figures per articles, indicating increasing reliance on figures to support empirical arguments.

All journals, except ECTA, show a statistically significant upward trends, with p-values of less than 0.001 and high F-statistics. This provides strong evidence for the increasing adoption of figures over time. AER has an adjusted R-squared value of 0.73 suggesting that 73% of the variance in figure usage is explained by year. These results align with broader academic observations that AER has progressively adopted more quantitative and visual methods in response to shifts in economic research practices. ECTA also exhibits an upward trend, although it is not significant and has a p-value of 0.10. This means that even at the 5% significant level, the model is not statistically significant.

The ADF tests do not reject a unit root for any journal (all p-values > 0.28), consistent with non-stationary/trending series in levels. Durbin–Watson statistics are below 2 for all journals, especially AER (0.893**)** and JPE (1.139), indicating positive autocorrelatio**n** in residuals. These diagnostics justify moving beyond a purely static trend. The LR tests results below show that adding a one-year lag of the dependent variable significantly improves fit for AER and JPE ($p < 0.001$), indicating short-run persistence in figure usage; the lag does not add explanatory power for ECTA or RES**,** and QJE shows only weak evidence at the 10% level.

OLS regression, with unit-root and autocorrelation diagnostics, results for figure usage per article across AER, ECTA, JPE, QJE, and RES (1940 – 2010)

	ADJUSTED R-SQUARED	F-STATISTIC	P-VALUE	ADF STAT	P-VALUE	DURBIN-WATSON
AER	0.73	188	<0.001	-0.549	0.882	0.893
ECTA	0.02	2.73	0.10	-2.001	0.286	1.736
JPE	0.52	78	<0.001	0.733	0.990	1.139
QJE	0.35	38	<0.001	-0.921	0.781	1.589
RES	0.38	44	<0.001	-0.624	0.865	1.702

Table 4: All journals, except ECTA, show statistically significant upward trends, indicating increasing reliance on data visualisation in economic publishing. AER reports the highest explanatory power with an Adjusted R^2 of 0.73.

I compare a baseline linear-trend model to a dynamic specification that adds a one-year lag of the dependent variable (proportion of figures per article). The LR statistic, $\chi^2(1)$, shows that the lag **a**dds significant explanatory power for AER and JPE ($p < 0.001$), indicating short-run persistence: years with more figures tend to be followed by years with more figures, even after controlling for the secular trend. For ECTA and RES the LR tests fail to reject the null ($p = 0.281$ and 0.286), and for QJE there is only weak evidence at the 10% level ($p = 0.083$). Thus, for these journals the lag does not provide additional predictive content beyond the time trend, consistent with greater year-on-year volatility in figure use.

Likelihood ratio results for figures use across AER, ECTA, JPE, QJE, and RES (1940 – 2010)

	LR STAT ($\boldsymbol{\chi 2}$)	$\boldsymbol{\Delta df}$	P-VALUE
AER	25.52	1.00	<0.001
ECTA	1.16	1.00	0.281
JPE	12.56	1.00	<0.001
QJE	3.01	1.00	0.083
RES	1.14	1.00	0.286

Table 5: AER and JPE show persistence in figure use over time, with p-values < 0.001. While ECTA and RES fail to reject the null and QJE shows weak evidence at the 10% level.

5.2.3. Summary of results

The analysis highlights the growing importance of visual representation in economics journals, with figures playing an increasing role in quantitative research across the five journals. The timing of significant changes, as shown in Figure 11, points to pivotal periods of transformation during the 1940s, 1950s, and 2000s. The regression analysis confirms these broader trends. All journals demonstrate a statistically significant upward trajectory in figure usage, except ECTA. JPE and RES have the steepest slopes, indicating rapid adoption rates. These findings underscore the rising emphasis on visual data representation across the field, driven by evolving methodological preferences and the increasing complexity of economic research. Together, these insights affirm the broader trend of increasing reliance on figures to clarify and support quantitative analyses. The variability across journals reflects their unique editorial priorities and methodological focuses, highlighting the diversity of approaches within economic research.

5.3. Tables

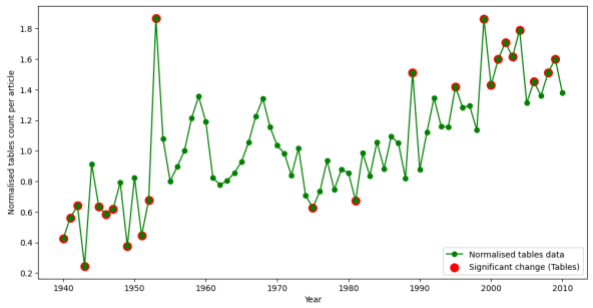
The proportion of tables per page across the five journals reflects a growing emphasis on the presentation of structured empirical data over the decades.

5.3.1. Timing of significant changes

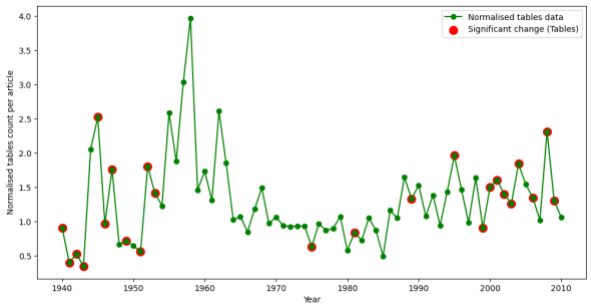
Figure 13 shows the trends in the normalised proportion of tables across the journals, alongside z-scores that identify statistically significant changes. The data reveals a general increase in the use of tables, with AER, JPE and QJE showing steady growth in table usage, especially during the 1990s and 2000s. These increases align with an increasing focus on empirical work in these journals. In contrast, ECTA shows volatility, lacking a clear upward trend, while RES shows irregular growth over the review period. Decades of significant change is the 1990s and 2000s for all journals. All journals, but QJE experience significant changes in the 1940s, this may indicate an early period of methodological shifts.

