



HAL
open science

Modelling intervention: Barbara Bergmann's micro-to-macro simulation projects

Cléo Chassonnery-Zaïgouche, Aurélien Goutsmedt

► To cite this version:

Cléo Chassonnery-Zaïgouche, Aurélien Goutsmedt. Modelling intervention: Barbara Bergmann's micro-to-macro simulation projects. *European Journal of the History of Economic Thought*, 2024, pp.1-21. 10.1080/09672567.2024.2433971 . hal-04208686v2

HAL Id: hal-04208686

<https://hal.science/hal-04208686v2>

Submitted on 3 Dec 2024

HAL is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.

Modeling intervention: Barbara Bergmann's micro-to-macro simulation projects

Cléo Chassonnery-Zaïgouche^{a*} and Aurélien Goutsmedt^b

^aUniversity of Bologna, Italy; ^bF.R.S.-FNRS; ISPOLE, UC Louvain, Belgium

cleo.chassonnery@unibo.it

Modeling intervention: Barbara Bergmann's micro-to-macro simulation projects

Over a period of twelve years, Barbara Bergmann developed several models of the labor market using microsimulation, eventually integrated in a “Transactions Model” of the entire US economy, built with Robert Bennett and published in 1986. The paper reconstructs the history of this modelling enterprise in the context of the debates on the micro-foundations of macroeconomics and the role of macroeconomic expertise from the 1970s to the late 1980s. It shows how her focus on the distributional effects of policies was central to the criticism of macroeconomic modelling and how both her epistemological and political positions were marginalized in the 1980s.

Keywords: microsimulation, Bergmann (Barbara R.), transactions model, microfoundations, economic expertise

Subject classification codes: B21, B22, B31, C69, E17

Introduction

Given the amount of pain and suffering inflicted by recessions, macro-economics is the most important field of economic study, and deserves more rigorous methods. Micro-simulation provides rigor, realism, and an ability to incorporate complexities revealed by more empirical investigations into the working of business.

(Bergmann 2005a, 10)

In the tumultuous economic landscape of the 1970s, a paradox emerged: as the United States grappled with “stagflation” and unprecedented economic challenges, sparking sharp criticisms of economic management, the influence of economists in policymaking surged to new heights (Berman 2022). This era was marked by profound shifts and crises, showcasing theoretical battles and policy experiments that shaped the next decades of economic policies. Economists and their sophisticated models became indispensable for governmental decision-making.

Historiography of the period typically depicts these years around a clash between Keynesianism and variously called thought collectives—neoliberal thinkers, monetarists, or new classical economists. This narrative, centered on macroeconomic issues, often frames the debate as one between active and discretionary interventionist policies on one hand and *laissez-faire*, reduced intervention, or rule-based policy on the other. However, a crucial but often overlooked aspect was the confrontation over the role of economists as experts. This confrontation was marked by an often implicit but profound debate among differing approaches to modeling intervention. When studying the history of economics during this era, particularly on such pressing topics as inflation, labor issues, and poverty, it becomes clear that epistemological and methodological considerations were deeply intertwined with views on the role of economists and their models, as well as with underlying political views.

This article offers a case study of the relationship between epistemic and political values by examining Barbara Bergmann’s contributions to modelling policy intervention.¹ Over a period of twelve years, Barbara Bergmann developed a unique “micro-to-macro” simulation model. Initially working on various labor market models based on microsimulation, she and her colleague Robert Bennett integrated these into a comprehensive “Transactions Model” of the entire US economy, which they eventually

¹ The relationship between epistemic and political values is a central issue in the history of economic thought. For a review of the literature contemporaneous to Bergmann’s work in the 1970s, see Warren Samuels’ (1977) “Economics and Ideology”. Recent case studies include Cherrier’s (2011) demonstration of the “lucky consistency” of Milton Friedman’s analytical premises and political values, and Cherrier (2009) on Gunnar Myrdal’s “scientific way to social democracy”. Additionally, Goutsmedt, Guizzo, and Sergi (2019) examine the entanglement of Robert Lucas’ methodological preferences with his views on expertise and economic policy.

published in 1986. Amid the stagflation of the 1970s, Bergman sought to exploit the advantages of microsimulation to build a model dealing with macroeconomic issues.

Simulation generally involves using computer programs to “mimic” or “reproduce” a (social) system, producing sets of “simulated” data through automatic runs (Fontana 2006b). *Micro*-simulation refers to the disaggregated level of the model and data produced. In the United States, microsimulation started to be used in the late 1960s in the context of Johnson’s series of policies known as the “war on poverty”. By the 1970s, it had become a central tool for evaluating the consequences of various welfare and social policies (Kraemer et al. 1987). However, Bergmann’s specific approach was to construct a *macroeconomic* model built on microsimulation: it starts with heterogenous agents making decisions—such as how much to work, consume or invest—based on various behavioral rules in reaction to specific policy interventions; by aggregating iteratively the results of individual actions, the model simulates the effects of this intervention on macroeconomic variables, such as inflation, unemployment and GDP.

Bergmann’s trajectory provides a fresh perspective on the 1970s debates among economists regarding the integration of micro and macroeconomics. While the history of economics has often centered on the so-called “Rational Expectations Revolution” and the criticisms of Keynesian macro-econometric models, Bergmann’s trajectory as a microeconomist who specialized in microsimulations offers a unique detour to the debates on the micro-foundations of macroeconomics. Bergman aimed to leverage the granularity of microsimulation models—a fine-grained depiction of the aggregation of individual behaviors—to address macroeconomic issues such as inflation and unemployment. Her innovative approach thus sheds light on the complexities and shifts within economic analysis, expertise, and policy interventions during the 1970s—and

especially the contentious debates around distributional effects of macroeconomic policies.

Bergmann's approach was driven by *epistemological motivations*. She praised the realism provided by the micro-to-macro model, which meticulously describes the behaviors of agents and the outcomes of their interactions through the iterative aggregation of individual actions. Starting at the micro level allows a detailed representation of policy interventions, which often depend on highly specific mechanisms that are difficult to capture at the macro level.² Furthermore, for Bergmann, the microsimulation approach avoids relying on the simplistic notion of a "representative agent," thereby addressing the diverse impacts of intervention on various economic groups. This last element connects her epistemology to her *political motivations*: she focused on distributional effects as a primary measure to evaluate the direction of policies and their implications for social justice. In her view, the true measure of economic expertise lies in its ability to analyze these effects.

The first section describes the microsimulation approach and Bergmann's own models of the labor market in the context of the "war on poverty". Her work aimed to develop a disaggregated view of unemployment and brings tools for new interventionist policies in a context of rising unemployment. The second section shows how Bergmann modeled policies using the "Transactions Model" of the U.S. economy, first applied to the *Humphrey-Hawkins Full Employment Act*. The modeling of intervention itself is the

² For instance, she studied with Bennett the incentives for households to utilize public employment services and how this could reduce unemployment, contingent upon the wage levels offered by these services (Bergmann and Bennett 1977). From this perspective, analyzing micro-level decisions was essential to comprehend the macro-level impacts of such policies.

point of departure, contrasting with modeling intervention as an external shock. In the next section, Bergmann's microsimulation project is contextualized within the debates on the micro-foundations of macroeconomics. Finally, her contribution is discussed in relation to policy interventions. Bergmann's micro-to-macro model was neither used by policymakers, nor recognized in academic circles. We describe in conclusion the main explanations of this "failure to influence" which are at once institutional, methodological, and political.

Microsimulation and the "war on poverty"

Microsimulation involves modeling the behavior of various types of agents—households, individuals, firms, public institutions. Each agent is represented as an independent entity with its own characteristics, preferences, and decision rules.

Microsimulation models aim to capture the heterogeneity among types of agents and how their decisions and interactions shape the overall outcomes of the system. The modeling usually starts by a representative sample of the population (e.g., groups of households with various levels of income) and the working of the model "consists in observing the state of the sample under different scenarios" (Fontana 2006b, 102).

