Advanced Studies in Theoretical and Applied Econometrics 57

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Seven Decades of Econometrics and Beyond

A Tribute to the Life and Work of Marc Nerlove

Springer

Chapter 1
Analysis of Business Surveys: The Mannheim Years

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Klaus F. Zimmermann (2025). Analysis of Business Surveys: The Mannheim Years, in: Badi H. Baltagi and László Mátyás (eds.), Seven Decades of Econometrics and Beyond. A tribute to the life and work of Marc Nerlove. Springer Nature. pp. 1-33

Abstract In 1979, Marc Nerlove and my doctoral advisor, Heinz König, launched a groundbreaking joint project on 'Business Survey Data Analysis', which continued for about 16 years. This project began during a period of transition in the economics profession, marked by a shift from macro theory to applied microeconomics, and from macro-econometrics to the study of qualitative micro data. Under the leadership of Nerlove and König, an international team pioneered the use of firm-level data for microeconometric analyses. This paper documents the team's work, the challenges they faced, their ambitions, and their academic achievements. It also highlights Nerlove's leadership, working style, and personality, as reflected in the project and beyond. As a member of the Mannheim research team, I also had the opportunity to become Nerlove's academic guest at the University of Pennsylvania in 1987.

1.1 Introduction

In the late 1970s, economics as a scientific discipline was still dominated by theoretical approaches, with macroeconomics shaping much of econometric research. Large-scale econometric models sought to model entire national economies, driven by the expectation that they could serve as tools for economic control. In Europe, academic research remained underdeveloped compared to the United States. Only a few European institutions, such as the London School of Economics (LSE) and CORE in Louvain-la-Neuve, had achieved significant international visibility. At that time, the University of Mannheim was emerging as a leading center for economic research in Germany. Among the country's foremost macroeconomists and macro-econometricians was Heinz König of the University of Mannheim, who, alongside Wilhelm Krelle at the University of Bonn, played a central role in shaping Germany's

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B. H. Baltagi and L. Mátyás (eds.), *Seven Decades of Econometrics and Beyond*, Advanced Studies in Theoretical and Applied Econometrics 57,
https://doi.org/10.1007/978-3-031-92699-0_1

econometric landscape. König's influence extended beyond research, as he also served as the Rector of the University of Mannheim from 1979 to 1982.

Marc Nerlove shared König's interest in time-series econometrics, particularly in spectral analysis. Despite their primary focus on macroeconomic research, they secured funding from NATO to establish a transatlantic collaboration aimed at creating and analyzing a new dataset based on firm-level surveys. Their efforts were rooted in the rich survey tradition of the Ifo Institute in Munich, which had conducted extensive monthly business surveys since the 1950s. However, the Ifo Institute only used this data in aggregated form for macroeconomic monitoring rather than for micro-level analysis. König's established connections with the Ifo Institute were instrumental in accessing this resource. He maintained regular exchanges with its leadership, particularly at the legendary annual Ottobeurer Seminar, where Germany's leading economists convened to discuss pressing economic issues.

The challenge was that the Ifo business survey data existed only in paper form, making individual firm-level records inaccessible for systematic analysis. Moreover, the data was qualitative and discrete rather than continuous, which posed methodological obstacles. At the time, economists largely dismissed qualitative data, favoring direct observations of economic behavior over subjective assessments. Additionally, statistical methods for analyzing qualitative data were underdeveloped. A breakthrough came through Marc Nerlove's methodological contributions to contingency table analysis, which he had already advanced in 1973 but had yet to apply extensively. The project also benefited from its connection to CIRET, an international research network focused on business cycle survey data, in which the Ifo Institute played a key role. This network facilitated the dissemination of new methods and research approaches, creating an environment for advancing micro-econometric applications.

Through this collaboration, Marc Nerlove, an academic entrepreneur with a global perspective, introduced Heinz König, a leading macroeconomist, to micro-econometric research. Over the years, Nerlove spent frequent research periods in Mannheim, contributing to the methodological and empirical development of firm-level data analysis. Despite the significant contributions of König and Nerlove, little research has focused on the methodological innovations and challenges of their collaboration, particularly in leveraging firm-level data for econometric analysis.

This chapter examines the transformative impact of Heinz König and Marc Nerlove's collaboration on the development of micro-econometric methods, focusing on their innovative use of firm-level data. It will outline the methodological innovations introduced, assess the impact of these innovations on econometric research, and explore the challenges and successes of their collaboration. The following sections detail the evolution of their research endeavor. Section 1.2 introduces Marc Nerlove and outlines my own involvement in the project. Section 1.3 provides an overview of the Ifo data and describes the working process of the Mannheim research team. Section 1.4 presents the methodological foundations and key research findings. Section 1.5 discusses subsequent research developments within the broader network. Finally, Section 1.6 summarizes and evaluates the overall contributions of this long-term collaboration.

1.2 Marc Nerlove – Visionary, Leader, Globalist, Generalist

1.2.1 Marc Nerlove

Marc Nerlove was a towering figure in economics and econometrics, whose methodological innovations and empirical investigations left a lasting imprint on the discipline. After earning his Ph.D. from Johns Hopkins University in 1956, he embarked on an academic career that spanned more than six decades, influencing generations of scholars across multiple domains.

Nerlove was a pioneer in microeconometrics, particularly in the estimation of dynamic models using panel data. His groundbreaking research on adaptive expectations and supply responses in agriculture remains a cornerstone of empirical work on producer behavior. His 1958 book, *The Dynamics of Supply: Estimation of Farmers' Response to Price*, was a pioneering effort to apply econometric techniques to agricultural data, setting a precedent for the integration of economic theory with empirical analysis (Nerlove, 1958b). His work laid the foundation for modern empirical studies on agricultural supply and demand, influencing policies on agricultural markets and price stabilization.

His contributions to time-series econometrics and macroeconomics are also significant. His 1964 Econometrica paper *Spectral Analysis of Seasonal Adjustment Procedures* introduced spectral methods to study economic fluctuations, demonstrating their application in evaluating seasonal adjustment techniques (Nerlove, 1964). His later work, particularly his book *Analysis of Economic Time Series: A Synthesis*, provided an extensive and rigorous framework for time-series modeling (Nerlove, Grether & Carvalho, 1979). This work synthesized approaches to time-series econometrics, bridging traditional econometric methods with modern spectral and state-space models. His research advanced the understanding of economic cycles, particularly how firms and individuals form expectations over time, and influenced the broader study of macroeconomic fluctuations.

Nerlove was also engaged in macroeconomic research. His 1962 American Economic Review paper, *A Quarterly Econometric Model for the U.K.: A Review Article*, was an important contribution to the growing field of macroeconometric modeling (Nerlove, 1962). His 1966 International Economic Review paper, *A Tabular Survey of Macro-Econometric Models*, provided one of the first comprehensive reviews of macroeconometric models, helping to systematize research in this field (Nerlove, 1966).

Beyond macroeconomics, Nerlove was a significant contributor to population economics. Together with Assaf Razin and Efraim Sadka, he explored the interplay between household decisions, demographic trends, and economic welfare using economic micro theory. Their joint book, *Household and Economy: Welfare Economics of Endogenous Fertility*, offered a formalized economic analysis of fertility decisions, treating fertility as an endogenous choice influenced by economic conditions, based on many top publications (Nerlove, Razin & Sadka, 1987). This study provides a theoretical foundation for understanding how economic incentives shape demographic

transitions, contributing to debates on population growth, pension systems, and intergenerational transfers. His work challenged traditional Malthusian perspectives by demonstrating that population growth could be optimally managed through economic incentives rather than coercive policies.

A further distinctive aspect of Nerlove's research is his pioneering use of the log-linear probability model for the analysis of categorical economic data. His collaboration with S. James Press on *Univariate and Multivariate Log-Linear and Logistic Models* (Nerlove & Press, 1973 and Nerlove & Press, 1976) laid a foundational framework for applying these models in economics. This work provided the methodology for analyzing contingency tables and categorical survey data, and provided a crucial tool in the study of business test data as will be the focus in this chapter (König, Nerlove & Oudiz, 1981, and Nerlove, 1983). The importance of this line of research was underscored when Nerlove chose to focus on expectations, plans, and realizations of business firms for his Presidential Address to the Econometric Society, published as *Expectations, Plans and Realizations in Theory and Practice* (Nerlove, 1983).

Throughout his career, Nerlove was a visionary, leader, globalist and generalist. He was visionary in the sense that his methodological advances anticipated and shaped the trajectory of modern econometrics. His emphasis on dynamic models, expectation formation, and panel data econometrics prefigured many contemporary approaches in applied economics. As a leader, he trained and mentored numerous students, many of whom became leading economists and econometricians in their own right. His work earned him numerous accolades, including the election as a Fellow of the Econometric Society, later on even the president, and the prestigious John Bates Clark Medal, awarded to the most promising American economist under 40.