Z-score analysis of the proportion of tables per page for each journal from 1940 to 2010

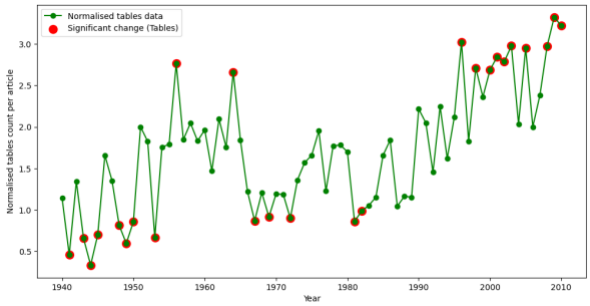
AER



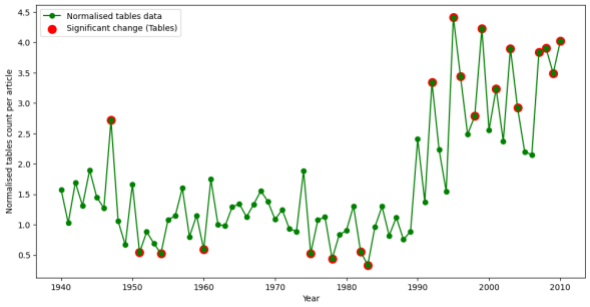
ECTA



JPE



QJE



RES

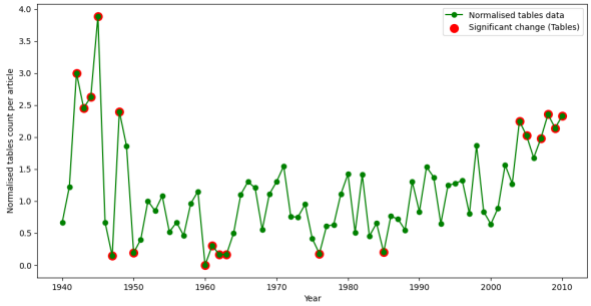


Figure 13: The figures above show the proportion of tables per article for each of the five journals evaluated over time, identifying years with significant changes in table usage by calculating the z-score. These figures highlight statistically significant increases and shifts in the use of tabular formats in economic publications evaluated.

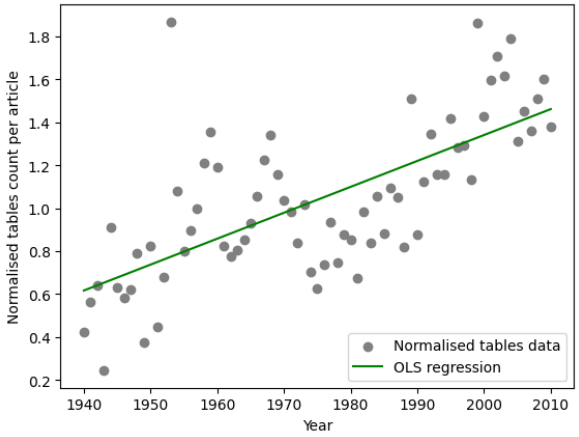
5.3.2. Regression analysis

To investigate the patterns in table usage over time, I run an OLS regression, modelling the normalised proportion of tables per page as a function of the publication year. This approach allows for identifying trends in table usage and to assess the role of tabular data in economics. Figure 14 illustrates the trends of tabular data across time, with fitted OLS regression lines and best-fit equations. At the starting point in 1940, ECTA demonstrates the highest intercept (1.30), indicating an early emphasis on tabular

representation, while AER and QJE both have the lowest intercept (0.62 and 0.61, respectively). These values point to the diverse methodological traditions and editorial priorities of the journals during the early period.

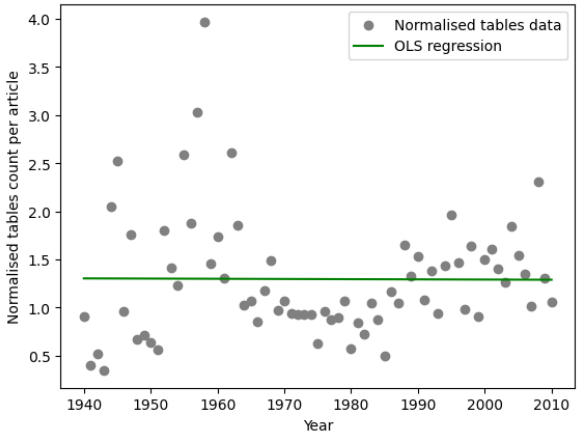
OLS regression for average proportion of tables per page across journals from 1940 to 2010

AER



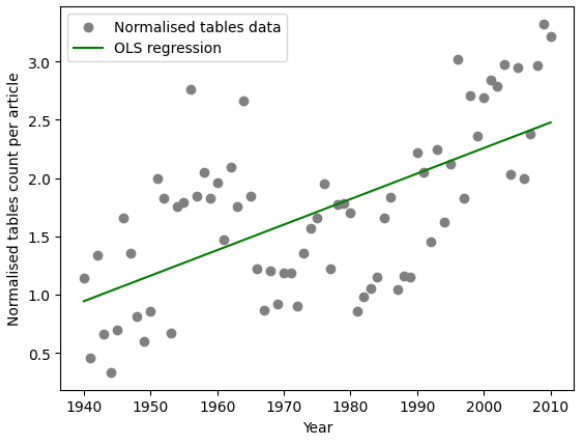
$$y = 0.62 + 0.01x$$

ECTA



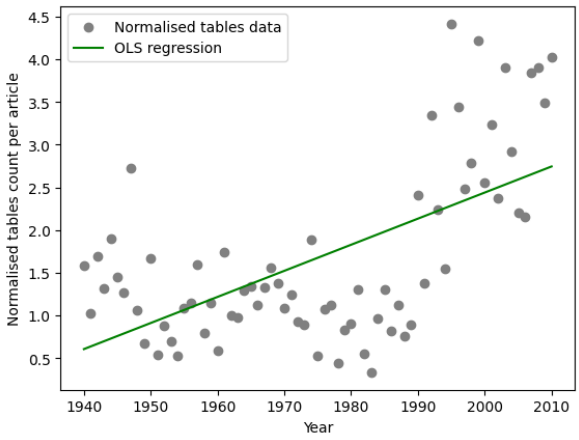
$$y = 1.30 - 0.002x$$

JPE



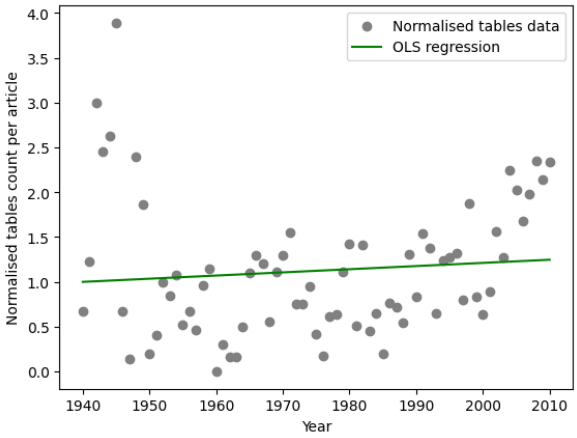
$$y = 0.94 + 0.02x$$

QJE



$$y = 0.61 + 0.03x$$

RES



$$y = 1 + 0.004x$$

Figure 14: Each dot represents a yearly average after the normalisation of count of tables per article over time. The regression lines track trends in the structured presentation of empirical data over time.