Crucially these types of models are not a set of simultaneous equations but rather an iterative recursive process based on the use of algorithms (Morgan 2012, 318).

Microsimulation produces information on individuals that can be aggregated to some levels (groups, sectors, nations) in a bottom-up fashion. Historically, this technique has been used to study the cost and distributional impact of public policies.

In the United States, microsimulation started to be used in the late 1960s. At the time, welfare issues came to the forefront of Cold War politics.³ In January 1964, Lyndon Johnson initiated the “war on poverty”, advocating for increased state involvement, notably in education and healthcare. This set of policies created incentives and allocated funds that prompted social scientists to develop models, produce evidence, and policy evaluation schemes, as well as to collect new data (e.g., O’Connor 2020). The Office of Economic Opportunity (OEO), the “weak agency” (Pedriana and Stryker 2004) established in 1964 to plan the “war”, had a pivotal role in promoting such research. While the first years of the agency were devoted to programs implementation, Nixon transformed the institution into a research agency, appointing Donald Rumsfeld as director in April 1969. Rumsfeld made the OEO an agency for research and experimentation, crucially moving away from its function of administrator of social programs (Gwyn 1976, 179). Many research centers and institutions received funding from the OEO to produce research, notably on microsimulations (Kraemer et al. 1987, chap. 2). The University of Maryland was such a place.

Barbara Bergmann arrived in Maryland in the mid-1960s. Born during the great Depression and originally from the Bronx, New York, Bergmann graduated in a time where discrimination against Jews and women was rampant: she had a lot of difficulties finding a job.⁴ After graduating from Cornell University in Mathematics, Bergmann

³ Historians documented the application of methods originated in the analysis of warfare towards applications to welfare issues (Light, 2005; Jardini, 1996; Forget, 2010; Chassonnery-Zaïgouche & Larrouy, 2017).

⁴ “I had graduated in the midst of the first post-World War II recession, and jobs were scarce. ... In those days, there was discrimination against Jews, and the want ads were segregated by sex under “Help Wanted, Male” and “Help Wanted, Female”. All of the latter were for maids, department store salesladies, and clerical workers. I looked for a job for months in

began working at the New York office of the Bureau of Labor Statistics in the late 1940s: she entered at the “lowest professional rung” and became Head of her unit within two years (Olson 2007, 477). There, she was advised by a “research economist” to apply for Graduate School she never thought of doing. Bergmann was admitted to Harvard a year later.

Bergmann became a teaching assistant for statistician and sociologist Fred Mosteller and economists Wassily Leontief and Franco Modigliani. Although she recalls being introduced to Keynesianism by Alvin Hansen (Olson 2007, 478), her strongest avowed legacies were to Guy Orcutt’s empirical work (Bergmann 2005a, 10). After receiving her PhD in 1959, she became a senior research associate for the Harvard Economic Research Project, then left for a position at the Council of Economic Advisor as a senior staff economist (1961-1962). After traveling to Peru and Bolivia as part of a Brookings Institution team studying highway investments the following years, she settled as an Associate Professor at the University of Maryland in 1965. It is in Maryland that she resumed her own work using simulation. Her personal passion and skills for computers and programming and her Harvard training in input-output modeling and microsimulation would be applied to the subject that will occupy her in the 1970s: how to fix the labor market?

In the 1960s, simulation was, in fact, an umbrella term for many practices. Historians usually locate early uses of simulations in a variety of practices associated with game theory, analog computer building and early artificial intelligence developments (Morgan 2004) whose origins are found in engineering and physics

the male category, never getting a nibble. ... (People ask me whether I myself have ever been discriminated against. My answer is, “Of course, from beginning to end.”).”
(Bergmann 2005a, 9)

practices from the mid-20th Century (Fontana 2006a). The democratization of mainframes, and later, the rise of personal computers from the 1980s radically changed the scale and usage of simulation. The use of microsimulation in public administrations, started in the late 1960s, rose to prominence in the 1970s, and became routine in the 1980s (Kraemer et al. 1987, chap. 2).

Bergmann's (1973; 1975) first project using microsimulation was funded by a grant from the Office of Economic Opportunity, and was technically supported by the Computer Science Centre of the University of Maryland, which offered an "extraordinarily free access to a mainframe computer" (Bergmann 2005a, 10). At the same time, she started two courses, first of their kinds in a US economics department: one on poverty and discrimination and one on computer simulation (Olson 2007, 478). Two papers resulted from this early project on the microsimulation of the labor market: one paper, published in *Econometrica*, focused on poverty incidence of rising unemployment (Bergmann 1973); the other "Econometrics and the labor market analysis" was presented at the annual American Economic Association meeting and modeled the "job search" in the labor market (Bergmann 1975).

In the first paper, Bergmann simulated the movements in and out of unemployment to study the impact of unemployment and income on poverty. She targeted previous works done in the context of the "war on poverty" (Aaron 1967; Gallaway 1965; Mooney and Metcalf 1965). While there seems to be little doubt that unemployment increases poverty incidence and growth of income reduces it, "regression [analysis] has contributed little more than a verification of this expectation" but "fails to deal with certain complexities of the process," in particular the timing of the impact (1973, 956).

The model simulated a labor market with 1000 workers representing the “working poor” (956). The time unit is a week. Each week, a certain number of randomly selected unemployed individuals would find employment, while an equal number would become unemployed (thus maintaining a constant unemployment rate). These weekly transitions in and out of employment (i.e. the “turnover”) resulted in varying weekly incomes for each individual. Successive rounds of simulation over a year allows to calculate the annual income of each individual and identify individuals below the designated “poverty threshold”.⁵ It was then possible to test “different values assigned to the weekly wage, the number unemployed, and the number of job slots turning over” (957). The main outcome demonstrated that poverty incidence was responsive to changes in turnover rates for given wage and unemployment rate. Moreover, the relationship between poverty and turnover was “by no means a simple linear or logarithmic [relation]. It is not even monotonic” (958)—concretely, a low or a high rate of turnover reduced poverty.

Bergmann’s main claim with these early simulations was methodological: “through the very process of mimicking in the computer the micro-processes of the phenomenon one is studying”, the method has the capacity “to automatically depicts the nonlinearities and interactions of variables implicit in the economist’s view of how the process under study works” (*ibid.*). Crucial here was the trade-off between adding variables to the model for increased realism, and the handling of the model.⁶ Bergmann also insisted on the plasticity of her model. Important elements such as the stratification

⁵ She used the poverty threshold for 1967 (\$3410 for a 4-person family) for non-farm laborers (regarding the calculation of this poverty threshold, see O’Connor 2001, 183–85).

⁶ On the importance of this practical aspects of modelling in the history of economics, i.e. the tractability of models, see Cherrier (2023).

of the labor market by race, sex and occupation, or the possibility to model more than one worker in a family (ruled out in the model here), could be incorporated. Indeed, it meant producing additional scenarios “of how the element in question affects the process one is studying and translating that scenario into a modification of the computer program of the simulation” (962).

Bergmann’s approach to microsimulation differed from other existing approaches, as she sought a “middle ground” between what she considered to be inadequate “regression-runners” and complex “large-model micro-simulators” that “take years to build” and “tend to be unavailable to economists not involved in their building” (955). In particular, she made explicit reference to the work of Orcutt’s team at the Urban Institute and the team of Harvard urban economists at the NBER.⁷ By contrast, Bergmann’s simulation projects were not a team effort, resulting in models of a smaller scale.⁸ Indeed, her first project was “a combination of a very simple do-it-yourself simulation model”, used “to prepare the data before regression” and “explor[e] the nonlinearities and variable interaction of the phenomena under study” (1973, 955). The “stripped-down simulation” itself is a 20-line program written in FORTRAN.

However, Bergmann soon became involved in the development of a larger model known as the “Transactions Model”, even though it remained manageable by a few individuals. While her early microsimulation projects, funded by the “war on

⁷ One can only speculate on why she did not work again with Orcutt on the Urban Institute model, operated from the next-door Brookings Institution, as they collaborated when she was a graduate student and will collaborate in the 1980s.

