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Backhouse, Roger; Maas, Harro

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Marginalizing Maclaurin: The attempt to develop an economics of technological progress at MIT, 1940-1950

Roger E. Backhouse and Harro Maas

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1. Introduction

Writing in 1949 to the Cambridge economist, Joan Robinson, whom he had met on his trip to Europe the previous year, Paul A. Samuelson summed up his colleague, W. Rupert Maclaurin:

> He is an able chap with interests largely in the field of applied economics, particularly technological innovation. He is also what we in America would call a "go-getter." A type that you have perhaps not sufficiently encountered.[1]

[1] Samuelson to Joan Robinson, May 23, 1949, PASP Box 63 (Robinson, Joan).

Since his arrival at the Massachusetts Institute of Technology (MIT) in October 1940, Samuelson had been closely involved with Maclaurin. In 1940, MIT's economists were members of the Department of Economics and Social Science, the function of which was to provide the economics and business-related courses that all students were required to take as part of their science and engineering education. The department did not have its own graduate program and its economists were few in number and were less significant figures than those at nearby Harvard.

Though not Department Chair (that position was filled by Ralph Freeman, with whom Maclaurin worked closely), Maclaurin was initially the driving force behind the transformation of the department, which grew in size and expanded the range of its activities.

In the early 1940s Maclaurin initiated a research project on the economics of technological change as the main instrument for this transformation. Strongly supported by MIT president Karl T. Compton, the intention was to develop MIT economics in parallel with the graduate program that they were about to establish, the topic being chosen so as to draw on the expertise of MIT's scientists and engineers by analyzing problems that would interest engineers and engineering students. Though undertaken within the economics department, it was to be a cross-disciplinary project creating a type of economics that Maclaurin and Compton believed MIT to be uniquely placed to develop. To support this program, Maclaurin turned to the Rockefeller Foundation, which funded it from 1941 to 1945.

The cross-disciplinary project Maclaurin envisaged never succeeded in its ambitions. Though Maclaurin was the dynamic figure amongst the economists in 1940, the rise of MIT economics in the post-war period would not be attributed to him, but to his younger colleague Samuelson who was also a Harvard graduate, but a mathematical economist with an altogether different background and vision on how the economic discipline should develop.

Writing about the history of economics and management at MIT many years later, former MIT President James Killian wrote,

> The growth to greatness of the Economics Department, and in fact the impressive development of the entire field of the social sciences at M.I.T., can be attributed to the fame of Paul Samuelson and other scholars in the Department such as Robert L. Bishop, Richard M, Bissell, E. Cary Brown, Charles P. Kindleberger, Charles A. Myers, Evsey Domar, Max Millikan, Walt Rostow, and Robert M. Solow, who found satisfaction in being members of a team which included Samuelson. (Killian 1985, p. 201

Though Killian recognized him as having been the key figure in the early 1940s, Maclaurin was absent from this list. On August 17, 1959, Maclaurin jumped off the Sheraton Plaza Hotel in Boston, the *New York Times* describing this as suicide following mental strain, attributed to the illness and death of his younger brother, a verdict accepted by Samuelson and many of his colleagues.[2]

Recent literature on the history of economics at MIT has placed the rise of MIT's economics in the context of the earlier transformation of its science and engineering departments, its openness to Jews, the development of its PhD program, and the emergence of a more technical way of doing economics (see Weintraub 2014, especially Cherrier 2014). This literature has noted the central role Compton envisaged for the social sciences, in particular economics, within the MIT's science and engineering curriculum but it has not addressed the different pathways that were available within the economics department in the

[2] His widow believed it to have been an accident. Samuelson to Donald Dewey, September 15, 1994, PASP 25 (Dewey); Godin 2008; *New York Times*, August 18, 1959.

early 1940s. Our paper complements this literature by analyzing the interdisciplinary research project that Maclaurin developed during the war years , but which failed to make the progress that the Rockefeller Foundation expected of it and which was increasingly overshadowed by Samuelson's technical way of doing economics. Maclaurin's program therefore shows a path that was not taken in what has been considered the transition from interwar pluralism to post-war neoclassicism in American economics (Morgan and Rutherford 1998).