Table 6 summarises the model statistics. For AER, JPE and QJE, the OLS regression indicates a statistically significant upward trend. The p-values of less than 0.001 support the statistical significance. The adjusted R-squared values of 0.46, 0.38 and 0.35, for AER, JPE and QJE, respectively, indicates moderate explanatory power. RES shows an upward trend that is not statistically significant (p-value = 0.42), with an adjusted R-squared value of -0.01, indicating limited explanatory power. ECTA's regression also has a downward trend, with a p-value of 0.96 and R-squared of -0.01. A negative adjusted R-squared indicates the model's inability to explain variation. This suggests that other factors may influence table usage and not time in ECTA and RES.

Unit-root tests suggest persistence in several series: for AER, JPE, and QJE the ADF test fails to reject a unit root (p = 0.355, 0.207, 0.972), whereas ECTA and RES reject at the 5% level (p = 0.002 and 0.003), implying stationarity for those journals, consistent with their flat/declining trends. Durbin–Watson statistics are close to 1 for all journals, indicating positive serial correlation in residuals. This supports the complementary dynamic checks reported elsewhere (LR tests with a lagged dependent variable), which show additional predictive content from past table usage.

OLS Regression results for table usage per page in AER, ECTA, JPE, QJE, and RES (1940 – 2010)

	ADJUSTED R-SQUARED	F-STATISTIC	P-VALUE	ADF STAT	P-VALUE	DURBIN-WATSON
AER	0.46	61	<0.001	-1.851	0.355	1.358
ECTA	-0.01	0.003	0.96	-3.921	0.002	1.139
JPE	0.38	44	<0.001	-2.199	0.207	1.083
QJE	0.35	39	<0.001	0.199	0.972	1.032
RES	-0.01	0.65	0.42	-3.764	0.003	1.000

Table 6: AER, JPE, and QJE display significant upward trends in tabular data presentation. ECTA and RES both show non-significant and negative trends, that time does not explain the variable in the proportion of tables per article.

Comparing the baseline linear-trend to a dynamic specification that adds a one-year lag of the dependent variable (proportion of tables per page). The LR statistics, χ^2 (1), rejects the null in all five journals (as shown in Table 7 below). Persistence is strongest for ECTA, JPE, QJE, and RES ($p < 0.001$), and present, though weaker, for AER ($\chi^2 = 7.47$, $p = 0.006$). Thus, conditional on the time trend, table usage exhibits year-to-year autocorrelation, consistent with editorial or disciplinary inertia in the formatting of empirical results.

Likelihood ratio results for tables use across AER, ECTA, JPE, QJE, and RES (1940 – 2010)

	LR STAT ($\chi 2$)	Δdf	P-VALUE
AER	7.47	1.00	0.006
ECTA	14.20	1.00	<0.001
JPE	16.01	1.00	<0.001
QJE	17.60	1.00	<0.001
RES	19.38	1.00	<0.001

Table 7: All journals show statistically significant persistence (AER: $p = 0.006$, while the other four journals have p-values of less than 0.001), this indicate that yeas with more tables tend to be followed by years with more tables tend to be followed by years with more tables, even after controlling for the secular trend.

5.3.3. Summary of results

The significant changes analysis highlights critical periods of methodological evolution. AER, JPE, and QJE show consistent and statistically significant growth in table usage from the 1990s onward. In contrast, RES displays infrequent increases, while ECTA's significant changes occur sporadically, reflecting diverse methodological approaches. The OLS analysis reveals journal-specific patterns that reflect differing editorial priorities and methodological traditions in relation to time. The steady increase in table usage over time in AER, JPE, and QJE reflects the growing reliance on tabular data to present empirical results, aligning with studies documenting the rise of empirical methods in economics (Togler and Piatti, 2013). ECTA's high initial intercept and subsequent decline suggests an early emphasis on quantitative methods, where tables serve as a key means of communicating data.

Overall, these findings highlight the diverse approaches in use of tables in economic research and their role in shaping the presentation of empirical data across journals. The steady rise in table usage in AER, JPE, and QJE underscores their increasing reliance on tabular formats to communicate complex empirical analyses, while the variability in RES and ECTA highlights differing editorial practices and methodological flexibility over time.

5.4. Comparative analysis across all five journals

As leading publications in economics, the top five journals show converging trends over time despite distinct editorial orientations. For instance, ECTA traditionally emphasises econometrics and mathematics, while AER increasingly prioritises research leveraging quantitative models (Torgler & Piatti, 2013). AER's editorial stance positions it as a pioneer in shaping modern economic research by emphasising empirical evidence and quantitative methodologies. Across all three quantitative indicators there is a shared shift toward more quantitative methods over time. However, the trends reveal distinct editorial strategies and priorities:

- **AER:** Demonstrates balanced, steady growth across all indicators, signalling adaptation to empirical and quantitative methods while retaining methodological diversity.

- **ECTA:** Maintains its econometric emphasis, reflected in a high prevalence of equations and relatively limited growth in figures and tables.
- **JPE and QJE:** Show similar trajectories, with significant growth in all three indicators, emphasising a strong commitment to integrating empirical methods.
- **RES:** Exhibits variability, suggesting a less linear adoption of quantitative approaches.

5.4.1. Pooled Model Analysis

To compare trends formally across journals, I estimate a pooled fixed-effects model with journal dummies and journal-specific time trends (journal and year interactions), clustering standard errors by year and using AER as the baseline. This setup allows baseline differences (intercepts) and slope differences in trends to be tested jointly. The pooled models are estimated separately for each quantitative indicator.