⁸ For example, the NBER Urban Simulation model was a large-scale model describing a city (based on studies of Detroit, Illinois) in terms of employment, population, housing, housing prices, and transit and road networks and produce simulated data on the location and investment decisions (Ingram, Kain, and Ginn 1972).

poverty” institutions, addressed debates in microeconomics, her aim was to develop a micro-to-macro approach capable of addressing macroeconomic phenomena. The objective was to tackle these issues within a realistic economic system, employing mainly a bottom-up approach. Additionally, the emphasis on increased model realism aimed to make it practical for simulating and analyzing policy interventions.

“Decision-Making and Its consequences”

Published under the auspices of the NBER, Bergmann developed a first micro-to-macro model simulating a “representative economy” of the US economy in 1974 (Bergmann 1974a). Over a period of more than twelve years, she developed several parts of this initial model which would eventually be integrated in the “Transactions Model” (Bergmann and Bennett 1977; Bennett and Bergmann 1984; 1986; Bergmann 1980). The latter was built in collaboration with economist Robert Bennett, a colleague at the University of Maryland and, during the last stage of the project, with programmer William T. Sutton.⁹ The project was supported by a National Science Foundation grant.¹⁰ Bergmann and Bennett do not explain the term “transactions,” but it may be a

⁹ We were unable to find any biographical and bibliographical information on Robert Bennett, except his affiliation.

¹⁰ Bergmann was Principal Investigator for the NSF Grant APR77-14693 entitled “Simulation of Varying Configurations of Policies Relating and Prices”. She received \$324,200.00 for the period 1977-1981. Interestingly, the grant was managed by the Engineering directorate (the “Civil, Mechanical and Manufacturing Innovation” division) of the NSF, not by the “social, behavioral and economic sciences” directorate which usually funds economics projects. This element calls for further research on the relationship between Bergman’s economics and engineering techniques as suggested by one reviewer. In comparison with Lucas’ use of “information engineering”, Bergman seems to rely on a type of “control engineering” less focused on informational issues—to use Boumans’ (2020) terminology. On the history of the engineering-economics nexus, see Duarte and Giraud (2020).

reference to John Commons who defines transaction as the “ultimate units of economic activity” (Commons 1931, 648).¹¹

The Transactions Model represents the U.S. economy “by a much smaller-scaled simulated economy, in which the actors are 800 worker-consumer-asset holders, 12 firms, each of which produces the product of a particular industrial sector, the federal government, a consolidated state/local government, and the monetary authority” (Bergmann and Bennett 1977, 267). The functioning of the simulation is similar to any microsimulation: it keeps “tracks” of the situation, history, “actions”, and interactions of the agents; the macroeconomic magnitudes are generated endogenously by the model, e.g. “the simulated GNP accounts and flow of funds accounts are based on the summed transactions between individual actors, in which money is exchanged against goods, services or claims” (*ibid.*). By contrast with Bergmann’s previous microsimulations, the supply side of the economy is fully represented: “firms make production and pricing decisions endogenously, and try to hire enough workers to realize their production plans at wages they set endogenously” (*ibid.*).

In the early version of the model, Bergmann (1974a, 488) listed the potential uses of the model. The “most obvious use” would be as a “forecasting tool”, even if she prudently mentioned that one needed to see “whether, when the monetary side is further flesh out, the model will do as well as the Wharton School model, the FRB-MIT model, the DRI model, or any of their competitors.” The inherent tension between Bergmann’s theoretical objective to rival large-scale macroeconometric models and the usual

¹¹ “An institution is defined as collective action in control, liberation and expansion of individual action. Its forms are unorganized custom and organized going concerns. The individual action is participation in bargaining, managing and rationing transactions, which are the ultimate units of economic activity” (Commons 1931, 648).

objectives and applications of microsimulations for welfare policy analysis becomes apparent even in her initial model of the entire US economy. She mentioned its “valuable use” as a “tool of policy analysis” (*ibid.*), giving two examples: taxation changes as well as price controls—a timely issue regarding the rising inflation of the period and Nixon’s government contemporary price controls policy. Finally, microsimulation can also “be modestly useful in mediating some of the doctrinal disagreements so prominent in current discussions of macro-economic issues” (488-489).

After the mid-1970s, microsimulation became increasingly defined in relation to policy analysis due to the fact such techniques were largely used by federal and state agencies (Haveman and Hollenbeck 1980; Kraemer et al. 1987, chap. 2). Some authors have proposed a definition of microsimulation specifically based on motivation by policy interest (e.g., Martini and Trivellato 1997). Bergmann and Bennett’s works exemplified a specific perspective that directly questions whether the same evaluation tools used for welfare and social policies—microsimulation models—were transferable to macroeconomic (monetary and fiscal) policy. The case of unemployment stands at the crossroads of these two applications.

The first use of the (yet unfinished) Transactions Model was an evaluation of the Humphrey-Hawkins bill (Bergmann and Bennett 1977), which had become a focal point of political debates regarding the fight against unemployment.¹² At the time of Bergmann and Bennett’s writing, the bill was still being discussed in Congress. The legislation aimed to establish a specific numerical target for unemployment, with the

¹² See Andelic (2019) and Goutsmedt (2022) for detailed history of the political and economic debates around this piece of legislation, from the first drafts in 1974 to its enactment by Carter in October 1978.

government pledging not to exceed that level (Goutsmedt 2022). Additionally, the bill proposed the creation of public jobs for individuals with limited prospects in the private sector. It was this aspect of the proposed legislation that Bergmann and Bennett sought to examine and test.

They used the micro-simulated macroeconomic model of the US economy to “rerun the history of the 1973-1975 period”, a timeframe that included the recession of 1974. They modelled two possible implementations of the bill: a “low option” where individuals could enter the Public Service Employment program after ten weeks of unemployment, with a wage set at 75% of corresponding private sector wages; and a “high option” where entry could occur after six weeks with a wage set at 75% of corresponding private sector wages but allowed for a higher maximum wage (Bergmann and Bennet 1977, 268). Assumptions were made regarding the likelihood of different groups of individuals joining the program and accepting a public job. Then, both options were tested using a simulated automatic mechanism of job creation in the event of worsening employment conditions (266). The results of the simulation were straightforward:

Neither of the [Public Service Employment] programs simulated was capable of preventing a rise in unemployment rates although the high option program succeeded in arresting the rise in unemployment rates by the end of 1974. Both programs significantly moderated the force of the recession on the labor market at a moderate net cost to the Federal government. (268)

The net cost of government action fell because of “extra tax revenues” in the second half of the period (270). Unlike unemployment insurance, which had similar fiscal implications, the Public Service Employment programs also provided the additional benefit of providing tangible services through the employment of individuals in the public sector. The authors emphasized that Public Service Employment should be used

as a complement to “conventional” policy instruments (i.e. macroeconomic policies), rather than as a substitute. Importantly, the simulation did not yield inflationary outcomes. As acknowledged by the authors, the accuracy of these results depended on the specific decision-making rules employed. And they argued that altering these rules could serve to test the model’s robustness (*ibid.*).

In this paper, microsimulation was framed as “an instrument”, “a vehicle” to simulate the effects of policy (266). It provided a way to do experiments with real and potential policies and advocate customization according to various theoretical insights.¹³ The policy intervention was the starting point. The focus was not solely on assessing the overall effectiveness of a particular policy, but rather on examining how it impacts specific groups of individuals and whether the targeted population was effectively reached through the program. Hence the insistence on the disaggregated level: for Bergmann, policymakers should be interested in understanding the distributional effects of policies rather than focusing only on aggregate outcomes.

Bergmann and Bennett later presented their model in two important conferences on microsimulation in Stockholm in 1977 and in Washington D.C. in 1978 (Bergmann, Eliasson, and Orcutt 1980; Haveman and Hollenbeck 1980).¹⁴ Both proceedings were an exposition of “state-of-the-art” microsimulation models (7 models in 1977, 13 in

¹³ For a similar vision of experiments, see Rivlin (1974).