Nerlove was globalist in both his research and academic engagement. His work spanned multiple countries and economic contexts, from U.S. agricultural markets to European business surveys to developing economies in Latin America and Asia. He collaborated extensively with international researchers, reflecting on his belief that economic knowledge should transcend national boundaries. His visiting appointments at leading institutions across Europe, Latin America, and Asia underscored his role as a bridge between different traditions and cultures of economic thought.

Finally, Nerlove was a generalist in the best sense. While many scientists specialize narrowly in methodology, theory, or applied work, he has moved seamlessly between theoretical economics and econometrics, empirical analysis, and economic policy. His research encompassed agriculture, macroeconomics, population, expectation formation, time-series analysis, and microeconometrics, reflecting a rare breadth of expertise.

Even in his later years, Nerlove remained intellectually engaged and continued to contribute to econometric methodology and applied economic research. His legacy endures not only in the methodologies he developed, but also in the scholars he trained and the empirical insights he provided. He passed away in 2023 at the age of 90, leaving behind a vast intellectual legacy that continues to shape his fields of analysis.

1.2.2 Background Reflections

The long-time research partner of Marc Nerlove in Germany was Heinz König (1927–2002), a leading figure in post-war German economics, a pioneer of empirical economic research, and econometrics. König began as a macroeconomist and, competing with Wilhelm Krelle from Bonn University, developed the first large-scale macroeconometric models in Germany. In 1958–1959, he was a Rockefeller Fellow at the Massachusetts Institute of Technology (MIT), Harvard University, and Stanford University. He became a Full Professor at the University of Mannheim in 1962, where he remained despite receiving numerous prestigious offers from other universities. He served as Rector of the University of Mannheim from 1979 to 1982, chaired the Verein für Socialpolitik (the German Economic Association) from 1987 to 1988, and was the founding director of the Centre for European Economic Research (ZEW) from 1991 to 1997. indexCentre for European Economic Research (ZEW)

Nerlove and König were both distinguished figures in their respective fields, each commanding a strong national reputation and possessing distinct yet equally formidable personalities. While König, whose name fittingly means 'king' in German, wielded his authority in the hierarchical chair-system of German universities at the time with an almost autocratic style, Nerlove's influence was more understated and diplomatic. Nevertheless, he too mentored a devoted group of PhD students and maintained an extensive global network of established research collaborators.

Both were natural leaders, earning huge respect through their intellectual rigor and visionary contributions. Their research interests overlapped in macroeconomic modeling and time-series econometrics. However, Nerlove's expertise extended into agricultural and population economics, while König also made significant contributions to labor economics. During what I refer to as *The Mannheim Years* (detailed more below), they collaborated on a project initially funded by NATO (research grant no. 1180, 1976–1979) and later by the National Science Foundation (USA, Grant SOC 74-21194), and Deutsche Forschungsgemeinschaft (Grant 219/10) focused on the creation and analysis of categorical business survey data to examine firm-level behavior. Through this collaboration, both evolved into microeconometricians.

Given their shared background, it is unsurprising that the central theme of their joint research was the formation of business expectations. Nerlove had been engaged with adaptive and other expectation-formation models since his doctoral work in agricultural economics in the late 1950s, later expanding this focus within time-series econometrics. König, in turn, explored adaptive and rational expectations in the context of the Phillips curve, a topic that was the subject of intense international debate at the time.

I studied economics and statistics at the University of Mannheim, earning my master's degree (*Diplom-Volkswirt*) in the fall of 1978. My diploma thesis examined the macroeconomic debate on the effectiveness of monetary and fiscal policies in the presence of rational expectations, including an empirical analysis of the Phillips curve in Germany. König awarded my diploma thesis the highest distinction and offered me a full-time position as a research assistant at his chair. This role encompassed not only teaching and grading assistance but also, early on, involvement in the business survey

project led by Nerlove and König. Alongside Gebhard Flaig, who had graduated from Mannheim two years earlier, I quickly became a key figure in König's chair system, helping to manage and direct a substantial portion of the research and teaching activities. Writing a dissertation was an after-hours task by university regulation anyway, and I found all these challenges inspiring and rewarding. These experiences later allowed me to conduct my own research with efficiency and the highest academic rigor. The chair system also had the advantage of providing a constant presence of colleagues who were available for guidance when needed. This system provided also more time and support at a later stage to prepare for the academic market.

I served as a research associate until 1984 and earned my doctoral degree in 1985, subsequently becoming a *Hochschulassistent* (Assistant Professor) at the University of Mannheim. In 1986, I was a Research Fellow at CORE, Université Catholique de Louvain in Louvain-la-Neuve, followed by a position as a Senior Research Fellow at the Wissenschaftszentrum Berlin (Social Science Research Center, WZB). I then held a Visiting Associate Professorship at the University of Pennsylvania in Philadelphia. Upon returning to Mannheim in 1988, I was awarded a Heisenberg Fellowship from the Deutsche Forschungsgemeinschaft (German Research Foundation, DFG), before moving to the University of Munich as a Full Professor of Economic Theory and director of the newly established Seminar for Labor and Population Economics. At Munich, I was also responsible for liaising with the Ifo Institute and served as a member of its supervisory board. In 1998, I declined an initiative of the Bavarian government to become President of the Ifo Institute, opting instead to move to the University of Bonn to establish the Institute for the Study of Labor (IZA).

This early success story owes much to Marc Nerlove and the dynamic research environment fostered by the Faculty of Economics at the University of Mannheim, particularly under Heinz König's leadership. For me, the project on the analysis of business survey data played a crucial role in this intellectual climate. Based on early publication successes related to the project (see section 1.5.1 for more details), Jacques Drèze invited me to join CORE, and Edmond Malinvaud to speak in his research seminar in Paris.

Many faculty members and their doctoral students later pursued highly successful careers in academia and beyond. Among them were Hans-Werner Sinn, who later became a professor at the University of Munich and President of the Ifo Institute, and Wolfgang Franz, who went on to serve as President of the ZEW following Heinz König. Gebhard Flaig was also appointed to a faculty position in Munich, and he eventually moved to the Ifo Institute to take over the business survey department and joined Ifo's executive board. Unlike Franz and Flaig, Sinn was not a student of König, although this is sometimes claimed in the social media.

Christoph Schmidt who was a master student and student helper at the König chair, completed his Ph.D. at Princeton University after moving the US on our advice, and got his habilitation with me at the University of Munich. Like Franz he later became a member and then the chair of the German Council of Economic Experts.

Other colleagues in Mannheim included my wife, Astrid Zimmermann-Trapp. A rising star in the faculty was Horst Siebert, an environmental economist, who led a large research center of the faculty before he moved to the University of Konstanz.

Siebert later became President of the Kiel Institute for the World Economy, a position that led to our renewed professional interactions when I served as President of the German Institute for Economic Research (DIW Berlin).

Marc Nerlove was relaxed, inquisitive, and highly sociable. He was genuinely interested in people and engaged with their work. It became my routine task to pick him up from the airport during his annual research visits and take him to his hotel, which was usually the *Goldene Gans* near Mannheim's central station. This location was also a frequent gathering place for König's team, where we would often meet in the restaurant after seminars over a glass of wine. Nerlove was a welcome participant in these informal discussions. Small gestures of his remain in my memory: although he somehow knew of my wife, they had not yet met. One day, when they encountered each other in the elevator of the university building, he walked up to her and introduced himself with the words, *You must be Astrid*.

Nerlove shared my interest in population economics, which I intended to make the focus of my doctoral research. Initially, Heinz König was not particularly enthusiastic about my idea of bringing Gary Becker's family economics to Germany. However, he soon changed his mind, particularly with Nerlove's support. This openness to new ideas was a defining trait of my doctoral advisor. König's understandable concern that I might be overburdened thematically dealing with household and firm decisions at the same time ultimately proved unwarranted, as I was able to apply the econometric techniques I had learned through the business survey project to my research in population economics (Zimmermann, 1985a).

What impressed me about Marc Nerlove was not only his diverse academic interests but also his exceptional ability to build and sustain research networks. For instance, he often combined his visits to Mannheim with research meetings on population economics with Assaf Razin and Efraim Sadka, who traveled from Israel. This early exposure allowed me to establish professional connections with both, and later I maintained frequent contact with Sadka. Nerlove also supported me in founding the *European Society for Population Economics (ESPE)* and delivered an invited lecture at its inaugural conference in Rotterdam. This lecture was later published in the *Journal of Population Economics* (Nerlove, 1988), which I had founded and which quickly became the leading journal in the field. Nerlove, Razin, and Sadka also contributed to an edited volume I published, *Economic Theory of Optimal Population* (Nerlove, Razin & Sadka, 1989).

A defining experience for me was the opportunity, initiated by Nerlove, to serve as a *Visiting Associate Professor* at the University of Pennsylvania in the calendar year 1987. This appointment allowed me to teach introductory courses in microeconomics and macroeconomics, as well as a lecture course on population economics. It also provided a strong foundation for successfully launching the *Journal of Population Economics* and for collaborating on research papers with his doctoral students, including David Ross and Lorenzo Pupillo. His research infrastructure supported me in numerous ways, and I fondly remember both professional discussions and private gatherings with him and my family. Even later, he remained genuinely interested in my daughter's development.