The results appear in Table 8. The reported intercepts are the AER baselines in 1940 (with standard errors). Joint F-tests on the interaction terms reject equal slopes across journals for each indicator (all $p<0.001$). Consistent with the single-journal regressions above, ECTA's trends in figures and tables are significantly flatter than AER's, while JPE and QJE show steeper positive trends. For equations, ECTA starts from a higher baseline, and its growth rate differs significantly from AER, confirming heterogeneous trajectories in mathematisation.

Pooled fixed-effects OLS regression results for equation, figure and table usage across AER, ECTA, JPE, QJE, and RES (1940 – 2010)

	ADJUSTED R-SQUARED	INTERCEPT	STANDARD ERROR	F-STATISTIC	P-VALUE
EQUATIONS	0.315	0.067	0.019	487	<0.001
FIGURES	0.493	0.187	0.033	76.04	<0.001
TABLES	0.323	0.617	0.067	23.75	<0.001

Table 8: Dependent variables are the normalised indicators; with AER as the baseline journal, with initial year being 1940. Joint tests of slope equality across journals reject at $p < 0.001$.

5.4.2. Summary of across-journal analysis

The pooled fixed-effects results in subsection 5.4.1 formally compare trends across journals by testing journal and year interactions. These models identify whether slopes differ by journal; they do not address the timing of shifts or structural breaks. By contrast, the journal-specific analysis in the previous sections (z-scores and single-journal OLS) shows clusters of significant changes occurring in similar periods across multiple journals, pointing to field-wide forces rather than isolated editorial choices. These developments coincide with the rise of econometrics, the expanding availability of datasets, and a growing emphasis on empirical rigour. For instance, the spread of econometric methods from the 1940s and the increasing integration of formal models during the 1990s are particularly noticeable. For figures, significant changes are more prominent after 1990, consistent with technological advances that facilitated data visualisation. This emphasis on making complex results accessible supports the empirical turn (Backhouse & Cherrier, 2017). Likewise, greater reliance on tables in the 1940s and 1990s aligns with a broader move toward structured presentation of empirical evidence.

Across indicators, the regressions reveal both shared disciplinary trends and journal-specific trajectories. The consistent increase in equations highlights the profession's shift toward formal mathematical modelling, though the pace differs: ECTA maintains the highest prevalence, reflecting its econometric focus (Bjerkholt, 2014). Figure usage rises in most journals, but the increase is not statistically significant for ECTA, consistent with its lesser reliance on visualisation. Tables show the greatest heterogeneity: ECTA exhibits a (statistically non-significant) downward trend, whereas AER, JPE, and QJE display clear, significant increases, underscoring the growing role of tabular reporting; RES also grows but more intermittently.

Overall, all three indicators point to a shared movement toward quantitative work, while the variability in slopes and levels confirms that journals adopt these methods in distinct ways. The comparative evidence therefore supports an economy-wide empirical turn, mediated by editorial mandates, disciplinary norms, and audience expectations, and characterised by an increasing premium on methodological rigour and empirical precision.

6. The evolution of economic publishing

Building on the findings from the previous chapter, this chapter examines key drivers of the empirical turn in economics. Three major themes emerge from both the literature and this study's results: the growing reliance on quantitative methods, the role of editorial decisions, and the measurement of research impact. Additionally, the chapter considers external influences such as economic and technological advancements, as well as future research opportunities and limitations.

6.1. The rise in quantitative methods on economics

Quantitative methods have fundamentally transformed economics, enabling researchers to explore complex relationships and refine theoretical predictions. This section considers the evolving role of mathematics, empirical techniques and the adoption of new methodologies that drive a shift towards rigorous data analysis. The increasing use of equations, tables, and figures highlight a broader disciplinary transformation, supported by computational advancements and a stronger emphasis on empirical validation.

6.1.1. The rise of causal inference in economics

The latter half of the 20th century marked a pivotal shift in economic research methods. Angrist and Pischke (2010) describe this transition as the "credibility revolution" in empirical economics. This period is characterised by heightened attention to empirical design and credible causal identification. It also marks a growing emphasis on empirical research that prioritises causal inference, moving beyond simple correlations to establish cause-and-effect relationships in economics. The quest for causal identification drives economists to adopt and adapt various quantitative methods. This changes how to address research questions and the formulation of policy recommendations. This focus on causality led to a surge in the use of experimental and quasi-experimental methods.

The increasing importance of causal inference has led to the widespread use of experimental and quasi-experimental methods. RCTs, once limited to medical fields, became widely adopted in development

and policy evaluation research (Banerjee, 2020). Quasi-experimental approaches, such as instrumental variables, regression discontinuity, and difference-in-differences, have proven valuable for identifying causal effects from observational data. These methods help economists overcome challenges related to endogeneity and omitted variable bias. Currie et al. (2020) further demonstrate how technology and big data are reshaping the field, enabling researchers to mine text and track methodological trends. They argue that the credibility revolution deepens as access to data improves and computational tools advance, making rigorous causal research more scalable and transparent.

This shift also coincides with the development of advanced econometric techniques. Methods like synthetic controls and refined regression models allow for precise estimation of causal impact. As Biddle and Hamermesh (2016) note, prioritising causal identification enhances the credibility and policy relevance of economic research. Section 6.4.1 explores how historical economic events contributed to these methodological developments and influenced academic publishing.

6.1.2. Key quantitative methods and their impact

The rise of causal inference drives the adoption of advanced quantitative methods in economics. This subsection discusses three key methodologies central to the empirical shift, namely; econometrics, game theory, and structural modelling. Each considers different approaches to which economists analyse data, test hypotheses, and inform policy.

A. Econometrics

Econometrics applies statistical techniques to quantify economic relationships, evolving from early applications of OLS regressions toward more sophisticated methods capable of addressing challenges such as endogeneity, omitted variable bias, and selection effects (Wooldridge, 2016). These developments have been central to the empirical turn, enabling economists to draw more credible inferences from observational and experimental data. A few examples of these techniques include:

Difference-in-Differences (DiD): A major advancement in this evolution is the **DiD** approach, which compares changes in outcomes over time between a treatment group and a control group. By exploiting temporal and group-level variation, DiD can help control for unobserved factors that are constant over time, strengthening causal inference. For example, Card and Krueger (1993) applied DiD to examine

the impact of minimum wage increases on employment in the fast-food industry, challenging conventional theory on labour markets.