¹⁴ The 1977 conference held in Stockholm was arranged jointly by The Industrial Institute for Economic and Social Research (IUI) and IBM Sweden. The second conference was held in Washington D.C. and sponsored by the Institute for Research on Poverty at the University of Wisconsin (created with an OEO grant), the NSF and Mathematica Policy Research. Mathematica Policy Research was a company created in 1968 to conduct the New Jersey Negative Income Tax Experiment and specialized notably in the development of microsimulation models (Kraemer et al. 1987, chap. 2).

1978), most of them built for specific institutions in the U.S., Sweden, West Germany, but also specific regions and cities. Applications' range was wide: food stamp policies, public transfers, negative income tax, welfare reforms of the labor market (e.g. the U.S. "Program for Better Jobs and Income"), energy policies, health care reforms, fiscal policy, corporate and personal tax integration proposal, regional impact of tax-transfer policies, housing programs, military exports policies, etc. The debates focused on comparative advantages of the models presented, and discussions on the relationship to (and the quality of) data. The main orientation of both conferences was the use of microsimulation for "rational decision making", specifically because the methodology provided analysis of distributional effects across specific micro-units, "not just an aggregate or a mean", and allow for the modeling of actors' response to policy (Haveman and Hollenbeck 1980, xxii).

Bergmann and the microfoundations of macroeconomics

Bergmann and Bennett published the full version of the Transactions Model in a monograph in 1986 (Bennett and Bergmann 1986), twelve years after Bergmann's (1974a) first publication about the model. The Transactions Model ambitions was to compete with macro-economic models, not just to test sectoral welfare policies.

Bergmann's macroeconomics envy reflected a "dissenting position" regarding the state of macroeconomics in the 1970s and the 1980s (Paulin 1998).

In the early 1970s, "new classical" macroeconomists Lucas and Sargent famously stressed the need for macroeconomics to rely more on microeconomic theory (Duarte and Lima 2012; De Vroey 2016): it was necessary to reintegrate "aggregative problems such as inflation and the business cycle within the general framework of

‘microeconomic’ theory” (Lucas 1987, 107).¹⁵ The underlying consideration was that “only when macroeconomic aggregates are explicable as consequences of well-formulated optimization problems for individuals [...] will macroeconomic reasoning be secure” (Hoover 1988, 87).

This criticism of macroeconomic theory extended to macroeconometric models used for forecasting and policy analysis: these models would be unreliable for policy analysis because they failed to consider the reaction of agents to changes in policy.¹⁶ If the new classical arguments gained traction in macroeconomics in the 1970s and beyond, the issue of the microfoundations of macroeconomics had already become prominent from the late 1960s, and other approaches to microfoundations had been proposed (Hoover 2012).¹⁷

New classical economists such as Lucas and Sargent introduced a research program grounded in two key principles: (i) the solving of optimization problems consistent with standard microeconomic theory, and (ii) rational expectations which assume that agents know the “model” of the economy and form expectations that are, on average, accurate. However, models that adhered to these principles while also

¹⁵ These economists’ approach was quickly labelled “new classical” in the 1970s in reference to John Hicks (1937) “Mr. Keynes and the ‘classics’”, because it relied on a market-clearing assumption (Hoover 1988, chap. 1).

¹⁶ That is the argument of the “Lucas critique” (Lucas 1976; see also Goutsmedt, Guizzo, and Sergi 2019). Outside of the criticism of macroeconometric models, new classical economists also developed different contributions concluding on the ineffectiveness of monetary or fiscal policies with respect to the real economy (De Vroey 2016, chap. 9).

¹⁷ The issue of the consistency between macroeconomic relationships and microeconomic behavior was as old as the conceptual separation between microeconomics and macroeconomics (Duarte and Lima 2012, 4–5). The term “microfoundations” was coined in the 1950s and predates by far the contributions of Lucas and Sargent.

incorporating multiple agents were not computationally tractable. New classical economists therefore resorted to the artifact of the representative-agent: their models were populated by one (representative) household and one firm, each optimizing respectively their utility and profits under constraints.

The new classical research program sparked intense debates in this period and was met with considerable resistance (Backhouse and Boianovsky 2012; Goutsmedt et al. 2019). Despite this, it was notably successful in bringing attention to the issue of the microfoundations of macroeconomics in subsequent years. Bergmann also endorsed the quest for anchoring macroeconomics “in descriptions of micro-economic behavior,” “a principle well understood and universally agreed to, although often only loosely honored in practice” (Bergmann 1974a, 475). But her micro-to-macro approach was in stark contrast to the new classical micro-foundational program. Bergmann targeted new classical economists for “pass[ing] from micro to macro informally” (Bergmann 2005b, 64).

Bergmann’s main contention concerned what she described as the unrealistic micro-foundations of the labor market that she found in Lucas and Rapping (1969), which implied that workers could forgo work today in hope of better real wages later. This vision of the labor market, in which individuals make decisions based on the disutility of labor, was in sharp contrast to both Keynesian and institutionalist views of the labor market. This application of price theory to labor was embedded in a larger movement that redefined labor economics in the 1960s and 1970s.¹⁸

¹⁸ See for example Bergmann’s criticism of the theory of labor discrimination (Bergmann 1989).

Bergmann criticized the “expectation-garbage” of the “rational expectation school” (Bergmann, 1987, 195). Her microsimulation models did not use rational expectations. In the Transactions Model, forward-looking expectations enter the decision of actors only when “considerable damage is possible if the future is very different from the present” (Bennett and Bergmann 1986, 10). Bennett and Bergmann disagree with the underlying hypothesis of rational expectations but did not ignore the problem of expectations altogether. According to Bergmann, economists using rational expectations as a concept did not put any effort into understanding how expectations are formed and how they evolve, simply assuming that on average, rational agents would not repeatedly make erroneous forecasts.

By contrast, Bergmann conducted an experiment on the formation and evolution of expectations (Bergmann 1988). A computer-based experiment, students in economics were shown different types of time series charts and asked to predict trends of various economic variables. The students’ predictions were systematically upward biased and were not corrected across time. By assuming away behaviors, modelling based on the rational expectations did not produce useful results on actual expectations mechanisms. Bergmann’s judgement on the status of rational expectations was clearly against the tide and would contribute to the marginalization of her perspective, even from the alternatives to the new classical program.

In the 1970s and early 1980s, the “aggregation program” (Hoover 2012) appeared as a significant competitor to new classical economics in the realm of microfoundations research. Unlike new classical economics, which primarily relied on logical implications from microeconomic theory, the aggregation program fostered a dialogue between microeconomics and macroeconomics that was “not merely theoretical (...) but empirical” (44). This research program was rooted at the Wharton

School of the University of Pennsylvania under the auspices of Lawrence Klein. Klein's ideal process was to start with existing data and some macroeconomic equations and then "constantly work to disaggregate it and to elaborate it in the direction of a complete" model (41).

Bergmann's approach, while closer to the "aggregation program" than to the "new classical" one, was nevertheless different. To put it simply, Klein's approach was top-down, while Bergmann's favored a bottom-up process. What came first for Bergmann was the multiplicity of agents: the Transactions Model simulated the succession of decisions by different households and firms, depending on some rules of thumb (Bergmann et al. 1980, 23-24). These decisions lead to interactions and thus to transactions between the different agents. The aggregation of all these transactions then determines the macroeconomic variables.¹⁹

Bergmann's position in the microfoundations debate can be first explained by her *epistemological motivations*: she saw micro-simulated macroeconomic models as more realistic. When remembering the 1980s, Bergmann recalled "equations with macro variables [were] constructed on the basis of loose verbal analogies to supposedly valid microeconomic equations" (Bergmann, 2005c, 10). She criticized the practices where "[h]ighly mathematical accounts of the derivation of individuals' behavior are

¹⁹ The bottom-up approach of Bennett and Bergmann starts from microeconomic behaviors and tests different parameters to see which set of parameters allows to aggregate microeconomic behaviors in a way that produce macroeconomic aggregates fitting the 'real world' macroeconomic data. Nonetheless, it is worth noting that Bennett and Bergmann sometimes resigned themselves to using standard estimation techniques "for dealing with parameter estimation in conventional macroeconomic models—fitting macro equations and translating the result onto the microeconomic level" (Bennett and Bergmann 1986, 4; see also Bergmann 1974a, 486).

not infrequently followed by vague verbal descriptions of what goes on when individuals come together and interact” (*ibid.*). This disconnect between individual behaviors and their aggregation was her main contention (Bergmann 1990).