2. Economics and Social Science

MIT first established an independent Department of Economics and Statistics in 1930, when Business and Engineering Administration became a separate department. In the following year, Ralph Freeman, then at Western Ontario, was appointed as an associate professor and in 1933, he replaced Davis R. Dewey as its Head. The following year it was renamed the Department of Economics and Social Science so as to reflect a broadening of its activities, and the appointment of a sociologist to its staff.[3]

The raison d'être of the department was providing service teaching to other departments; it did not have a pronounced research profile of its own. Its main activity was teaching the elementary course in economics taken by almost all MIT undergraduates, to which most members of the department contributed, and it taught courses in subjects such as American government, city planning, social investigation, housing legislation and

[3] This account is based on various editions of the annual MIT Report to the President, and Course Catalogs. It differs slightly from the account given in Killian (1984).

transportation. Much effort went into improving teaching in labor relations, sociology and psychology.[4]

In 1936, Maclaurin, who had a PhD from the Harvard Business School with a thesis on economic planning in Australia, was appointed as an assistant professor. At Harvard, he had been one of Schumpeter's favorite students. Maclaurin had close family connections with MIT, his father having been the President responsible for moving Boston Tech across the Charles River to become MIT. Rupert's father, Richard Cockburn Maclaurin,[5] died in 1920 at the age of fifty, leaving his son in the intellectual care of people such as Compton, a physicist who became President of MIT in 1930, and E.B. Wilson, a mathematician who shared responsibility of running MIT until a new President could be appointed, before moving to Harvard where he was to become a mentor to Samuelson. In 1937, responding to the suggestions from two businessmen, Compton took the initiative in setting up an Industrial Relations Section, modeled on the ones established at Princeton and University of Pennsylvania's Wharton School of Business, that concentrated on labor relations. Assisted by Freeman and Maclaurin, he raised $125,000 to support the new unit over its first five years. Maclaurin was appointed its Head in which function he initiated similar research.[6]

The section was pluralistic in its choice of research methods and aimed to meet the needs of business. It studied the status of older workers (with the US Department of Labor), and the hiring and layoff policies in conjunction with a leading Massachusetts industrial company, and it responded to seventy requests from industry for information.[7] It undertook a study of wages and employment in a New England manufacturing community, an intensive

[4] MIT Report of President 1939: 137.
[5] Maclaurin's family lineage goes back to Colin Maclaurin, the eighteenth century Scottish mathematician who provided ingenious geometric interpretations of Newton's *Principia*.
[6] MIT Report of President 1937: 17-18.
[7] MIT Report of President 1938: 18.

study of industrial relations in a specific firm, and was investigating the connection between movements of wages and technical change in selected industries.[8] It engaged in a case study on management structures in a small Cambridge manufacturing plant; it sought to establish the characteristics of the demand and supply of labor from the records of 15,000 workers across 35 firms; it surveyed the North American paper industry and made a detailed analysis of the way in which some companies used job analysis.[9] Thus, the section chose a mix of methods considered best fit to understand the complexity of concrete problems at hand.

This was the approach to research Maclaurin had learned at the Harvard Business School and that Schumpeter, despite his awe for mathematical economics, had recommended to Maclaurin. It was not so different from the approach to research of American institutionalists (Rouvray, 2005; Rutherford 2011). In 1942, Maclaurin's status changed to Professor of Economics.