Instrumental Variables (IV): Another pivotal method is the **IV** technique, which uses an external variable that influences the independent variable of interest but does not directly affect the outcome. This isolates exogenous variation, allowing for cleaner estimation of causal effects. An IV estimator is often defined as an estimator of the local average treatment effect, which is the average effect of the treatment for individuals whose treatment status is affected by the instrument (Athey and Imbens, 2017).

Regression Discontinuity (RD): The RD design is another quasi-experimental method that estimates causal effects by exploiting cut-off points in policy or treatment assignment. RD has been used to assess the impact of unemployment insurance benefits on unemployment duration, demonstrating the precision of the approach in settings with sharp thresholds. In addition, RCTs long considered the gold standard in medical research, has gained increasing prominence in economics. By randomly assigning subjects to treatment and control groups, RCTs ensure that differences in outcomes can be attributed to the intervention itself. Notable examples include Banerjee et al. (2015), who evaluate microcredit interventions in six countries, providing rigorous evidence on the limited but nuanced effects of such programmes.

Together, these methods, along with advances in panel data and time-series econometrics, have strengthened the empirical basis of economics. By prioritising designs that explicitly address causality, they have contributed to a shift from purely theoretical modelling to policy-relevant research, reinforcing the credibility and influence of the discipline (Angrist & Pischke, 2009; Currie et al., 2020).

B. Game Theory

Game theory provides a framework for analysing strategic interactions between individuals or firms. Traditionally used for theoretical modelling, it now integrates empirical approaches to study strategic behaviour. Key applications include:

- **Behavioural Game Theory:** Incorporates psychological insights into decision-making, examples of application includes the use this approach to analyse cooperation in public goods games.

- **Experimental Economics:** Uses lab experiments to test strategic interactions. Acedo and Gomila (2013) examines how communication influences trust and cooperation.

These developments make game theory more empirically grounded, expanding its relevance in economic analysis.

C. Structural Modelling

Structural models use economic theory to estimate relationships while accounting for real-world complexities. Advances in computation enhance their flexibility and empirical accuracy. Key applications include:

- **Structural Labour Economics:** Analyses labour supply and human capital decisions for example. Heckman et al. (2015) use structural models to evaluate early childhood interventions on later-life outcomes.
- **Dynamic Stochastic General Equilibrium (DSGE) Models:** These models are widely used in macroeconomics to analyse business cycles, monetary policy, and other macroeconomic phenomena. Christiano et al. (2018) employ DSGE models to assess the effects of the GFC (which I expand on in section 6.4.1. for the discussion on economic events).

By integrating theory with data, structural models improve economic forecasting and deepen policy insights.

These three methods, along with other quantitative techniques, enable economists to address a wide range of economic questions with greater rigour and precision. Their adoption and development have been crucial to the empirical turn in economics, leading to more credible and policy-relevant research.

6.1.3. Mathematics in economics

The integration of mathematics into economics plays a pivotal role in formalising the discipline. Beginning in the mid-20th century, mathematical modelling became a cornerstone of economic analysis, with the support from institutions like the Cowles Commission providing foundational work. The Cowles Commission, founded in 1932, actively promoted the use of formal mathematical and statistical methods in economics through research conferences and support of the Econometric Society. Methods initially developed for theoretical exploration were later applied empirically to address practical problems such as resource allocation and market efficiency. The Cowles Commission's emphasis on

mathematical modelling contributed to the development of econometrics and the use of statistical methods for economic analysis (Dimand, 2020).

The results from the analysis in this study, show that the increasing prevalence of equations is a result of the discipline's shift towards precision and providing evidence to research questions. Although some journals may maintain a stronger focus on theoretical methods, while others embrace mathematical modelling approaches more readily. This variation reflects the diversity of perspectives within the discipline and the ongoing debate about the appropriate balance between theory and empirical work in economics (Dimand, 2020). Economists differ from other social scientists by their relative extensive use of mathematical methods, which includes multivariate calculus, optimisation, and game theory. While these methods may be less complex than those used in physical sciences, they provide economists with the necessary tools to construct simplified models that explain real-world events (Dani, 2015).

6.2. The role of editorial decisions in shaping research trends

While methodological advancements and external factors contribute to the empirical turn, editorial decisions play a crucial role in shaping the direction of economic research. The preferences of journal editors influence what gets published, which methodologies gain prominence, and how research is presented. The increasing emphasis on quantitative methods in top economics journals suggests that editorial policies reinforce the discipline's shift towards empirical and data-driven research.

This section examines two key editorial influences; mandates of publishing houses and reader preferences. Understanding editorial dynamics provides insight into why quantitative methods dominate modern economics and how the empirical turn is sustained through publishing practices.

6.2.1. Mandates of publishing houses

The concentration of editorial power within a select group of top journals has significant influence on the direction of economic research. Rather than a broad evaluation of scholarly work, these journals often shape research trends based on the preferences and judgments of a small group of editors. This may not always reflect the diversity and complexity of studies and topics within the field. This

concentration of influence can lead to a lack of methodological diversity and a bias towards certain research topics or approaches. For example, a study by Colander et al. (2004) found that editorial boards of top economics journals tend to be dominated by economists from a small number of elite universities, potentially reinforcing existing research methodologies and limiting intellectual diversity. This raises concerns about the inclusivity and representativeness of economic research, as well as the risk of groupthink in economics.

6.2.2. The influence of reader preference on editorial decisions

Reader preferences shape editorial decisions, as journals strive to balance academic rigour with accessibility. Policymakers and business leaders often rely on economic research for decision-making. This creates demand for quantitative methods that are perceived as objective, credible, and readable (supporting the wide range of readers). This demand reflects the increasing prominence of figures and tables, which provide intuitive visualisation of complex results. Fourcade et al. (2015) highlight the influence of economists in policymaking and business, emphasising how their work needs read to non-economist audiences. This impacts the level of rigour of quantitative methods that authors use, considering their target audience. This influences journals to favour quantitative research that caters to a broader audience of policymakers and business leaders. Hamermesh (2013) also notes that one of the reasons for the empirical turn is that economic theory on its own may present an ambiguous view to readers. This leads to increasing need for visual representation for readers to comprehend the theory. Therefore, the target audience shapes the presentation style and methodological choices in economic publications.