In addition to her criticism of the unrealistic modeling of individuals’ behaviors, Bergmann also voiced concerns regarding the representation of firms in macroeconomics. The critique stemmed partly from the limited availability of disaggregated data on firms, in comparison to households’ data (an observation shared by labor economists, see Stafford 1986). Moreover, economists had “very little knowledge of how [firms] make their decisions and conduct their business” (Bennett and Bergmann 1984, 94). This, they argued, was the consequence of economists “theorizing (...) in the offices and seminar rooms” and running regressions “on data collected for other purposes” rather than deriving firms’ behavior “from first-hand contact with business people” (*ibid.*).²⁰

Finally, Bergmann believed that microsimulation models offered another additional advantage over standard macroeconometric models: they facilitated a more “realistic representation” of the various policy instruments that “frequently work on the micro level” (Bennett and Bergmann 1984, 92-94). This aspect aligned with Bergmann’s ambition with the Transactions Model: to propose a new approach to building macroeconomic models and transform the way macroeconomists approached

²⁰ Later on, she made a similar point by referring to Hall and Hitch’s (1939) survey of firms’ practices regarding price-setting (Bergmann 2005b, 63). The results of the initial study called into question the theoretical ideas that firms set their prices at their marginal cost, in a similar fashion as Lester’s famous study (1946) that triggered the so called marginalist controversy (Hausman and Mongin 1997). Bergmann’s stance testified to the persistence of this controversy in economics.

policy analysis. This last point reflected the *political motivations* of the criticism of macroeconomic models.

An alternative to macroeconomic models for new policy

Bergmann's ambition was to compete with large-scale macroeconomic models to foster the adoption of new policy, targeting the reduction of inequalities. A political element, in addition to epistemological motivations, explains Bergmann's modelling choices and her dissenting position.²¹ A "old Keynesian" and a "welfare liberal feminist" (Paulin 1998), Bergmann favored strong intervention in the economy, at a micro and macro level. Her political values aligned perfectly with her scientific perspective, much like Friedman or Myrdal's respective positions (Cherrier 2011, Cherrier 2009).

As soon as 1974, as mentioned already, Bergmann claimed the Transactions model should soon do "as well as the Wharton School model [headed by Klein], the FRB-MIT model, the DRI model" (Bergmann 1974a, 488). These large-scale forecasting models had gained traction in various institutions since the late 1960s and early 1970s.²² The FRB-MIT model had become widely utilized within the Federal

²¹ The phrase "political element" is a reference to Gunnar Myrdal's book *The Political Element in the Development of Economic Theory* on the role of values in scientific methods.

Bergmann was influenced by Myrdal's (1944) *An American Dilemma*, read when she was a graduate student at Harvard in the mid-1950s (Bergmann 2005a). In this book, Myrdal presented his last version of the solution to the value problem in science: epistemic, moral and political values are unescapable in scientific works, but needs to be explicit. He insists his updated thought are contained in the appendices of *An American Dilemma* in the preface to the new English edition (Myrdal 1953, vii).

²² For a general history of large-scale macroeconomic models, see Bodkin, Klein, and Marwah (1991).

Reserve for forecasting the future behavior of macroeconomic variables and assessing the impact of different policies (Acosta and Cherrier 2021; Backhouse and Cherrier 2019; Rancan 2019). These macroeconometric models gradually spread to public administrations during the 1970s (Kraemer et al. 1987, chap. 3; Berman 2022, chap. 3). They also entered the market of business forecasts, with models like the DRI one experiencing a surge in sales for their forecasting services (Duarte and Sergi 2023).

As large-scale macroeconometric modeling gained wider usage, they also faced mounting criticism. The oil shock of 1973 following the Yom Kippur war and the resulting increase in inflation exposed their difficulty to correctly forecast the rise of prices (Lucas and Sargent 1978). New classical economists were particularly vocal in their critique, highlighting the arbitrary adjustments made to the models' forecasts to align them with actual data (Lucas 1976, 23).

Bergmann followed a similar line of criticisms some years later: she considered that current macroeconometric models were performing “little better” than the Klein-Golberger model of 1955 (Klein and Goldberger 1955; Bennett and Bergmann 1984, 92; see also 1986, 1). Yet, the research program around large-scale macroeconometric models remained dynamic in the 1970s, even if their popularity collapsed in academia (Goutsmedt 2017). In his presidential lecture for the American Economic Association in 1977, Klein advocated for the development of a “Keynes-Leontief” modeling approach, which would place greater emphasis on capturing the supply-side dynamics of the economy (Klein 1978). Klein defended the expansion of large-scale models through the incorporation of “satellite” models, such as a model of commodities markets, to better understand notably the behavior of oil prices. This proposed extension aimed to enhance the overall capability of the models to provide a more comprehensive analysis of the

economy, considering various interrelated factors that influence macroeconomic outcomes.

Bergmann's reservations about the aforementioned perspective may stem from her focus on different issues. She kept underlining the limitations of large-scale macroeconometric models in carefully assessing the distributional effects of various policies, an area in which microsimulation excelled (Bennett and Bergmann 1986, 2).²³ She argued that the regressions used to estimate macroeconometric models equations tended to overlook "non-linearities and boundary conditions" (Bennett and Bergmann 1984, 92), which are precisely where potential distributional effects and the understanding of how different social groups would be impacted by a policy intervention reside.

The approach taken by Bergmann and Bennett (1977) in assessing the potential effects of the Humphrey-Hawkins bill provides a notable example of Bergmann's perspective: while perspicacious on distributional effects, was not in tune with growing concerns over inflation.²⁴ During the bill's negotiations, economists expressed concerns that implementing a binding numerical target for unemployment could lead to

²³ Bergmann made this point again in her later criticisms of macroeconomics, underlying the inability of macroeconomic equations to "capture distributional effects" (Bergmann 2005b, 61). She targeted explicitly the lack of analysis on the effects of tax cuts, which are generally concentrated on the wealthy. Her point echoes the criticisms raised in the 1960s against Kennedy's tax cuts and the macroeconomic Keynesian approach of Kennedy's Council of Economic Advisers (CEA) that left out the distributional effects (Goutsmedt 2022). Bergmann was a senior economist working at the CEA during Kennedy's administration.

²⁴ More generally, the impact of inflation was not central in the Transactions Model, by contrast with policy discussions at the time (Goutsmedt et al. 2019b). For instance, inflation was barely mentioned by Bergmann and Bennett (1986) and is discussed by Bergmann only in relation to women's labor supply (Vickery, Bergmann, and Swartz 1978).

inflationary pressures (Goutsmedt 2022). These concerns were rooted in the concept of the Phillips curve, which posited a negative relationship between unemployment and inflation rates. Lower levels of unemployment would result in increased wage demands by workers, in turn leading to higher prices. Economists thus relied on regression analyses of inflation and unemployment to evaluate the inflationary risks associated with the bill.

However, this approach overlooked the true intent of the legislation, which was to counter the exclusion of specific demographic groups, such as African Americans and other minorities, from the labor market by creating employment opportunities (Andelic 2019). The Transactions Model was particularly relevant to assess this aspect of the bill. Its advantage lay in its focus on aspects that large-scale macroeconomic models typically miss. Specifically, it facilitated an in-depth analysis of the mechanisms through which public jobs were created to employ the unemployed as unemployment rates escalated.