During my time in Philadelphia, I also met (among many other long-lasting connections) Lars-Hendrik Röller, who was completing his doctorate there, and Manfred Deistler, a leading scholar in time-series econometrics, who was on a research visit. Over the years, I maintained regular contact with both. With Röller, in his capacity as Chief Economic Advisor to Chancellor Angela Merkel, we engaged in discussions on labor market reforms and migration policies. With Deistler, we have frequently debated strategic questions of science policy and ways to strengthen research in our respective countries, drawing on insights from our experiences in the United States.

1.3 Business Test Data and the Mannheim Years

1.3.1 The Ifo Business Test

The Ifo Institute in Munich, Germany, a prominent publicly funded economic research institution in the country, has consistently conducted business surveys since 1949, establishing a foundation for systematic data-based economic analysis in Germany. Analogous questionnaires were subsequently developed for Italy (1949), France and Japan (1951), Austria (1953), Belgium, the Netherlands, Sweden, and South Africa (1954), Switzerland (1955), Denmark (1956), Finland (1957), and the United Kingdom (1958), and by 1995 were already available for 56 countries (Zimmermann, 1997).

The Ifo data collected in Germany initially encompassed manufacturing companies from 1949 onward. In 1950, the monthly survey was extended to include the retail trade sector, and in 1951, it incorporated the wholesale trade sector. The construction industry was integrated in 1956, while the service sector was not included until 2001.

The Ifo Business Climate Index for Germany, established through surveys conducted in the 1950s, gained recognition since the 1970s as one of the most significant indicators of economic activity in the country. This index is derived from approximately 7,000 monthly responses from businesses (Becker & Wohlrabe, 2008), and these responses were only recently stored as microdata within the Ifo Business Survey files. Although time series data for various industries and sectors have long been accessible through the Ifo macro database, access to the underlying microdata was historically first impossible and later limited for research purposes only.

Several scholars have provided a comprehensive review of the history of Ifo Business data (formerly referred to as Ifo Business Test or Ifo Konjunkturtest), including Oppenländer and Poser (1989); Zimmermann (1997); Becker and Wohlrabe (2008), and most recently Sauer, Schasching and Wohlrabe (2023).

Since 2004, the Ifo Institute had systematically converted its microdata inventory into Stata format, facilitating access to these data through the Ifo Data-Pool. This development enabled external researchers to conduct scientific analyses at the Ifo Institute utilizing anonymized microdata from four standard Ifo surveys: the Ifo Business Survey, the Ifo Investment Survey, the Ifo Innovation Survey, and the Ifo

World Economic Survey. To maintain confidentiality for participating companies, the dataset is anonymized and was accessible only under stringent criteria at a designated Ifo-based single-user computer.

Economic tendency surveys constitute systematic instruments designed to capture qualitative information regarding the current economic situation and future expectations from businesses and consumers. In contrast to traditional quantitative economic indicators that rely on empirical data such as output, employment, or sales figures, these surveys collect subjective assessments and anticipations, thereby providing timely insights into economic trends. The European Union's Joint Harmonised EU Programme of Business and Consumer Surveys exemplifies this methodological approach, conducting monthly surveys across various sectors—including manufacturing, construction, retail trade, services, financial services, and among consumers—to generate harmonized economic indicators.

The standard questions posed monthly in the Ifo Business Survey pertain to both the current and anticipated economic circumstances of firms, differentiated across several segments. The participating firms provide at the establishment rather than the firm level categorical variables that can be classified into three groups: (i) *ex ante* variables measuring plans or expectations; (ii) *ex post* variables reporting realizations; and (iii) variables reflecting *evaluations* of factors like order backlogs or inventories. Reported categories are typically trichotomous, responses are increase (+), no change (=), or decrease (-); or greater than normal (+), normal (=), or less than normal (-); or too large (+), about right (=), or too small (-). The +, =, - categories can also be coded as 1, 2, 3.

The aggregated indicators derived from such data are instrumental in short-term forecasting and identifying turning points in business cycles, thereby complementing official statistical data that often become available only after significant delays and are subject to subsequent revisions. Due to the categorical nature of micro-level data, the application of regression analysis at the firm level has long been unclear.

The initial documented scientific utilization of Ifo data was carried out by Anderson (1952). He employed time-series data (January 1950 – February 1952) to investigate the correlation between Ifo Business Survey data and official statistics. Through correlation analysis, he demonstrated that partial aggregates of the Business Survey, such as those pertaining to nutrition, closely approximated official statistics. Anderson proposed and illustrated the utility of balances calculated as the difference between the percentage of positive responses minus the percentage of negative responses at a specific point in time. He successfully utilized such data to forecast macroeconomic time-series.

Theil (1955) subsequently expanded this approach, focusing particularly on the use of balances as an aggregation method and pioneering the application of microdata analysis for manufacturing, specifically in the leather and shoe industry. Thonstad and Jochems (1961) further advanced the field by modeling production plans based on company expectations and assessments of the business climate, continuing the research initiated by Theil and applying similar methodologies to data from the leather and shoe industry (1956–1958).

The Centre for International Research on Economic Tendency Surveys (CIRET) emerged as the academic entity within the business survey movement, facilitating conferences and exchanges to promote the collection of such data globally. CIRET's origins can be traced to 1952, when an informal group of economists from institutions such as the Ifo Institute (Germany), the Institut National de la Statistique et des Études Économiques (INSEE, France), and the Association of Italian Chambers of Commerce collaborated under the designation *Comité International pour l'Étude des Méthodes Conjuncturelles* (CIMCO). This informal cooperation was formalized in 1960 with the establishment of the 'Contact International des Recherches Economiques Tendancielles' (CIRET). Initially affiliated with a research group directed by Theil at the Econometrisch Instituut in Rotterdam and later led by Anderson since 1966 at the University of Mannheim, CIRET also maintained a documentation center at the Ifo Institute (see also Knoche, 2025).

In 1971, CIRET and its documentation center merged and were fully integrated into the Ifo Institute, adopting the designation 'Centre for Economic Tendency Surveys'. By 1999, CIRET established a new legal foundation under Belgian law and relocated its headquarters to the KOF Swiss Economic Institute at ETH Zurich, adopting its current designation to reflect its international scope. A study by Abberger et al. (2022) developing a composite monthly indicator for the world business cycle (the Global Economic Barometers) utilizes business survey data from over 50 countries worldwide (Abberger, Graff, Müller & Sturm, 2022).

1.3.2 Marc Nerlove and the Mannheim Team

The *Mannheim Years* refer to the period during which our team at the University of Mannheim was actively engaged in a research project on expectations, plans, and realizations in economic decision-making of business firms. This project was initially funded by NATO from 1976 to 1979. The first publication by a team member appeared in 1979, authored by Heinz König, while the final publication co-authored by Marc Nerlove was in 1995. This marks a span of 16 years, which can be considered the primary project period. However, an alternative perspective extends this timeline from the start of funding in 1976 to the publication of my handbook article in 1997, making it a 21-year period.

The core members of the Mannheim support team included Gebhardt Flaig, Seiichi Kawasaki, and Klaus F. Zimmermann. Flaig was involved from 1976 to 1983, while Kawasaki joined in 1980 after completing his dissertation at Northwestern University under Marc Nerlove in 1979. Kawasaki remained in Mannheim until 1985, constrained by the maximum duration of temporary university contracts. I was at the chair from 1978 to 1985, took leave from 1986 to 1987, returned to Mannheim in 1988 to direct an independent research team, and moved to the University of Munich in 1989.

During the key Mannheim years, the presence of Flaig and Zimmermann defined the team's core period from 1978 to 1983 (five years). If the period is broadened to

include years when at least one of them was present, it extends from 1976 to 1985, covering nine years.

Within the team, roles varied. Kawasaki, already holding a Ph.D., focused on complex theoretical and technical challenges, often involving programming or statistical problems. His perseverance was remarkable, and he frequently returned with solutions to problems that others could not resolve. He also contributed a core Fortran program, already developed at Northwestern, which was integral for analyzing data and running regressions for the project. He named this program *Tornado*, signifying speed, though the team humorously dubbed it *Snail*.

At that time, computational work relied on the University of Mannheim's mainframe system. Programs were input via punch cards, which had to be manually loaded in the cellar of our building, since the computing center was far away. The process was cumbersome and prone to errors—cards could be misplaced or damaged, leading to significant setbacks. Each researcher handled their own jobs, as dropping the card decks could be disastrous. Computation times were long, sometimes taking a full week, rapidly exhausting our annual computing quotas. Fortunately, Heinz König, who also served as university rector, ensured that we received additional capacity when needed.

Operational tasks fell primarily to Gebhard Flaig and me. Flaig was a highly skilled econometrician with deep statistical expertise and programming experience. When Marc Nerlove visited, research discussions often led to new ideas requiring additional programming. Occasionally, this meant working overnight to ensure results were ready before Nerlove's departure at the end of the week.