The approach to research by the Industrial Relations Section was not the only one available within the department. Another major activity was industrial statistics, in which there was collaboration with the Mathematics Department, for which Harold Freeman (no relation of Ralph Freeman) was appointed in 1939. Freeman had been an undergraduate at MIT who had gone to Harvard for postgraduate study, where he had written a thesis on "The projective differential geometry of plane and space curves". Freeman undertook quality-control consulting work with industrial concerns and published on statistical methods relating to the subject.[10] Though his consulting work equally served the concrete demands of business, his approach to research aimed at finding simple mathematical expressions for patterns in

[8] MIT Report of President 1939: 138.
[9] MIT Report of President 1940: 135.
[10] Maclaurin, December 4, 1940, Synopsis of training and experience of staff members, RFP-MIT (1939-41).

statistical data and was therefore very different from Maclaurin's. The mathematical side of the department was substantially strengthened after Maclaurin helped Freeman to recruit Samuelson, who under E.B. Wilson's tutorship, had developed similar mathematical interests (Backhouse 2015). Samuelson's recruitment shows Maclaurin's openness to different modes of research and MIT's openness to Jews at a time when anti-Semitism was still widespread at Harvard (see Weintraub 2014b and Backhouse 2014).

Thus, around 1940 there were two different approaches to the analysis of economic phenomena within the economics department: The approach of the Industrial Relations Section that combined a variety of research methods considered appropriate to the complex concrete questions at hand, and the mathematical-statistical approach associated with Freeman and Samuelson, that favored generality in its method and questions. Though different, both methods coexisted as part of Maclaurin's multi-method approach to research. Compton's strong support for Maclaurin was motivated by his belief that the economics department should be sensitizing engineers to the institutional prerequisites for technological innovations that could be fruitfully commercially exploited. One needed institutionally savvy engineers to see how new techniques could lead to economically successful applications.

3. Planning a new future for economics at MIT

On April 8, 1939, Maclaurin approached Joseph Willits, at the Rockefeller Foundation, asking for research support.[11] Willits had previously (in 1921) established the Industrial Relations section at the Wharton School of Business together with Anne Bezanson, who

[11] Maclaurin to Willits, April 8, 1939, RFP-MIT (1939-41).

became the first tenured woman at University of Pennsylvania. Both of them took the view that research should be grounded in the collection of facts relevant for the concrete question at hand, instead of starting from abstract theoretical notions (Rouvray 2005). They were therefore favorably disposed to the research of Maclaurin's section, though they did not share his belief that it should be strongly linked to teaching. Explaining that MIT believed that its graduate program in economics would be stronger with an organized research program, for which reports on topics of current interest and contacts with business were no substitute, Maclaurin proposed a three-year study of the labor market in a Massachusetts industrial community. Research would be conducted by a cross-disciplinary team comprising himself and four colleagues: Douglass V. Brown (a labor economist), C. M. Arensburg (a social anthropologist), Douglas McGregor (a social psychologist) and Dwight L. Palmer (with a PhD covering economics and sociology). Maclaurin proposed to study the labor market in Fitchburg, a town with a mixed population not dominated by any large firms, not too far from Boston, for which they had already done preparatory work. The proposal was strongly supported by Compton, who claimed that this research would bring MIT students into "intimate contact with the problems and personnel of the field."[12]

Willits was not convinced.[13] Neither did Maclaurin's subsequent pleas persuade him, for Willits wanted to see some evidence of success before any grant could be given.[14] The following year Maclaurin continued his efforts but on a much reduced scale. In October 1940, he applied for $3,500 to support research on the location of industry in New England. This was declined on the grounds that the Foundation did not like supporting "small, scattered

[12] Compton to Willits, April 8, 1939, RFP-MIT (1939-41).
[13] Willits to Maclaurin, May 1, 1939, RFP-MIT (1939-41).
[14] Willits to Maclaurin, Nov 28, 1939. Maclaurin to Willits, May 4, 1939, November 24, 1939, December 4, 1939; Willits to Maclaurin, December 7, 1939, RFP-MIT (1939-41).

research projects."[15] Maclaurin then approached the Foundation about putting in a broader project that would be more suited to "appeal to the imagination and fitness of technical students."[16] After obtaining a favorable response to the idea that he might investigate "the processes by which technical improvements spread through industry, or a study of the types of companies in different industries which are the initiators of technical change, whether the same types of companies initiated such changes,"[17] Maclaurin proposed a program directed at studying innovation and technical change that would support a PhD program in industrial economics. Though he was asking for research support, not funds to support students, it was headed, "Memorandum on proposal for advanced study in industrial economics at MIT."[18] His justification for the program mirrored, very precisely, Compton's views about the type of training that the world of business required.