Bergmann's modeling approach and her views about policy intervention must be understood in the context of the debates that permeated the "liberal bloc" since the mid-1960s onwards. Even in the 1960s, Keynesian expertise faced criticism from left-wing politicians and intellectuals. Kennedy's tax cut advocated by the "New economics" of Harvard and MIT macroeconomists (Romani 2018) came under attack for neglecting the distributional consequences of the policy, which was perceived as favoring the wealthy (Goutsmedt 2022). The Department of Labor and its staff advocated for "more interventionist micro-level approaches" but received "little serious consideration" due to the "intellectual dominance of the macro-oriented Council of Economic Advisers" (Weir 1987, 393). This dynamic persisted into the 1970s when Carter's CEA undermined the Humphrey-Hawkins bill, which initially aimed to promote low

unemployment as a means to foster the integration of minorities (Andelic 2019). The opposition to the bill was indeed grounded in a macroeconomic relationship between inflation and unemployment (Goutsmedt 2022).

The debates surrounding these policy issues illustrate the ongoing tensions and disagreements within the liberal bloc over the appropriate approach to economic policy. In this context, Bergmann's perspective and emphasis on micro-level interventions and distributional consequences contrasted with the dominant macroeconomic focus of the time. More than just a methodological innovation or a new academic research area, Bergmann's Transactions Model testifies of a desire to produce interventionist knowledge that would transform the current state of economic policy and macroeconomic expertise, running against the rising tide of macroeconomics' new mainstream. The questions addressed by Bergmann, however, will later resurface in macroeconomics debates: first in the context of discussions from the turn of the 1980s on household heterogeneity in macroeconomic models (Cherrier, Duarte, and Saïdi 2023); second, in the context of the development of large-scale agent-based modelling in the late 1990s (Richiardi 2014).

Conclusion

A quick look at bibliometric data shows that the Transactions Model has gained little recognition in economics (Table 1). Already in the 1980s was the model received with skepticism. During the Stockholm conference on microsimulation models, Donald Nichols (1980) insisted on the scientific benefit of the approach, "since this model is a first", demonstrating "it was possible to construct such a thing". "Like the first automobile, the fact that it runs is of interest rather than the question of whether it's better than a horse for the purpose of transportation": From this point of view, it's a success, but Nichols "d[oesn't] think [the model] beats the horse" (41).

Three elements explain the fate of the Transactions Model: institutional grounding, technical change, and timing. Contrary to Klein, Bergmann could not count on fellow economists and institutional support (see Pinzon-Fuchs 2017 for a description of Klein's institution building) nor on a private company (on the example of the DRI, see Duarte and Sergi 2023). The same argument applies to a comparison with Orcutt's career and impact. After a first failed attempt in the 1960s (Cheng 2020), Orcutt later succeeded in raising money and build a strong institutional network to support his project, whose nature was fundamentally collective. Bergmann did not have a large team, she did not receive support from her institution. Bergmann spent a large amount of her time fighting a discrimination case against her own employer in a promotion dispute as well as testifying in employment discrimination cases in court (Small 2022; Chassonnery-Zaïgouche 2020). As a woman and a Jew, she always insisted she was not welcomed in the profession in the early day of her career and never felt "plug-in" the elite of the discipline, a sentiment reflected in her somewhat ambivalent position: recognized and celebrated for some of her works in feminist economics (see Strober 1998 and the whole issue in *Feminist economics*), ignored when talking about anything else, and in particular macroeconomics—she was both well-known and relatively isolated her entire career.

These institutional elements combined with technological changes. Bergmann was an early adopter of computers technology and a programmer herself. In 1983, the Wharton model was introduced to micro-computer (Renfro 2004, 67). The Transactions Model was made for mainframe and was not transferred to personal computers. Orcutt's hopes to build a microsimulation of the entire economy were also diverted by technological changes and later he shift towards smaller scale projects (Day 1990, 3). Lacking financial and organizational support, as well as genuine interest from other

researchers, the Transactions model never became a serious contender in the macroeconomics wars.

Another element is timing. In the 1980s, Bergmann was already well advanced in her career. She was stunned to the core by the contemporary developments in macroeconomics from a relatively newer generation. Bergmann's last paper using microsimulation was published in the *Journal of Economic Perspectives*. A broad presentation of her micro-to-macro perspective, the paper presents a simple program that could be run on any personal computer. Written with the more popular BASIC language, she envisions the model can be used for "theoretical exploration, empirical research, or classroom demonstrations" (Bergmann, 1990, 99). Her ambitions were dramatically scaled down, a reflection of a new rising mainstream in macroeconomics.

We would like to thank Chung-Tang Cheng, Francesco Sergi, Juan Acosta and Maxime Desmarais-Tremblay for helpful comments on various versions of this draft. We are grateful to the participants to the workshop in Zurich on the history of interventionist knowledge, especially Eric Hounshell and Verena Halsmayer.

Aaron, H. 1967. "The Foundations of the 'War on Poverty' Reexamined". *The American Economic Review* 57 (5): 1229–1240.

Acosta, J., and B. Cherrier. 2021. "The Transformation of Economic Analysis at the Board of Governors of the Federal Reserve during the 1960s". *Journal of the History of Economic Thought* 43 (3): 323–349.

Andelic, P. 2019. "'The Old Economic Rules No Longer Apply': The National Planning Idea and the Humphrey-Hawkins Full Employment Act, 1974–1978". *Journal of Policy History* 31 (1): 72–100. <https://doi.org/10.1017/S0898030618000349>.

Backhouse, R. E., and M. Boianovsky. 2012. *Transforming Modern Macroeconomics: Exploring Disequilibrium Microfoundations, 1956-2003*. Cambridge: Cambridge University Press.

Backhouse, R. E., and B. Cherrier. 2019. "The Ordinary Business of Macroeconometric Modeling: Working on the Fed-MIT-Penn Model, 1964– 74". *History of Political Economy* 51 (3): 425–447.

- Bennett, R. L., and B. R. Bergmann. 1980. "Policy Exploration with the Transactional Model of the United States". In *Microeconomic Simulation Models for Public Policy Analysis*, edited by R. H. Haveman and Kevin Hollenbeck. A 1978 Conference Sponsored by the Institute for Research on Poverty. Mathematica Policy Research, Inc. the National Science Foundation, Academic Press.
- Bennett, R. L., and B. R. Bergmann. 1984. "Macroeconomic Models on Microfoundations: Data Requirements". *Review of Public Data Use* 12 (2): 91–96.
- Bennett, R. L., and B. R. Bergmann. 1986. *A Microsimulated Transactions Model of the United States*. Baltimore: John Hopkins University Press.
- Bergmann, B. R. 1971. "The Effect on White Incomes of Discrimination in Employment". *Journal of Political Economy* 79 (2): 294–313.
<https://doi.org/10.1086/259744>.
- Bergmann, B. R. 1973. "Combining Microsimulation and Regression: A 'Prepared' Regression of Poverty Incidence on Unemployment and Growth". *Econometrica* 41 (5): 955. <https://doi.org/10.2307/1913816>.
- Bergmann, B. R. 1974a. "A Microsimulation of the Macroeconomy with Explicitly Represented Money Flows". *Annals of Economic and Social Measurement* 3 (3): 475–489.
- Bergmann, B. R. 1974b. "Occupational Segregation, Wages and Profits When Employers Discriminate by Race or Sex". *Eastern Economic Journal* 1 (2): 103–110.
- Bergmann, B. R. 1975. "Empirical Work on the Labor Market: Is There Any Alternative to Regression Running?" *Proceedings of the 27th Annual Meeting of the Industrial Relations Research Association*, 243–251.
- Bergmann, B. R. 1980. "Discrimination and Unemployment". In *Unemployment in Western Countries*, edited by E. Malinvaud and J.-P. Fitoussi, 420–442. Berlin: Springer.
- Bergmann, B. R. 1980. "A Short Description of a Microsimulated Macroeconomic Model: The Transactions Model of the U.S. Economy". In *Micro Simulation--Models, Methods, and Applications: Proceedings of a Symposium on Micro Simulation Methods, in Stockholm, September 19-22, 1977*, edited by B. R. Bergmann, G. Eliasson, and G. H. Orcutt, 23–54. Stockholm: Industrial Institute for Economic and Social Research.