6.3. Assessing the impact of economic research

Measuring the impact of economic research is complex, as traditional metrics like citations do not fully capture real-world influence. Economic research can drive policy reforms, business strategies, and public debates, yet its academic impact is primarily assessed through citation counts. While useful, this approach can distort evaluations by reinforcing existing methodological trends, particularly the growing emphasis on quantitative research.

Citations reflect both the academic influence of individual articles and the reputation of the journals in which they are published. High citation counts often indicate a paper's contribution to the field and

influence career progression. Card and DellaVigna (2013) analyse citation trends from 1970 to 2010 and find that while journal rankings remain stable, two major shifts occur. The first being a decline in ECTA's relative impact and, secondly, a rise in QJE citations. Fourcade et al. (2015) further show that between 19% and 25% of citations in economics come from outside the discipline, particularly from finance and political science. They also find that citations to mathematics and statistics have significantly declined. This shift suggests an increasing interdisciplinary influence and competitiveness, while reinforcing the dominance of empirical methods.

Citations can also signal changing research priorities. Topics with declining interest tend to be cited less, while those aligned with emerging trends receive more attention. Bornmann and Leydesdorff (2017) highlight that quantitative studies consistently attract more citations, reinforcing their prevalence in economic research. Angrist et al. (2017) further demonstrate that while theoretical work published in the 1980s and 1990s was more frequently cited than empirical work from the same period, this trend reversed after 2000, with empirical studies receiving more citations. This shift reflects the broader empirical turn in economics.

The increasing reliance on citation count as a measure of research impacts the preference for data-driven studies. To achieve popularity within the field, authors will tend to include quantitative work in their articles and editors will favour more quantitative work. While citations highlight influential work, they also shape the direction of economic research, reinforcing the dominance of quantitative methodologies as the standard in academic publishing.

6.4. External drivers of research trends

Economic and technological advancements influence the adoption of quantitative methods in economics. Financial crises and technological breakthroughs, for example introduce opportunities for new research and the furthering of existing research. Increasing research investments, because of research requirements and demand, can lead to methodological innovations. This section explores how these external factors and their influence shape economic publishing.

6.4.1. Economic events

Economic events have historically played a significant role in shaping the methods and focus of economic research. Periods of major economic events can prompt scholars to go back to the drawing board, using the practical examples as evidence to prove or disprove economic theories. From such events, new hypothesis arises, prompting for further research. The Great Depression, following the First World War, created an urgent demand for economic analysis to diagnose and solve systematic issues. Economists developed new tools, including mathematical and statistical models, to address these challenges. During the Second World War, economists applied mathematical models to practical problems such as optimising resource allocation and planning bombing raids. This wartime experience established the value of "toolkit" economics, which prioritised mathematical and statistical techniques for solving specific, well-defined problems (Biddle & Hamermesh, 2016). The Second World War catalysed further development of economic research, with economists focusing on rebuilding public finances and curbing inflation. During this period, the inadequacy of existing models prompted the need for more robust approaches, increasing interest in quantitative methods. The oil crisis and stagflation of the late 1970s similarly challenges traditional models, leading to a re-evaluation of economic frameworks and the adoption of advanced quantitative techniques (Morgan & Rutherford, 1998).

Beyond reacting to crises, economic research is also expected to anticipate them. Before the GFC of 2008, scholars would have been able to identify indicators of asset bubbles as the data in existence in the financial systems might have been enough (Akerlof, 2020). The GFC highlighted the need for robust empirical methods that can help address contemporary economic shocks. The GFC exposed the shortcomings of existing economic models in accounting for the rapid growth and vulnerabilities of the shadow banking sector. The events of 2008 underscore the crucial fact that even small shocks can trigger a system-wide crisis - given the interconnectedness and leverage within the financial system. This gave rise to the experimentalist paradigm, which focuses on identifying causal relationships through quasi-experimental methods. This reflects a growing demand for economic models that explain and predict changes, guiding policy responses to economic shocks. The evolution of the DSGE models, for example, incorporates financial frictions and housing markets, recognising the crucial interplay between these factors and macroeconomic dynamics. Christiano, et al. (2018) DSGE model includes financial frictions that amplify and propagate shocks, as well as mechanisms to account for the role of

housing prices in household and firm borrowing. These developments illustrate how economic events drive the demand for innovative methods and models, shaping economic research.

6.4.2. Technology as an enabler

Technological advancements, particularly in computational tools and data accessibility have revolutionised economic research. Technology enables the creation and use of large datasets. This leads to the data revolution, increasing accessibility and availability of data, bringing about the data revolution. Data accessibility and use of data allows for better measurement of economic effects, improving model accuracy and expanding research questions (Einav & Levin, 2014). Technological advancements in computational tools enabled the creation and analysis of complex models. Events such as the dotcom bubble of the early 2000s and the 2008 GFC further underscored the need for advanced and predictive models to guide policy responses. These crises provide practical data for refining existing models and testing new theories.

The 21st century continues to witness an explosion of new technologies with the potential to further reshape economics. Artificial intelligence (AI) and machine learning (ML), for example, are changing the way economists approach research by detecting patterns in large datasets, refining forecasting models and automating processes. Researchers, for example, analyse large datasets such as online transactions to uncover new economic relationships, patterns and estimate predictions. Since these models handle large datasets, more sophisticated and realistic economic models that capture the complexities of human behaviour can be developed (Varian, 2014). The inclusion of a wider range of factors, such as social norms and network effects, can lead to increasing accuracy of predictions. This leads to improvement in the quality and accuracy of policy recommendations. Additionally, technology can reduce time taken to complete research by automating mundane tasks such as data cleaning and analysis. This gives researchers an opportunity to focus on other strategic aspects of research (Agrawal et al., 2019).

While the potential benefits of AI and ML in economics are significant, it is essential to consider the ethical implications of these technologies. Issues such as data privacy, algorithmic bias, and the potential for job displacement need to be carefully addressed to ensure that these technologies are used responsibly and equitably (Benthall & Haynes, 2019). Hamermesh (2013) considers the advancement in

technology as one of the possible reasons for the empirical turn in his assessment of AER, QJE, and RES. This trend is supported by the findings in Chapter 4, which indicate significant methodological shifts between the late 1980s and early 2000s. This period saw rapid computational advancements, enabling economists and researchers to perform more quantitative work.