Both König and Nerlove were demanding scholars, always pushing for the best possible results while recognizing the challenges involved. Working with them was intellectually stimulating and rewarding.

Despite intense work periods, there was also space for independent research. The University of Mannheim maintained an exchange program with the University of Western Ontario, allowing us to collaborate with visiting scholars. Through this, John McMillan contributed significantly to our work on business survey data by providing the right framing of the articles (Kawasaki, McMillan & Zimmermann, 1982 and Kawasaki, McMillan & Zimmermann, 1983). Additionally, I pursued research on correlation measures for qualitative data, leading to ideas for pseudo-R^2 measures, which I later developed into publications with Mike Veall (Veall & Zimmermann, 1996). These methodological papers remain among my most highly cited works, surpassing even my publications in top-tier economics journals.

In business surveys, variables are typically categorized as increase (+), no change (=), or decrease (-). The challenge arises in calculating how these variables change over time or differ from one another. Specifically, how is a change defined? For instance, how can one effectively compare a change in price or a shift in production between consecutive periods? Additionally, how can plans or expectations be evaluated against actual outcomes, which is essential for assessing forecast errors, unmet plans, or unexpected results?

After extensive internal discussions, a straightforward solution was identified in the team by utilizing the ordered nature of the variable categories (see Nerlove, 1983,

1259-1260), which has gained broader acceptance in the literature. This is further elaborated upon in Figures 1.1 and 1.2.

Figure 1.1 presents a comparison between the expected or planned value (Y*) and the actual realization (Y). In addition to conducting a regression analysis of Y* on Y, it is pertinent to examine the difference Y-Y*, which represents the forecast error, insufficient plan fulfillment, or unexpected outcomes. The difference Y-Y* can be interpreted as no change (=) when situated on the main diagonal of the figure. It is considered a decrease (-) in the upper right section of the figure and an increase (+) in the lower left section. A Y-Y* value denoted as '+' signifies a positive surprise, an underestimation, or a development exceeding the plan, whereas a Y-Y* value denoted as '–' indicates a negative surprise, an overestimation, or a development falling short of the plan.

		Y_t		
		+	=	−
Y^*_{t-1}	+	=	−	−
	=	+	=	−
	−	+	+	=

Fig. 1.1: Realizations Y_t given expectations or plans Y^*_{t-1} and definition of forecast error, insufficient plan fulfillment or surprise

Simple differences between variables can be categorized in a manner similar to the method suggested in Figure 1.1, as illustrated in Figure 1.2. Beyond regressing a variable on its previous value, it may be interesting to examine changes in the direction of change. In Figure 1.2, no change (=) represents situations along the main diagonal. An increased (+) value indicates an upward trend over time, whereas a decreased (-) value indicates a downward trend.

Although it was possible to define the (3,1) cell of the figures as $+,+$ and the (1,3) cell as $-,-$, this approach was not adopted due to considerations of simplicity and computational efficiency. The construction of such five-category variables was avoided, particularly considering the substantial computation times required on the mainframe computer, as reported above. The introduction of additional categories would have increased computing time and significantly raised the likelihood of encountering empty cells, thereby rendering the applied models inapplicable.

Y_{t-1} \ Y_t	+	=	−
+	=	−	−
=	+	=	−
−	+	+	=

Fig. 1.2: Realizations Y_t given past values Y_{t-1} and definition of categorical change

1.4 Business Survey Data Analysis

1.4.1 The Log-linear Probability Model

In the contemporary statistical literature, the log-linear probability (LLP) model is highly valued for its capacity to examine categorical data within an explorative research framework. This approach allows researchers to explore and comprehend complex relationships within contingency tables, thereby shedding light on the interplay between multiple categorical variables. The LLP model is particularly adept at detecting and measuring dependencies, offering a thorough understanding of how various categories affect each other. Researchers from diverse fields such as economics, sociology, demography, psychology, epidemiology, and marketing have shown considerable interest in this method. Typically, LLP models are employed to investigate associations among categorical variables. LLP models can also be expressed as multinomial logit models. This section explains the core econometric methodology of the Mannheim business survey data analysis project.

Drawing on Nerlove and Press (1973) and Nerlove and Press (1976), LLP models emerged as a prominent technique for analyzing business survey data in the 1970s and 1980s. As of March 9, 2025, the former report had garnered 668 Google Scholar citations, while the latter had received 73, demonstrating significant interest from the academic community.

In business surveys, the majority of variables are categorical, and the data can be analyzed using contingency tables. Consequently, it is useful to examine the nature of associations between these variables, or to what extent these associations deviate from a model of statistical independence. Typically, this method assumes a nominal scale for the variables, thereby disregarding the ordinal nature of some data. In

addition to the work of Nerlove and Press, key references for the subsequent analysis include Bishop, Fienberg and Holland (1988), Kawasaki and Zimmermann (1981), and Zimmermann (1997).

Assume two categorical variables A and B with categories $i = 1,2,\ldots,I$; $j = 1,2,\ldots,J$. Let $\{\pi_{ij}\}$ be the contingency table of the probabilities involving these variables, where π_{ij} are the probabilities. The statistical model of independence implies

$$\pi_{ij} = \pi_{i+}\pi_{+j},$$

where π_{i+} and π_{+j} are the row and column marginals. The Pearson χ^2 statistic can examine this specification.

To allow for non-independence, the model can be generalized by

$$\pi_{ij} = \bar{\mu}\pi(i)\pi(j)\pi(i,j)$$

with

$$\sum_i \pi(i) = \sum_j \pi(j) = \sum_{i,j} \pi(i,j) = \sum_{i,j} \pi_{ij} = 1,$$

where $\pi(i)$, $\pi(j)$ and $\pi(i,j)$ are component probabilities and $\bar{\mu}$ is a normalization constant. Model (1.2) nests model (1.1) if the departure from independence has equal probability, $\pi(i,j) = 1/IJ$ for all i,j, and one obtains $\bar{\mu} = IJ$, $\pi(i) = \pi_{i+}$, and $\pi(j) = \pi_{+j}$. A logarithmic transformation of (1.2) leads to the log-linear probability model

$$\log \pi_{ij} = \mu + u_i + u_j + u_{ij} \tag{1.1}$$

with restrictions

$$\sum_i u_i = \sum_j u_j = \sum_i u_{ij} = \sum_j u_{ij} = 0. \tag{1.2}$$

Equations (1.2) are the so-called analysis of variance (ANOVA) restrictions. μ $(= \log \bar{\mu})$ is a constant, while u_i and u_j represent the main effects of variables A and B, respectively. The parameters u_{ij} denote the bivariate interaction terms, which quantify the association between categories i and j of both variables. A positive association is indicated by $u_{ij} > 0$, whereas a negative association is indicated by $u_{ij} < 0$. Through straightforward algebraic manipulation of equations (1.1) and (1.2), it can be demonstrated that u_{ij} represents the deviation of $\log \pi_{ij}$ from the arithmetic means of the respective column and row logged probabilities, in addition to the overall mean of the logged probabilities.

Consider now three categorical variables A,B,C with categories $i = 1,2,\ldots,I$; $j = 1,2,\ldots,J$; $k = 1,2,\ldots,K$ with contingency table $\{\pi_{ijk}\}$. Then the corresponding LLP model is

$$\log \pi_{ijk} = \mu + u_i + u_j + u_k + u_{ik} + u_{jk} + u_{ijk}, \tag{1.3}$$

where restrictions similar to (1.2) hold. Restrictions $u_{ijk} = 0$ for all i,j,k impose independence of association. If $u_{ijk} = 0$ and $u_{ij} = 0$ for all i,j,k, variables A and B are conditionally independent. Equation (1.3) (like equation (1.1) in the two-variable

case before) is nothing more than a re-parameterization of the underlying three-way contingency table. It is therefore also called a 'saturated' model specification.

Equation (1.3) considers *joint dependence* of variables A, B, and C. A conditional probability model $Pr(A|B,C)$, where A is endogenous and B,C are exogenous, is provided by

$$\log \pi_{ijk} = \mu_{jk} + u_i + u_{ij} + u_{ik}. \tag{1.4}$$

This presumes the independence of association, a common assumption in econometrics. The conditional probabilities of the categories of one or more dependent variables, given one or more independent variables, are determined solely by the main effects of the dependent variables, the interactions among the dependent variables, and the interactions between the dependent and independent variables, excluding the main effects of and the interactions among the independent variables.

Parameter estimates u for (1.4) are obtained by assuming product multinomial sampling and maximizing the concentrated log-likelihood function

$$L(m_{ijk}|u) = \sum_{i,j,k} m_{ijk} \log \pi_{i|jk},$$

using standard techniques. An asymptotically valid covariance matrix Ω of the estimates allows for the usual testing procedures. Estimation details are provided in Nerlove and Press (1973), Kawasaki and Zimmermann (1981) and Bishop et al. (1988).