- Bergmann, B. R. (1987). "Measurement" or Finding Things Out in Economics. *The Journal of Economic Education* 18 (2): 191-201.
- Bergmann, B. R. 1988. "An experiment on the formation of expectations". *Journal of Economic Behavior & Organization* 9 (2): 137-151.
[https://doi.org/10.1016/0167-2681\(88\)90070-4](https://doi.org/10.1016/0167-2681(88)90070-4)
- Bergmann, B. R. 1989. "Does the Market for Women's Labor Need Fixing?" *Journal of Economic Perspectives* 3 (1): 43-60. <https://doi.org/10.1257/jep.3.1.43>
- Bergmann, B. R. 1990. "Micro-to-macro simulation: a primer with a labor market example". *Journal of Economic Perspectives* 4 (1): 99-116.
- Bergmann, B. R. 2005a. "Pushing for a More Humane Society". *Interview for the CSWEP - CSWEP News*.
- Bergmann, B. R. 2005b. "The Current State of Economics: Needs Lots of Work". *The ANNALS of the American Academy of Political and Social Science* 600 (1): 52–67. <https://doi.org/10.1177/0002716205276731>.
- Bergmann, B. R., and R. L. Bennett. 1977. "Macroeconomic Effects of a Humphrey-Hawkins Type Program". *The American Economic Review* 67 (1).
<http://www.jstor.org/stable/1815914>.
- Bergmann, B. R., G. Eliasson, and G. H. Orcutt, eds. 1980. *Micro Simulation--Models, Methods, and Applications: Proceedings of a Symposium on Micro Simulation Methods, in Stockholm, September 19-22, 1977*. Stockholm: Industrial Institute for Economic and Social Research.
- Bergmann, B. R., and W. R. Krause. 1972. "Evaluating and Forecasting Progress in Racial Integration of Employment". *ILR Review* 25 (3): 399-409.
- Berman, E. P. 2022. *Thinking like an Economist - How Efficiency Replaced Equality in U.S. Public Policy*. Princeton: Princeton University Press.
<https://press.princeton.edu/books/hardcover/9780691167381/thinking-like-an-economist>.
- Bodkin, R. G., W. R. Klein, and K. Marwah. 1991. *A History of Macroeconometric Model-Building*. Cheltenham: Edward Elgar.
- Boumans, M. 2020. "The engineering tools that shaped the rational expectations revolution". *History of Political Economy* 52 (S1): 143-167.
- Chassonnery-Zaïgouche, C. 2020. "How Economists Entered the 'Numbers Game'. Measuring Discrimination in the U.S. Courtrooms, 1971-1989". *Journal of the History of Economic Thought* 42 (2): 229–259.

- Chassonnery-Zaïgouche, C., and L. Larrouy. 2017. “‘From Warfare to Welfare’: Contextualising Arrow and Schelling’s Models of Racial Inequalities (1968–1972)”. *The European Journal of the History of Economic Thought* 24 (6): 1355–1387.
- Cheng, C. 2020. “Guy H. Orcutt’s Engineering Microsimulation to Reengineer Society”. In *Economics and Engineering: Institutions, Practices, and Cultures*, edited by Y. Giraud and P. G. Duarte. Durham: Duke University Press.
- Cherrier, B. 2011. “The lucky consistency of Milton Friedman’s science and politics, 1933–1963”. In *Building Chicago Economics: New Perspectives on the History of America’s Most Powerful Economics Program*, edited by R. Van Horn, Philip Mirowski, and Thomas A. Stapleford, 335-367. Cambridge: Cambridge University Press.
- Cherrier, B. 2009. “Gunnar Myrdal and the Scientific Way to Social Democracy, 1914–1968”. *Journal of the History of Economic Thought* 31 (1): 33-55.
- Cherrier, B. 2023. “The Price of Virtue: Some Hypotheses on How Tractability Has Shaped Economic Models”. *Æconomia – History, Methodology, Philosophy* 13 (1): 23-48.
- Cherrier, B, P. G. Duarte, and A. Saïdi. 2023. “Household heterogeneity in macroeconomic models: A historical perspective”. *European Economic Review* 158: 104497.
- Commons, J. R. 1931. Institutional Economics. *The American Economic Review* 21 (4): 648-657.
- Day, R. 1990. “Editorial”. *Journal of Economic Behavior and Organization* 14 (1): 1–3.
- De Vroey, M. 2016. *A History of Macroeconomics from Keynes to Lucas and Beyond*. Cambridge: Cambridge University Press.
- Duarte, P. G., and G. T. Lima. 2012. “Introduction: Privileging Micro over Macro? A History of Conflicting Positions”. In *Microfoundations Reconsidered. The Relationship of Micro and Macroeconomics in Historical Perspective*, edited by P. G. Duarte and G. T. Lima, 1–18. Cheltenham: Edward Elgar Publishing.
- Duarte, P. G., and Y. Giraud. 2020. “Introduction: From ‘Economics as Engineering’ to ‘Economics and Engineering’”. *History of Political Economy* 52 (S1): 10-27.
- Duarte, P. G., and F. Sergi. 2023. “Computer Operators and Software Engineers at Data Resources Inc.: An Oral History (1969-1983)”. *Æconomia. History, Methodology, Philosophy* 13 (3): 723-768.

- Fontana, M. 2006a. "Simulation in Economics: Evidence on Diffusion and Communication". *Journal of Artificial Societies and Social Simulation* 9 (2): 8.
- Fontana, M. 2006b. "Computer Simulations, Mathematics and Economics". *International Review of Economics* 53 (1): 96–123.
<https://doi.org/10.1007/BF03029851>.
- Friedman, M. 1953. "The Methodology of Positive Economics". In *Essays in Positive Economics*, edited by M. Friedman. Chicago: Chicago University Press.
- Forget, E. L., 2011. "A Tale of Two Communities: Fighting Poverty in the Great Society (1964–68)". *History of Political Economy* 43 (1): 199–223.
- Gallaway, L. E. 1965. "The Foundations of the 'War on Poverty'". *The American Economic Review* 55 (1/2): 122–31.
- Goutsmedt, A. 2017. "Stagflation and the Crossroad in Macroeconomics: The Struggle between Structural and New Classical Macroeconometrics". *Documents de Travail Du Centre d'Economie de La Sorbonne* 2017.43.
- Goutsmedt, A. 2022. "How the Phillips Curve Shaped Full Employment Policy in the 1970s: The Debates on the Humphrey-Hawkins Act". *History of Political Economy* 54 (2): 619–653.
- Goutsmedt, A., D. Guizzo, and F. Sergi. 2019. "An Agenda without a Plan. Robert E. Lucas's Trajectory through the Public Debate". *OEconomia – History, Methodology, Philosophy* 9 (2): 289–314.
- Goutsmedt, A., E. Pinzón-Fuchs, M. Renault, and F. Sergi. 2019b. "Reacting to the Lucas Critique: The Keynesians' Pragmatic Replies". *History of Political Economy* 51 (3): 533–56.
- Gwyn, W. B. 1976. "Obstacles within the Office of Economic Opportunity to the Evaluation of Experimental Ombudsmen". *Public Administration* 54 (2): 177–97.
- Hall, R. L, and C. J. Hitch. 1939. "Price Theory and Business Behaviour". *Oxford Economic Papers*, no. 2: 12–45.
- Hausman, D. M., and P. Mongin. 1997. "Economists' Responses to Anomalies: Full-Cost Pricing versus Preference Reversals". *History of Political Economy* 29 (4): 255–72.
- Haveman, R. H., and K. Hollenbeck, eds. 1980. *Microeconomic Simulation Models for Public Policy Analysis*. Cambridge (MA): Academic Press.