6.5. Chapter summary

As Chapter 5's analysis shows, *year* generally does not have a high R-squared value, indicating its limited ability to explain the variance in quantitative indicators. Chapter 6 extends the analysis beyond these statistical results, examining the broader institutional and external forces driving the empirical turn in economics. This includes the influence of editorial mandates, reader preferences, and major economic and technological developments. By prioritising rigorous quantitative analysis, editorial policies in top journals shape the direction of economic inquiry and reinforce the prominence of mathematical and statistical methods. Reader preferences, particularly from policymakers and business leaders, further amplify this trend by creating demand for research that delivers robust empirical evidence to support economic arguments and policy decisions.

Beyond institutional influences, external drivers such as economic crises and technological advancements have profoundly shaped economic research. Major financial events have prompted economists to refine existing models and develop new quantitative techniques capable of explaining and predicting economic shocks. Among these techniques, DiD and RCTs have become pivotal in advancing causal inference. RCTs, once rare in economics, are now widely used to evaluate policy interventions in development, labour, and public economics, offering the highest standard of causal identification. DiD methods, in turn, allow researchers to exploit policy changes or events over time to estimate causal impacts in real-world settings. Together, these approaches have set new benchmarks for empirical rigour, influencing both the methodological expectations of journals and the design of applied economic research.

Advances in computing, such as AI and ML have also transformed data analysis, enabling more complex and precise empirical studies. These technologies allow researchers to process vast datasets, detect patterns not visible through traditional methods, and integrate behavioural and contextual factors

into models. This computational progress has equipped economists with the tools necessary for increasingly sophisticated quantitative work, further reinforcing the empirical turn.

In conclusion, Chapter 6 demonstrates how a combination of institutional priorities, audience expectations, methodological innovations such as DiD and RCTs, and external economic and technological shifts has entrenched the dominance of quantitative methods in economics. While Chapter 5 quantified the rise of equations, figures, and tables, this chapter offers a qualitative perspective on the forces behind these trends, together providing a more comprehensive understanding of how and why empirical research has become central to the discipline.

7. Conclusion

To conclude this study, this chapter discusses the implications of the increasing reliance on quantitative work in economic research and identifying opportunities for further exploration. Despite the extensiveness of the data analysis, there remains areas that warrant deeper investigation. By reflecting on the evolution of economic research up until 2010, this chapter also considers the broader implications of recent trends and the potential trajectory of future economic studies. Studies by authors such as Hamermesh (2013) provide a useful lens for comparing past trends with the current state of economic publishing.

7.1. Implications of increasing quantitative work

The shift towards quantitative methods in economics has significant implications for the discipline. Quantitative approaches bring rigour, precision, and replicability to economic research. This enables scholars to test hypotheses and model complex systems effectively. However, this focus also raises critical questions about inclusivity and scope. For instance, there are limitations of focusing solely on equations, figures, and tables as proxies for quantitative work. Many authors articulate quantitative insights verbally, meaning that their contributions may be underrepresented in the current analysis of this study. This observation aligns with findings by Hamermesh (2013), who emphasises the importance of capturing all forms of quantitative expression, including verbal and descriptive articulations. Future research should aim to address these gaps by developing more comprehensive frameworks that accurately reflect the diversity of quantitative methodologies in economics. By expanding the scope of analysis to include qualitative representations of quantitative methods, researchers can gain a more holistic understanding of the empirical turn in economics (Backhouse & Cherrier, 2017).

7.2. Opportunities for future research

There are several promising avenues for future research stemming from the findings of this study:

1. **Incorporating qualitative insights**:

Future models can integrate qualitative assessments, like that done by Hamermesh (2013) to complement quantitative measurements. This approach would ensure that verbal articulations of quantitative insights are not overlooked, and thus addressing the limitation of not capturing quantitative work beyond the quantitative indicators.

2. **Automation and scalability**:

The reliance on manual data collection, while it does ensure accuracy, poses significant constraints for scalability and reproducibility. Future research could explore advancing AI and ML tools to automate data collection and classification processes. This would enable researchers to analyse larger datasets more efficiently (Varian, 2014).

3. **Tracking economic themes over time**:

Computational advancements could facilitate the analysis of thematic trends in economic research. For instance, identifying the prevalence of terms such as "asset bubble," "financial crisis" or "Great Depression" could reveal how major economic events shape the trajectory of academic inquiry. Studies suggest that understanding these thematic evolutions could shed light on the interplay between historical context and academic priorities.

4. **Technological impacts on economics**:

Exploring the integration of AI and ML into economic research could provide insights into how technology is shaping the field. Potential areas of focus include the use of AI in modelling economic phenomena, the automation of repetitive tasks, and analysing vast datasets. Such studies would offer a forward-looking perspective on the tools and methods driving contemporary economic research (Cockburn et al., 2019).

Future research in similar studies can be enhanced by integrating the four avenues detailed above. These avenues would further refine the understanding of the empirical turn and its impact on the discipline.

7.3. The future direction of economic research

As the field of economics continues to evolve, it is essential to reflect on the potential impact of the empirical turn on the future direction of research. The increasing reliance on quantitative methods will likely continue to shape the direction of economic research in the coming decades. As these methods become more sophisticated, they will influence the types of questions being asked, the frameworks being employed, and the focus of the discipline. For instance, the intersection of economics with computational sciences is creating opportunities to develop more realistic models of economic behaviour (Varian, 2014). However, this trend also raises important challenges. The focus on quantitative rigour may sideline qualitative insights, which are critical for understanding complex economic issues. Striking a balance between empirical rigour and conceptual breadth will be essential for fostering a holistic and impactful approach to economic research (Backhouse & Cherrier, 2017). Additionally, as noted by Hamermesh (2013), adopting innovative methodologies will be key to maintaining relevance and adaptability in a rapidly changing academic landscape.

References

Acedo, C. and Gomila, A., 2013. Trust and cooperation: a new experimental approach. *Annals of the New York Academy of Sciences*, *1299*(1), pp.77-83.

Agrawal, A., Gans, J. and Goldfarb, A., 2019. Economic policy for artificial intelligence. *Innovation Policy and the Economy*, *19*(1), pp.139-159.