The LLP model provides detailed category-wise associations between categorical variables; however, it lacks an overall measure that summarizes the effects, such as a correlation coefficient for continuous variables. (Of course, a straightforward likelihood-ratio test can be employed to assess the significance of the entire set of bivariate interaction parameters, as compared to a model that omits these parameters.) Conversely, numerous nominal and ordinal association measures have been employed in traditional contingency table analysis, independent of the LLP approach (for references see Bishop et al., 1988). Despite this, no dominant index for discrete data has emerged. While most variables in the business survey are ordinal, some are nominal. The Mannheim project conducted an intensive examination of this literature and attempted to integrate contingency table association measures into the LLP analysis.

Following Kawasaki and Zimmermann (1981), two association measures are examined within the framework of the LLP model. Numerous applications in the business survey literature have used this research approach (see, for instance, Nerlove, 1983 and Kawasaki et al., 1983). It is noteworthy that the LLP model does not impose any ordering. Thus, the detailed effect parameters capture associations solely on a nominal scale. By connecting these parameters with association measures, the information contained within the various parameters can be consolidated into a single index, which can then be interpreted ordinally.

The bivariate component probabilities $\pi(i,j)$ and $\pi(i,k)$ are directly related to the estimated interaction parameters for equation (1.7), e.g., for $\pi(i,j)$:

$$\pi(i,j) = \frac{\exp(u_{ij})}{\sum_{i'}\sum_{j'}\exp(u_{i'j'})}, \quad i,i' = 1,2,\ldots,I; j,j' = 1,2,\ldots,J.$$

The core idea is now to apply association measures to those tables: Following Kawasaki and Zimmermann (1981), the two measures suggested here are γ and Φ^2. The first is an ordinal measure, while the second is a nominal measure of association. γ was initially introduced by Goodman and Kruskal (1979) for standard contingency table analysis and is highly regarded in that literature.

The first measure is defined as

$$\gamma = \frac{PS - PD}{PS + PD},$$

where

$$PS = 2\sum_i\sum_j \pi(i,j)\left[\sum_{i'>i}\sum_{j'>j}\pi(i',j')\right]$$

$$PD = 2\sum_i\sum_j \pi(i,j)\left[\sum_{i'>i}\sum_{j'<j}\pi(i',j')\right].$$

PS (PD) is the probability of a positive (negative) association between both variables based on the orders of the categories for both variables. Hence, γ is positive (negative) if it is more probable to obtain a positive (negative) than a negative (positive) association if one selects individual observations.

Φ^2 quantifies the difference between a set of probabilities $\pi(i,j)$ and the expected values derived from a specific probability model. When the equal probability model ($\pi(i,j) = 1/IJ$) is used as the reference, the result obtained is:

$$\Phi^2 = \sum_i\sum_j \frac{[\pi(i,j) - \hat{\pi}(i,j)]^2}{\hat{\pi}(i,j)} = \frac{1}{IJ}\sum_i\sum_j [IJ\pi(i,j) - 1]^2.$$

Φ^2 measures how different the association for a given model specification is from a reference model of zero bivariate interaction parameters.

Let $\mathbf{u}_{AB}$ represent the vector of the bivariate interaction parameters u_{ij} between variables A and B, and Ω_{uu} denote the corresponding covariance matrix. The asymptotic distributions of the estimated association measures can then be derived using the delta method. For instance, one obtains for γ the variance formula $\gamma_u'\Omega_{uu}\gamma_u$, where γ_u is the gradient of $\gamma(\mathbf{u}_{AB})$. Kawasaki and Zimmermann (1981) provide detailed formulas.

It is important to note that the LLP model primarily identifies correlations or associations rather than establishing causality. While it provides valuable insights into the relationships between variables, it does not inherently determine causal links. Therefore, researchers must employ additional methods and frameworks, such as experimental designs or causal inference techniques, to establish causality with greater confidence. LLP models nevertheless remain an important instrument for explorative data analysis.

1.4.2 Formation of Price Expectations, Output Plans, and Subsequent Realizations

The Mannheim business survey data project has resulted in a substantial number of published research papers, which are too numerous to comprehensively review and evaluate within this chapter, although some work will be discussed later on. Consequently, this section concentrates on the two flagship publications of the project, examining their efforts to reveal the microdata-based evidence concerning the formation of price expectations, output plans, and their subsequent realizations by business firms. The two key studies are: Marc Nerlove's 1983 paper, *Expectations, Plans, and Realizations in Theory and Practice*, published in *Econometrica*, and the 1981 study co-authored by Heinz König, Marc Nerlove, and Gilles Oudiz, *On the Formation of Price Expectations. An Analysis of Business Test Data by Log-Linear Probability Models*, published in the *European Economic Review* (König, Nerlove & Oudiz, 1981 and Nerlove, 1983).

The paper by König et al. (1981) was presented at the prestigious *International Seminar on Macroeconomics* (ISoM), held on June 23-24, 1980, in Oxford, UK. The inclusion of a business survey paper in a macroeconomic conference underscored the growing significance of microdata analyses in addressing macroeconomic questions.

The ISoM was initiated in 1978 as a joint venture between the *National Bureau of Economic Research* (NBER) and the French *École des Hautes Études en Sciences Sociales* (EHESS). At its inception, it was co-directed by Georges de Ménil, Robert J. Gordon, and Jean Waelbroeck, who were instrumental in guiding its academic focus. The seminar evolved into a crucial forum for the exchange of innovative macroeconomic research, promoting collaboration among economists from Europe and the United States. With the exception of its first year, the seminar's proceedings were consistently published in the *European Economic Review*, facilitating broad distribution of the research presented. Although EHESS was instrumental in ISoM's establishment, the leadership has since 1993 become more globally inclusive, with leading economists from various institutions assuming control. The latest ISoM event was held on June 4–5, 2024, and was hosted by the *Bank for International Settlements* in Basel, Switzerland.

Marc Nerlove delivered Nerlove (1983) as the Presidential Address at the 1981 *European Meeting of the Econometric Society*, which took place in Amsterdam from August 31 to September 4, 1981. The fact that Marc selected this subject for his address as the President of the *Econometric Society* indicates that, among the diverse research areas he engaged in, he considered the outcomes of the Mannheim Business Survey project to be of significant importance. The paper not only reviews previous studies of the project but also considerably expands on the research questions and findings. In the following, I will first summarize and examine the key findings of Nerlove (1983), and then highlight the differences and additions with respect to König et al. (1981).

Marc Nerlove's Presidential Address to the Econometric Society

In his 1983 research, Marc Nerlove explores the complex link between the expectations or plans of firms regarding prices and output and the actual outcomes they experience. Utilizing comprehensive business survey data from manufacturing companies in France (INSEE) and Germany (Ifo data), the study examines how accurately firms predict outcomes, the consistent biases in their forecasts, and the processes that shape expectation formation. A major conclusion of the study is that firms often underestimate the probability of change, with their expectations frequently centering around the 'no change' category, while actual results show more variability. Additionally, the research highlights notable differences between countries, with German firms demonstrating more stability in their expectation-formation processes compared to French firms.

Expectations and plans are crucial in the economic decision-making processes of firms, yet modeling these empirically had been challenging at the time of the research work. The paper examines several straightforward models of expectation formation, such as extrapolative expectations, adaptive expectations, and error-learning mechanisms, to assess their ability to explain firm behavior. The findings indicate that firms mainly apply error-learning models, where expectations or plans are adjusted based on previous forecasting errors, rather than solely on extrapolative models that simply project past trends into the future. A significant finding is that, although price and output expectations show some persistence, firms tend to be systematically conservative in their forecasts about future conditions. This conservatism is evident in a strong tendency to predict 'no change', a pattern observed in both French and German firms. However, the data suggest that this conservative approach is more evident among German firms, while French firms exhibit more variability in their expectations and plans.

The paper further explores the systematic biases present in the expectations of firms. German companies consistently underestimate the extent of changes in demand, production, and prices. Although they predict changes less often than they actually occur, their forecasting errors remain relatively stable over time. This consistency indicates that German firms use fairly uniform rules for forming expectations, making their biases foreseeable. In contrast, French companies show significant variability in how they form expectations. The study reveals that the connection between planned and actual changes in production, demand, and prices is much more erratic among French firms, suggesting that their forecasting rules are less consistent or that they operate in a more unpredictable economic environment. The instability of conditional distributions in the French data suggests that economy-wide factors, such as macroeconomic shocks or policy changes, may affect firms' expectation errors in an inconsistent way.

How closely are firms' price expectations linked to their production plans? If companies determine prices based on forecasted demand and anticipated production limitations, one would anticipate a strong connection between changes in price expectations and adjustments in production plans. Yet, the findings in the paper indicate a surprising level of independence between these two processes. A joint

model estimated for price expectations and production plans shows that changes in price expectations and production plans occur almost independently. This observation is consistent among both French and German firms, challenging standard economic models that suggest firms adjust prices and output simultaneously in response to demand shocks. The observed independence might be due to rigidities in price-setting behavior. German firms, in particular, seem to modify their production plans in response to unexpected demand changes but do not necessarily alter their pricing strategies accordingly. This implies that supply-side constraints or competitive pressures might restrict firms from freely adjusting prices in response to actual shocks.