- Hicks, J. R. 1937. "Mr. Keynes and the 'classics'; a suggested interpretation". *Econometrica* 5 (2): 147-159.
- Hoover, K. D. 1988. *The New Classical Macroeconomics*. Oxford: Blackwell Publishers.
- Hoover, K. D. 2012. "Microfoundational Programs". In *Microfoundations Reconsidered*, edited by P. G. Duarte and G. T. Lima, 19–61. Cheltenham, UK; Northampton, MA, USA: Edward Elgar.
- Ingram, G. K., J. F. Kain, and J. R. Ginn. 1972. "The NBER Urban Simulation Model". In *The Detroit Prototype of the NBER Urban Simulation Model*, edited by G. K. Ingram, J. F. Kain, and J. R. Ginn, 1-8. Cambridge (MA): NBER.
- Jardini, D. R. 1996. "Out of the Blue Yonder: The RAND Corporation's Diversification into Social Welfare Research, 1946-1968". Ph.D. Dissertation, Carnegie Mellon University.
- Klein, L. R. 1978. "The Supply Side". *The American Economic Review* 68 (1): 1–7.
- Klein, L. R., and A. S. Goldberger. 1955. *An Econometric Model of the United States, 1929-1952*. Amsterdam: North Holland Publishing.
- Kraemer, K. L., S. Dickhoven, S. F. Tierney, and J. L. King. 1987. *Datawars: The politics of modeling in federal policymaking*. New York: Columbia University Press.
- Lester, R. A. 1946. "Shortcomings of marginal analysis for wage-employment problems". *The American Economic Review* 36 (1): 63-82.
- Light, J. S., 2005. *From warfare to welfare. Defense intellectuals and urban problems in Cold War America*. Baltimore: Johns Hopkins University Press.
- Lucas, R. E. 1976. "Econometric Policy Evaluation: A Critique". *Carnegie-Rochester Conference Series on Public Policy* 1: 19–46. [https://doi.org/10.1016/S0167-2231\(76\)80003-6](https://doi.org/10.1016/S0167-2231(76)80003-6).
- Lucas, R. E. 1987. *Models of Business Cycles*. Oxford: Basil Blackwell Oxford.
- Lucas, R. E, and L. A. Rapping. 1969. "Price Expectations and the Phillips Curve". *The American Economic Review* 59 (3): 342–350.
- Lucas, R. E., and T. J. Sargent. 1978. "After Keynesian Macroeconomics". In *After the Phillips Curve: The Persistence of High Inflation and High Unemployment*, 49–83. Boston: Federal Reserve Bank of Boston.
- Martini, A., and U. Trivellato. 1997. "The Role of Survey Data in Microsimulation Models for Social Policy Analysis". *Labour* 11 (1): 83–112.

- Mooney, J. D., and E. Metcalf. 1965. "Aggregate Demand Model". *Unpublished Paper from the OEO*.
- Morgan, M. S. 2004. "Simulation : The Birth of a Technology to Create « evidence » in Economics / La Simulation : Naissance d'une Technologie de La Création Des « indices » En Économie". *Revue d'histoire Des Sciences* 57 (2): 339–375. <https://doi.org/10.3406/rhs.2004.2216>.
- Morgan, M. S. 2012. *The World in the Model: How Economists Work and Think*. Cambridge: Cambridge University Press.
- Myrdal, G. 1944. *An American Dilemma: The Negro Problem and Modern Democracy*. New York: Harper, 1964.
- Myrdal, G. 1953. *The Political Element in the Development of Economic Theory*. Abingdon: Routledge, 1998.
- Nichols, D. 1980. "Is There an Efficient Level of Unemployment? Simulation Experiments on a Labor Market Model". In *Micro Simulation-Models, Methods and Applications*, edited by B. R. Bergmann, G. Eliasson, and G. H. Orcutt, 349–64. Stockholm: Industrial Institute for Economic and Social Research.
- O'Connor, A. 2001. *Poverty Knowledge: Social Science, Social Policy, and the Poor in Twentieth-Century U.S. History*. Princeton: Princeton University Press.
- O'Connor, A. 2020. "Poverty". In *Society on the edge: Social science and public policy in the postwar United States*, edited by P. Fontaine and J. D. Pooley, 137-172. Cambridge: Cambridge University Press.
- Olson, P. I. 2007. "On the Contributions of Barbara Bergmann to Economics". *Review of Political Economy* 19 (4): 475–496. <https://doi.org/10.1080/09538250701622303>.
- Patterson, J. T., 2000. *America's struggle against poverty in the twentieth century*. Cambridge, MA: Harvard University Press.
- Paulin, E. A. (1998). "The seditious dissent of Barbara R. Bergmann. In Richard Holt and Steven Pressman". In *Economics and its Discontents*, edited by R. P. Holt and S. Pressman, 1-20. Cheltenham: Edward Elgar Publishing.
- Pedriana, N., and R. Stryker. 2004. "The Strength of a Weak Agency: Enforcement of Title VII of the 1964 Civil Rights Act and the Expansion of State Capacity, 1965–1971". *American Journal of Sociology* 110 (3): 709–760.

- Pinzon-Fuchs, E. 2017. "Economics as a 'Tooled' Discipline: Lawrence R. Klein and the Dissemination of Macroeconometrics, 1930-1955". Thesis dissertation Université Paris 1 Panthéon-Sorbonne, Paris.
- Pinzon-Fuchs, E.. 2019. "Lawrence R. Klein and the making of Large-Scale Macroeconometric Modelling, 1938-55". *History of Political Economy* 51 (3): 401-423.
- Rancan, A. 2019. "Empirical Macroeconomics in a Policy Context: The Fed-MIT-Penn Model versus the St. Louis Model, 1965–75". *History of Political Economy* 51 (3): 449-470.
- Rees, A. 1976. "H. Gregg Lewis and the development of analytical labor economics". *Journal of Political Economy* 84 (4): S3-S8.
- Renfro, C. G. 2004. *Computational Econometrics: Its Impact on the Development of Quantitative Economics*. Amsterdam: IOS Press.
- Richiardi, M. 2014. The Missing Link: AB Models and Dynamic Microsimulation. In *Artificial Economics and Self Organization*, edited by S. Leitner and F. Wall. Berlin: Springer.
- Rivlin, A. M. 1974. "How can experiments be more useful?". *The American Economic Review* 64 (2): 346-354.
- Romani, R. 2018. "On Science and Reform: The Parable of the New Economics, 1960s–1970s". *The European Journal of the History of Economic Thought* 25 (2): 295–326.
- Samuels, W. J. 1977. "Ideology in Economics". In *Modern Economic Thought*, edited by S. Weintraub, 467-484. Philadelphia: University of Pennsylvania Press.
- Small, S. F. 2022. "Tracing Barbara Bergmann's Occupational Crowding Hypothesis: A Recent History". *History of Political Economy* 54(1): 193-220.
- Snowdon, B., and H. R. Vane. 2005. *Modern Macroeconomics: Its Origins, Development and Current State*. Cheltenham: Edward Elgar.
- Stafford, F. 1986. "Forestalling the demise of empirical economics: The role of microdata in labor economics research". In *Handbook of Labor Economics*, edited by O. C. Ashenfelter and R. Layard, 387-423. Amsterdam: Elsevier.
- Strober, M. 1998. "Introduction: This One's For You, Barbara". *Feminist Economics* 4 (3), 1.

- Vickery, C., B. R Bergmann, and K. Swartz. 1978. "Unemployment Rate Targets and Anti-Inflation Policy as More Women Enter the Workforce". *The American Economic Review* 68 (2), 90-94.
- Weir, M. 1987. "Full Employment as a Political Issue in the United States". *Social Research* 54 (2): 377-402.

Reference	Citations
Bergmann, B. R. (1971). The effect on white incomes of discrimination in employment, <i>Journal of Political Economy</i>	137
Bergmann, (1986), The Economic Emergence of Women	136
Bergmann, B. R. (1974). Occupational segregation, wages and profits when employers discriminate by race or sex. <i>Eastern economic journal</i>	74
Bergmann B. R. et al. (1980), Micro Simulation--Models, Methods, and Applications: Proceedings of a Symposium on Micro Simulation Methods, in Stockholm	4
Bennett and Bergmann, (1986), A Microsimulated Transactions Model of the United States	3

Table 1: Citations of some contributions of Bergmann (1969-1995; Web of Science data)