Akerlof, G.A., 2020. Sins of Omission and the Practice of Economics. *Journal of Economic Literature* 58, 405–418. https://doi.org/10.1257/jel.20191573

Angrist, J., Azoulay, P., Ellison, G., Hill, R., Lu, S.F., 2017. Economic Research Evolves: Fields and Styles. *American Economic Review* 107, 293–297. https://doi.org/10.1257/aer.p20171117

Angrist, J.D., Pischke, J.-S., 2010. The Credibility Revolution in Empirical Economics: How Better Research Design is Taking the Con out of Econometrics. *Journal of Economic Perspectives* 24, 3–30. https://doi.org/10.1257/jep.24.2.3

Athey, S., Imbens, G.W., 2017. The State of Applied Econometrics: Causality and Policy Evaluation. *Journal of Economic Perspectives* 31, 3–32. https://doi.org/10.1257/jep.31.2.3

Backhouse, R.E., Cherrier, B., 2017. The Age of the Applied Economist. *History of Political Economy* 49, 1–33. https://doi.org/10.1215/00182702-4166239

Banerjee, A.V., 2020. Field experiments and the practice of economics. *American Economic Review*, *110*(7), pp.1937-1951.

Banerjee, A., Duflo, E., Goldberg, N., Karlan, D., Osei, R., Parienté, W., Shapiro, J., Thuysbaert, B. and Udry, C., 2015. A multifaceted program causes lasting progress for the very poor: Evidence from six countries. *Science*, *348*(6236), p.1260799.

Benthall, S. and Haynes, B.D., 2019. Racial categories in machine learning. In *Proceedings of the conference on fairness, accountability, and transparency* (pp. 289-298).

Biddle, J., Hamermesh, D., 2016. Theory and Measurement: Emergence, Consolidation and Erosion of a Consensus (No. w22253). *National Bureau of Economic Research, Cambridge, MA.* https://doi.org/10.3386/w22253

Bjerkholt, O., 2014. Promoting Econometrics Through Econometrica 1933-39. SSRN Journal. https://doi.org/10.2139/ssrn.2401990

Bornmann, L. and Leydesdorff, L., 2017. Skewness of citation impact data and covariates of citation distributions: A large-scale empirical analysis based on Web of Science data. *Journal of Informetrics*, *11*(1), pp.164-175.

Card, D. and DellaVigna, S., 2013. Nine facts about top journals in economics. *Journal of Economic literature*, 51(1), pp.144-161.

Card, D. and Krueger, A.B., 1993. Minimum wages and employment: A case study of the fast food industry in New Jersey and Pennsylvania. *National Bureau of Economic Research,* Working Paper no.4509. DOI: 10.3386/w4509

Christiano, L.J., Eichenbaum, M.S., Trabandt, M., 2015. Understanding the Great Recession. *American Economic Journal: Macroeconomic*s, 7(1), pp. 110-167

Christiano, L.J., Eichenbaum, M.S., Trabandt, M., 2018. On DSGE Models. *Journal of Economic Perspectives,* 32, 113–140. https://doi.org/10.1257/jep.32.3.113

Cockburn, I.M., Henderson, R., Stern, S. 2019. The Impact of Artificial Intelligence on Innovation: An Exploratory Analysis. *University of Chicago Press*. Volume ISBN: 978-0-226-61347-5

Colander, D., Holt, R., Rosser, B., 2004. The changing face of mainstream economics. *Review of Political Economy* 16, 485–499. https://doi.org/10.1080/0953825042000256702

Currie, J., Kleven, H. and Zwiers, E., 2020, May. Technology and big data are changing economics: Mining text to track methods. In *AEA Papers and Proceedings* (Vol. 110, pp. 42-48). 2014 Broadway, Suite 305, Nashville, TN 37203: *American Economic Association.*

Dimand, R.W., 2020. The Cowles Commission and Foundation for Research in Economics, in: Palgrave Macmillan (Ed.), The New Palgrave Dictionary of Economics. Palgrave Macmillan UK, London, pp. 1–12. https://doi.org/10.1057/978-1-349-95121-5_3111-1

Einav, L., Levin, J., 2014. The Data Revolution and Economic Analysis. *Innovation Policy and the Economy* 14 (1): 1-24

Figlio, D., 1994. Trends in the Publication of Empirical Economics. *Journal of Economic Perspectives* 8, 179–187. https://doi.org/10.1257/jep.8.3.179

Fourcade, M., Ollion, E., & Algan, Y., 2015. The Superiority of Economists. *The Journal of Economic Perspectives 29*(1), 89–113. http://www.jstor.org/stable/43194697

Hamermesh, D.S., 2013. Six Decades of Top Economics Publishing: Who and How?. *Journal of Economic Literature* 51 (1): 162–72**.**

Heckman, J.J. and Moktan, S., 2020. Publishing and promotion in economics: The tyranny of the top five. *Journal of Economic Literature*, *58*(2), pp.419-470.

Heckman, J., Pinto, R. and Savelyev, P., 2013. Understanding the mechanisms through which an influential early childhood program boosted adult outcomes. *American Economic Review*, *103*(6), pp.2052-2086.

Moed, H.F., Halevi, G., 2015. Multidimensional assessment of scholarly research impact. *Journal of the Association for Information Science and Technology* 66 (10), 1988-2002.

Morgan, M.S. and Rutherford, M., 1998. American economics: the character of the transformation. *History of Political Economy*, *30*(Supplement), pp.1-26.

Oliveira, T.D., Dávila-Fernández, M.J., 2020. From modelmania to datanomics? The rise of mathematical and quantitative methods in three top economics journals. *Scientometrics* 123, 51–70. https://doi.org/10.1007/s11192-020-03375-y

Rodrik, D., 2015. Economics rules: Why economics works, when it fails, and how to tell the difference. *OUP Oxford.*

Rodrik, D., 2017. Economics rules: why economics works, when it fails, and how to tell the difference. Oxford University Press, Oxford New York, NY.

Stigler, G.J., Stigler, S.M., Friedland, C., 1995. The Journals of Economics. *Journal of Political Economy* 103, 331–359. https://doi.org/10.1086/261986

Torgler, B., Piatti, M., 2013. A Century of American Economic Review. Palgrave Macmillan UK, London. https://doi.org/10.1057/9781137333056

Varian, H.R., 2014. Big data: New tricks for econometrics. *Journal of Economic Perspectives*, *28*(2), pp.3-28.

Wooldridge, J.M., 2016. Introductory econometrics a modern approach. South-Western Cengage Learning.