What is the role of demand shocks in plan fulfillment? The study also identifies the elements that influence whether companies stick to their original plans. A central hypothesis examined is that unforeseen shifts in demand significantly impact whether companies alter their production strategies and pricing forecasts. The findings reveal a strong link between unexpected demand changes and the inability to meet production plans. For both French and German firms, when actual demand diverges considerably from what was expected, they are much more inclined to modify their production strategies. However, there are differences in how these companies adjust their pricing strategies. German companies are more likely to change their price forecasts in response to production deficits, whereas French companies do not show a consistent pattern between unexpected demand and changes in price expectations. This indicates that price-setting in France might be more inflexible, potentially due to regulatory limitations, labor market challenges, or institutional factors that restrict firms' ability to adjust prices in response to demand changes.

The paper further explores an economically rich conditional probability model that connects firms' production strategies to crucial economic factors like demand expectations, inventory appraisals, and recent demand fluctuations. The empirical findings indicate that firms are more inclined to plan production increases when (i) they have recently observed a rise in demand, (ii) they perceive their inventory levels as insufficient, and (iii) they anticipate an increase in future demand. These results strongly support the idea that firms' production planning is influenced not just by extrapolative trends but by a combination of demand conditions and inventory assessments. Additionally, the empirical estimates for both French and German firms are strikingly similar, implying that the fundamental economic mechanisms driving production planning are largely consistent across different institutional settings.

In conclusion, Nerlove (1983) enhances the understanding of how expectations are formed and their influence on the decision-making processes of firms. The research emphasizes the systematic biases present in firms' predictions, which often lean towards anticipating stability in prices and output, even though actual outcomes show significant fluctuations. While error-learning models effectively explain price and demand expectations, production plans seem to be more closely linked to economic fundamentals like demand expectations and inventory levels. The apparent disconnect between price expectations and production plans indicates that firms' pricing strategies might be constrained, limiting their adaptability. This has significant implications for economic modeling, especially regarding monetary and fiscal policy, as it implies that firms might not react to demand shocks as standard equilibrium models would

predict. The differences observed between French and German firms highlight the impact of institutional factors on expectation formation and the execution of plans. The more stable expectation processes of German firms suggest they operate in more predictable market conditions, whereas the instability in the French data indicates a more volatile economic environment.

Comparing Nerlove, 1983, with König, Nerlove and Oudiz, 1981

Marc Nerlove's 1983 paper and the earlier 1981 study co-authored by Heinz König, Marc Nerlove, and Gilles Oudiz analyze business survey data from German and French firms. Both articles employ data from the Ifo Institute (Germany) and INSEE (France) to examine how firms form expectations, revise their plans, and ultimately adjust their business decisions in light of realized outcomes. However, while the 1981 article focuses exclusively on price expectations, the 1983 study expands the scope to include production plans and demand forecasts, providing a broader view of firm behavior. This comparative analysis highlights the methodological advancements, empirical findings, and theoretical contributions of both works, while also considering their implications for economic modeling and firm decision-making.

Methodological foundations and innovations. Both articles share a *methodological commitment* to using log-linear probability models to analyze categorical business survey data. The 1981 study introduces this approach as an alternative to traditional time-series analysis, arguing that direct survey data on firms' expectations provide richer insights into the expectation formation process than conventional econometric models that rely on observed outcomes alone. The 1983 article builds upon this foundation, maintaining the log-linear probability framework while further extending it with recursive conditional probability models. This additional methodological layer allows the later study to examine how different business expectations—such as price anticipation, production plans, and demand forecasts—interact with one another and evolve over time.

A significant *methodological difference* is how expectations are modeled. While Nerlove (1958a) laid the groundwork with the adaptive expectations model, emphasizing how expectations adjust in response to forecast errors, this early work relied on time-series macro data estimation rather than directly observed micro expectation data. The 1981 study now focuses on price expectations using qualitative micro data, examining them through adaptive and extrapolative models. It investigates whether firms rely more on past realizations or on adjustments based on recent forecast errors. The 1983 study broadens this approach, applying similar models not only to price expectations but also to production planning and demand forecasting. In doing so, it tests whether firms treat these different expectations as interconnected or if they develop them in isolation from one another. The 1983 study also provides a more refined assessment of expectation stability, comparing how German and French firms revise their forecasts in response to past realizations.

A notable *methodological advancement* in the 1983 paper is its application of recursive models to capture the sequential nature of business decision-making. By

structuring the analysis to acknowledge the interdependencies among various decision variables, the 1983 study offers a more nuanced view of firm behavior. This is evident in its treatment of production plans, where the paper investigates whether firms adjust their planned output in response to unexpected demand fluctuations.

Empirical findings. The two articles arrive at different conclusions regarding how companies develop and adjust their expectations. The 1981 study reveals a strong link between price expectations and past outcomes, indicating that firms often base their future price forecasts on recent pricing patterns. However, it also highlights notable differences in expectation formation between German and French firms. German firms' price expectations exhibit greater stability over time, whereas French firms' expectations fluctuate more widely. This implies that the process of forming expectations is shaped not only by economic fundamentals but also by institutional and behavioral influences.

The 1983 study builds on these findings by demonstrating that the stability of expectations varies depending on the type of business decision. German firms show consistency in their price and demand expectations but display more variability in production planning, suggesting that they treat pricing and production decisions as somewhat separate. Conversely, French firms exhibit more volatility in their expectations for prices, demand, and production, indicating a less structured approach to business planning.

One of the most striking findings in the 1983 paper is that production plans and price expectations are nearly independent of one another. This contradicts conventional economic models that assume firms jointly determine pricing and output strategies in response to market conditions. Instead, the study finds that firms often revise their price expectations based on past price trends, while production plans are adjusted primarily in response to demand fluctuations. This suggests that firms may not always coordinate their pricing and output decisions optimally, either due to rigidities in pricing strategies or constraints in adjusting production capacity.

The differences between German and French firms are especially insightful in this context. The 1983 paper indicates that German firms typically adjust production in response to demand changes, whereas French firms show greater uncertainty in revising their expectations. This instability might be attributed to macroeconomic factors such as inflationary pressures, labor market rigidities, or variations in industrial policy. The greater stability in German firms' production plans suggests a reliance on structured forecasting methods or long-term strategic planning.

Challenges of rational expectations. Both studies have added to the prevailing debate at the time on rational expectations, a theory suggesting that economic agents form their expectations using all available information in an unbiased statistical manner. The 1981 study already reveals that firms' price expectations do not entirely align with rational expectations; instead, they are shaped by a combination of extrapolative and adaptive processes. Firms adjust their expectations based on past outcomes but also display systematic biases in their predictions. This finding contradicts the rational expectations hypothesis, which assumes that economic agents will eventually eliminate systematic forecast errors.

The 1983 study supports this conclusion and broadens it to include other business decisions beyond price expectations. By demonstrating that firms' production plans and price expectations are largely independent, the later study indicates that firms do not always optimize their decisions in a fully coordinated way. This challenges standard economic models that assume firms maximize profits by jointly determining prices and output levels. Instead, it suggests a more fragmented decision-making process, where pricing and production planning function as separate mechanisms influenced by different sets of expectations.

An additional significant contribution of the 1983 study, beyond the earlier work, is its examination of the stability of expectations over time. While rational expectations theory posits that firms should gradually refine their forecasts as they gather more information, the study finds that expectation formation remains highly variable, particularly among French firms. This implies that firms may encounter constraints in processing information efficiently or that they rely on heuristics rather than formal predictive models.

1.5 Research Impact

1.5.1 Firm Price and Output Changes and Rational Expectations

Marc Nerlove inspired numerous research papers involving him and/or other members of the Mannheim group. In relation to the key papers examined in section 3.2, Nerlove (1983) and König et al. (1981), this section highlights four papers that expand on these themes, authored by junior team members, specifically Kawasaki et al. (1982) on *Disequilibrium dynamics: An empirical study* and Kawasaki et al. (1983), *Inventories and price inflexibility*, on the development of firm price and output changes, as well as Kawasaki and Zimmermann (1986), *Testing the rationality of price expectations for manufacturing firms*, and Zimmermann (1986), *On rationality of business expectations: A micro analysis of qualitative responses*, on rational expectations. The fact that we were able to undertake this work independently was a remarkable acknowledgment of our strong support for the general project.

Output and price flexibility

Kawasaki et al. (1982) primarily examines how firms adjust their prices and output levels in response to disequilibrium situations. It focuses on whether these adjustments move firms closer to or further away from equilibrium. The paper defines disequilibrium based on firms' assessments of their inventory levels and unfilled orders. It finds that firms often experience disequilibrium, with around 60 percent of observations indicating misalignment in either inventories or order backlogs. The study also finds that firms respond to stock disequilibrium within one month, using both price and output adjustments, but with a notable difference in flexibility: output adjustments

are more frequent than price changes. Contrary to conventional expectations, the study finds no significant evidence that prices are less flexible downward than upward. The authors also highlight that flexibility in price and quantity adjustments varies significantly across industries.

Kawasaki et al. (1983) extends this analysis by providing a more nuanced explanation of why prices appear less flexible than quantities. Developing a theoretical model following Kirman and Sobel (1974) for orientation, it introduces a distinction between firms' responses to transitory versus permanent changes in demand. The study argues that firms react differently depending on whether demand fluctuations are perceived as short-term or long-term. Using changes in incoming orders from the previous month as a measure of short-run demand shifts, and expected changes in business conditions over the next six months as a proxy for long-run demand shifts, the study demonstrates that firms adjust both price and output when responding to permanent demand changes. In contrast, firms primarily adjust output, rather than prices, in response to transitory changes in demand. This theoretical refinement helps explain why price changes are observed less frequently than output adjustments in the short run.

Overall, while Kawasaki et al. (1982) focuses on the general disequilibrium behavior of firms and their tendency to favor output over price adjustments, Kawasaki et al. (1983) deepens the analysis by distinguishing between different types of demand shocks and showing that price changes are more likely to accompany long-term shifts in demand. The latter study thus provides an explanation for the empirical finding that price flexibility appears lower than quantity flexibility. Together, these papers contribute to a better understanding of firm behavior in disequilibrium situations by clarifying the role of demand expectations in shaping firms' pricing and production decisions.

How are Kawasaki et al. (1982) and Kawasaki et al. (1983), in the following KMZ, related to Nerlove (1983)? Beyond common data and similar methods, a common interest is to understand how firms adjust prices and output in response to economic conditions, though they approach these questions with different emphases.

The 1982 finding of KMZ that firms more frequently adjust output than prices in response to inventory imbalances and unfilled orders aligns with Nerlove's broader theme that expectations and realizations often diverge due to structural constraints and uncertainties in firms' decision-making processes. The 1983 extension by KMZ refines this analysis by distinguishing between permanent and transitory demand shocks, showing that price adjustments primarily occur when demand changes are perceived as long-term, whereas short-term fluctuations tend to induce output changes instead. This finding intersects with Nerlove's work, which examines how firms' expectations about future conditions shape their planning and decision-making.

Nerlove (1983) while explicitly modeling the process by which firms develop price and production plans based on past realizations and expected future demand demonstrates that firms systematically underestimate the volatility of their environment. Their expectations disproportionately concentrated in the 'no-change' category compared to actual realizations. This tendency is consistent with the findings of KMZ

1983, who also observe that firms exhibit inertia in their pricing behavior, preferring to adjust output rather than prices unless they perceive demand shifts as permanent.

The findings of KMZ contributed significantly to the macroeconomic debates of the 1980s, particularly in the discourse surrounding Keynesian and neoclassical perspectives on price and output flexibility. In the Keynesian tradition, particularly in the emerging *New Keynesian* framework, price and wage stickiness were central tenets, implying that firms tend to adjust output rather than prices in response to demand fluctuations. The 1982 study reinforced this view, demonstrating that firms predominantly altered quantities rather than prices when reacting to disequilibrium. This evidence supported Keynesian models emphasizing nominal rigidities, which explain persistent unemployment and output fluctuations. The observation that output is more flexible than prices bolstered the argument that aggregate demand shocks have tangible effects on employment and production rather than being quickly neutralized through price adjustments.

However, their 1983 study introduced a nuanced perspective, complicating the Keynesian interpretation. By differentiating between permanent and transitory demand shocks, the authors found that firms adjusted prices when demand shifts were perceived as permanent but changed output levels when shifts were seen as temporary. This behavior aligned with rational expectations theory, a core component of neoclassical economics, which also gained prominence in the 1980s (see below). The evidence suggested that firms acted with foresight, adjusting prices strategically based on their expectations of future demand rather than being universally constrained by price rigidity.

These findings also had implications for *Real Business Cycle* (RBC) theory, developed by Kydland and Prescott (1982), which posited that business cycles stem primarily from real supply-side shocks rather than demand fluctuations. The tendency of firms to adjust output more than prices in response to short-term shocks was consistent with RBC models, which downplayed price distortions as a driver of economic fluctuations. However, the fact that firms adjusted prices in response to long-term demand shifts indicated that price flexibility was conditional rather than absolute, contradicting the RBC assumption of continuously clearing markets.

Ultimately, KMZ bridged the divide between Keynesian and neoclassical perspectives. The 1982 study reaffirmed the Keynesian argument for output flexibility and price stickiness, justifying fiscal and monetary interventions to stabilize demand. Their 1983 research, however, highlighted the role of expectations and selective price adjustments, incorporating elements of rational expectations into the analysis of market behavior. By distinguishing between short- and long-term adjustments, these studies helped refine macroeconomic modeling, influencing the evolution of New Keynesian economics, which sought to integrate rational expectations into traditional Keynesian frameworks.

Their work also resonated with the broader RBC literature by acknowledging that while short-run price rigidity exists, firms adjust strategically when they anticipate permanent shifts in demand. This insight challenged the pure RBC view that markets always clear efficiently but suggested that elements of RBC modeling could be reconciled with observed price-setting behavior.

In sum, their findings provided empirical support for both Keynesian and neoclassical theories, demonstrating that firm behavior is more complex than either paradigm alone suggests. By illustrating how firms navigate disequilibrium through both output and price adjustments based on expectations, their work contributed to the ongoing development of macroeconomic thought in the 1980s and beyond.

Rational expectations

Kawasaki and Zimmermann (1986) analyze the rationality of price expectations among German manufacturing firms using data from the Ifo Business Survey. Their study examines the biases in firms' prediction-realization tables for prices, production, and demand, testing whether these expectations align with the rational expectations hypothesis. Their findings suggest that firms exhibit systematic biases with a tendency to overestimate their prices and predict price changes more conservatively than actual realizations.

One key finding is that German firms are more likely to overestimate rather than underestimate their future selling prices. This means that firms systematically predict price levels to be higher than they turn out to be. This pattern contradicts the rational expectations hypothesis, which assumes that forecasting errors should be random rather than displaying a systematic bias. The authors quantify this bias using measures of forecast accuracy and consistency and find that firms exhibit a clear tendency toward over-prediction.

Another crucial result relates to firms' expectations regarding price changes. Firms tend to be conservative in their predictions, meaning that they systematically underestimate the magnitude of their price fluctuations. Instead of forecasting large shifts in prices, firms expect smaller and more gradual changes. This finding suggests that firms may relate their expectations too heavily to recent past price movements rather than efficiently incorporating all available information, which is another violation of the rational expectations hypothesis.

To formally test for rationality, the study employs an efficiency test to examine whether price forecast errors are systematically related to past price changes. If firms were forming rational expectations, forecast errors should be uncorrelated with past information. However, the study finds a strong and persistent relationship between price surprises and one-period lagged price changes. This result indicates that firms' price expectations are influenced by past trends in a way that makes their errors predictable, another departure from rationality.

Beyond price expectations, the study also investigates production and demand forecasts. Similar to their findings on prices, the authors observe that firms' expectations for production and demand also exhibit systematic biases, with firms tending to overpredict levels of demand and underpredict variability in production levels. These biases further support the conclusion that firms do not form expectations in a fully rational manner.

The implications of these findings extend to broader economic modeling and policymaking. Many macroeconomic models assume that firm and individual ex-

pectations are rational, meaning that systematic forecasting errors should not persist over time. However, Kawasaki and Zimmermann's results suggest that firms' price expectations are neither unbiased nor efficient. This challenges the assumptions underlying many economic models and suggests that firms' price-setting behavior may not fully account for all available information, possibly because of adjustment costs, informational constraints, or behavioral tendencies.

The rational expectations hypothesis was originally formulated by Muth (1961) in his seminal paper. He argues that economic agents form their expectations in a way that is consistent with the true underlying economic model, meaning that, on average, their forecasts do not systematically deviate from the predictions that would be made using all available information. This concept became central to macroeconomics, particularly through the work of Robert E. Lucas Jr. in the 1970s, who integrated it into macroeconomic models (Lucas, 1976 and Lucas, 1972). His application of rational expectations laid the foundation for the *New Classical approach*, which fundamentally challenged Keynesian economics by arguing that systematic monetary policy interventions would be largely ineffective in influencing real economic variables. This perspective was reinforced by Sargent and Wallace (1975), who introduced the policy ineffectiveness proposition, arguing that only unexpected policy changes could affect output and employment.

The findings of Kawasaki and Zimmermann (1986) and Zimmermann (1986) are consistent with the research results by Nerlove (1983) and König et al. (1981) as summarized in section 1.4.2. They had significant implications for these macroeconomic debates. As the rational expectations framework underpinned the policy ineffectiveness proposition, the empirical rejection of unbiased and efficient expectations suggests that government policy could still have real effects, even if anticipated. This provides empirical support for the emerging *New Keynesian* critique of the *New Classical* approach. If expectations were not fully rational and exhibited systematic biases, this implied that price and wage rigidities, as modeled in *New Keynesian* frameworks, could have real economic consequences.

1.5.2 Development of the Research Field

The research output from project-related scholars and beyond experienced a significant surge, expanding in multiple directions. Reviews of this evolution can be found in Zimmermann (1997) and Becker and Wohlrabe (2008). Zimmermann (1997) examines various topics, including 'predictive performance,' 'the formation of anticipations,' 'rational expectations,' 'output and price responses,' 'determinants of labor demand,' 'innovations, patent activity, and trade,' as well as 'seasonality in business surveys'. Meanwhile, Becker and Wohlrabe (2008) focus on 'studies on expectation formation,' 'special survey questions on innovation,' and 'business cycle analysis'.

For a long time, German and French datasets dominated publications in this field. However, research soon expanded to other countries. Notable examples include Nerlove and Zepeda Payeras (1986) for Mexico, Ghysels and Nerlove (1988) for

Belgium, Pupillo and Zimmermann (1991) for Italy, and Nerlove and Schuermann (1995) for Switzerland and the United Kingdom.

The project's earliest publications include König (1979) written in German, and Koenig and Oudiz (1979) written in French. An important milestone was König and Nerlove (1980), initially presented at the CIRET conference in Lisbon and later published in the conference proceedings. These early contributions laid the groundwork for later studies such as König et al. (1981) and Nerlove (1983).

Over a span of 16 years, Marc Nerlove maintained a strong research focus on business cycle-related topics. Of the 23 papers he published on the topic between 1979 and 1995, nine appeared in CIRET conference volumes—representing approximately 39 percent of his output in this area. This translates to an average of 1.4 papers per year, alongside numerous other contributions across diverse fields.

In the following discussion, I highlight several key studies carried out or inspired by the work of Marc Nerlove and his team. These studies examine various topics, including expectation formation, labor demand, innovation, international trade, and seasonality. Beyond expanding the range of topics, researchers have also introduced different econometric methods, enriching the analytical approaches applied in this field.

Expectation formation. The debate on expectation formation remains unresolved, with findings varying depending on the measurement approach and data source. Using a latent variable model and business survey data, Ivaldi (1992) finds that the rational expectations hypothesis is not consistently rejected for the French manufacturing sector. In contrast, Nerlove and Schuermann (1995), applying different latent variable models, firmly reject rational expectations for firms in Switzerland and the UK. However, their analysis also challenges the validity of adaptive and naive expectations models. Further evidence from British business survey data by Low, McIntosh and Schiantarelli (1990) reveals systematic biases in firms' forecasts. Their study indicates a tendency to overpredict changes in prices, costs, and new orders, while underestimating actual production levels.

Labor demand. What drives firms' labor demand? The Ifo business survey data do not include direct information on wages or labor costs, and technical change is often poorly measured. To address this, König and Zimmermann (1984) integrated industry-level wage and nonwage labor costs from macroeconomic sources. Their analysis, based on log-linear probability models, finds that while these costs have a statistically significant effect on employment plans, their influence is surprisingly weak. Instead, labor demand is primarily shaped by capacity utilization and production expectations. To explore this further, Ross and Zimmermann (1993) use a categorical indicator model, leveraging a specific Ifo survey question where firms identify up to two key factors influencing their employment plans. The available options include demand uncertainty, insufficient demand, high labor costs, a shortage of skilled workers, and labor-saving technical progress. Their findings strongly indicate that insufficient demand is the dominant factor driving labor demand. This result remains robust across different model specifications, including adjustments for firms' export market integration and disequilibrium conditions.

International trade. Using Italian business survey data and Probit models, Pupillo and Zimmermann (1991) find evidence that Italian foreign and domestic markets are segmented, as firms can set different prices, with foreign markets displaying greater price elasticity. In a related study, Zimmermann and Pupillo (1992) analyze the factors influencing firms' export activities using OLS and Poisson regressions. Their results show that firm size positively affects relative export levels and the number of export regions, while its impact on export share variability is negative and often insignificant. Market concentration variables yield inconclusive results.

Innovations. Business survey data often provide discrete information on a firm's introduction of product or process innovations, the number of patents, or innovation expenditures. According to industrial organization research, innovative activity is typically linked to firm size, market concentration, and demand pressure. Zimmermann (1985b) was the first to analyze these relationships using business survey data. Employing Ifo data and Probit models, the study integrates industry-level information with firm-level data to capture industry structure more precisely. The results confirm that while firm size and market concentration positively influence innovation, the most decisive factor is firms' expectations of long-term demand. Building on this, König and Zimmermann (1986) merge innovation data from the German business test with information on innovation expenditures from the Ifo innovation test. Using Probit and Tobit models, their analysis further reinforces the conclusion that demand expectations play the dominant role in driving innovative activity.

Seasonality. A technical challenge in analyzing business surveys is accounting for seasonality. Firms are often instructed to exclude seasonal fluctuations from their responses, yet seasonal effects may still persist in the data. Using log-linear probability models and German data,Flaig and Zimmermann (1983) show that production plans and realizations exhibit seasonal patterns, though the extent varies across variables, potentially biasing parameter estimates. Ghysels and Nerlove (1988) examine seasonality in business survey data from Belgium, Germany, and France, also using log-linear probability models. They find substantial seasonal effects but note that responses to seasonally adjusted questions generally reflect a reasonable level of adjustment.

1.6 Conclusions

This chapter examined a significant period in the academic career of Marc Nerlove, documenting his contributions to the economics profession and his broader influence as a researcher and mentor using his long-term project on business test data as a case study. In general, Nerlove's work exemplifies visionary leadership and intellectual breadth, spanning a remarkable array of subdisciplines within economics and econometrics. His research has had a lasting impact on fields such as agricultural and development economics, labor and population studies, time-series and microeconometrics, qualitative data analysis, business cycle theory, and forecasting. His legendary curiosity and openness to new challenges, topics, and collaborations

made him an entrepreneurial figure in the academic world. By fostering international networks of scholars, he shaped the careers of numerous PhD students and research partners, many of whom have made it later into influential positions in academia and policy institutions. His extensive publication record in top-tier journals and widely respected books underscores his intellectual rigor but also reflects his commitment to the broad dissemination of ideas. Unlike those who prioritize publishing only in the most prestigious journals, Nerlove seemed to strategically chose diverse outlets, including book chapters and lesser-ranked journals, demonstrating a strong belief in making high-quality research widely accessible across the profession.

One of the major undertakings of the Mannheim group, the Mannheim Business Survey project, co-directed by Heinz König, is a landmark in the early development of microeconometrics for qualitative firm data. The project played a crucial role in advancing qualitative data econometrics at a time when the field was still dominated by time-series analyses of macro-data and a rapidly rising interest in creating individual data-based household-level studies. Introducing log-linear probability models and applying association measures and Pseudo-R^2s provided methodological innovations that expanded the possibilities for empirical research. Moreover, it was the first to apply these techniques to business survey data, thereby integrating micro-level firm data into econometric research in a novel and influential manner. These contributions not only served as methodological milestones, but also influenced subsequent large-scale survey initiatives, such as the German Socio-Economic Panel (GSOEP), which emerged in the same period with support from members of the Mannheim group. While access to Ifo business data was initially restricted and limited to a short time period of the data source, the Ifo Institute has since made these data available for researchers, reflecting a long-term impact on the accessibility and use of business survey data in empirical economics.

The Mannheim project vitalized the CIRET research conferences, fostering an enduring global forum for the exchange of ideas in business cycle analysis and survey-based research. While the impact of the work has been felt across multiple economic subfields, the research contributions of the group have been particularly influential in shaping the microfoundations of key macroeconomic debates. Empirical insights were provided into the evolution of firm-level output and pricing behavior, the nature of disequilibrium adjustments in response to economic shocks, and the role of rational expectations in shaping business decisions.

In the broader context of macroeconomic theory, the Mannheim group offered a data-driven perspective on the Keynesian-neoclassical debate, particularly through the lens of rational expectations. By rigorously analyzing firm-level data on price and production expectations, their research tested the extent to which firms rationally form expectations or whether systematic biases exist. These findings challenged some of the prevailing assumptions in macroeconomic modeling, highlighting the importance of micro-level heterogeneity and the limitations of aggregate models that overlook firm-specific behaviors. These insights have had lasting implications for both theoretical and applied research, influencing how economists conceptualize expectation formation, policy effectiveness, and business cycle dynamics. Through their empirical approach, the Mannheim group not only enriched the discussion on

rational expectations but also demonstrated the necessity of grounding macroeconomic debates in robust microeconometric evidence. The legacy of this research lies not only in methodological contributions but also in the persistent advocacy of data-driven economic inquiry, a principle that continues to shape the field today.

Acknowledgements

I wish to thank Meinhard Knoche and Klaus Wohlrabe for very helpful discussions during the preparation of this contribution. I also owe my former colleagues and co-authors at the time, Gebhard Flaig, Seiichi Kawasaki, John McMillan, Lorenzo Pupillo, David Ross, Mike Veall, and in particular my PhD supervisor Heinz König, quite a lot for their support and inspirations.

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