> The increasing number of courses in industrial economics that are being offered in universities and engineering schools throughout the country has intensified the demand for teachers who understand industrial procedures and practices. There is also an increasing demand for adequately trained men in the various administrative agencies of the government that are concerned with industrial regulation. Other graduates of this program might get positions in trade associations, or as assistant to

[15] Maclaurin to Bezanson, December 6, 1940, RFP-MIT (1939-41).
[16] Willits and Bezanson, November 27, 1940, Memorandum on interview with W. Rupert Maclaurin, RFP-MIT (1939-41).
[17] ibid.
[18] 1940, Memorandum on proposal for advanced study in industrial economics at MIT, RFP-MIT (1942-43).

> the economist in some of the large industrial concerns that have an economic specialist.[19]

He supported this proposal by pointing to the rising interest that many engineers were showing in economics. Problems of mutual interest to economists and engineers could "best be developed if a special research fund were made available for graduate students and staff research devoted to the economics of industrial technology."[20]

This proposal was the first expression of Maclaurin's interest in technology, but it emphasized the need for education, not the need for research on innovation in its own right, even though this was the driving motive behind the proposal. It is easy to see a Schumpeterian influence on his overall topic, "The impact, timing and effect of technological change upon the American economy."[21] Given this, it is remarkable that the emphasis on technological change seemed to come, not from any specific hypothesis of his own, but from the input of his new colleagues, Douglass V. Brown, Freeman and Samuelson. The proposal listed 13 loosely related topics of study.[22] This was a research program within which specific projects should be developed, Maclaurin explained, "after the ground had been thoroughly explored by means of graduate seminars carried on in co-operation with some of the technical

[19] Memorandum on proposal for advanced study in industrial economics at MIT, RFP-MIT (1942-43): 1.
[20] ibid.: 2.
[21] Godin 2008 has explored the Maclaurin-Schumpeter connection in some detail.
[22] Memorandum on proposal for advanced study in industrial economics at MIT, RFP-MIT (1942-43); 3-7. The topics listed were: 1. Patents and technological change; 2. Industrial research and technological change; 3. How technological change was initiated; 4. Innovations and the business cycle; 5. Innovations and long term trends; 6. Optimal money and wage policy in a world of change; 7. The initiation of change in individual firms; 8. The control of technological change; 9. Effects of technological change on the worker; 10. Technological change and the location of industry; 11. Technological innovation and the labor market; 12. Technology, war and the defense program; 13. Technological change and the cost accountant

specialists from the engineering departments.[23] Pointing to the already existing collaboration of economists (such as Freeman and Samuelson) with the mathematics department, Maclaurin emphasized it was to be a cross-disciplinary research venture involving economics and engineering.

He was interviewed on November 27, 1940 by Willits and Bezanson.[24] Maclaurin drew attention to the work that had already been undertaken and pointed to the new appointments. He described Samuelson as a student of Schumpeter who had done graduate work in the Harvard School of Business Administration, implicitly attributing to him a training much more like his own than was the case.[25] He used Samuelson and Freeman's mathematical and statistical work, which he did not perceive as alien but as complementary to his own approach, to support the credibility of his own ideas. When the Foundation refused its support on the grounds that they could not support teaching, Maclaurin promised that he would outline "an actively integrated research program."[26]

He sent Willits a new research proposal on April 3, 1941, asking for $50,000, "to initiate a series of studies under the general topic of 'The Impact, Timing and Effect of Technological Change upon the American Economy'", stating:

> We believe that this is an area in which an Economics Department with a young and growing Division of Industrial Relations located in an engineering school should be in a position to make a significant contribution. It would be our hope that over a period

[23] ibid.: 3.
[24] ibid.
[25] Samuelson, like all other graduate students, had taken courses with Schumpeter, but he had never been registered in the School of Business Administration. Maclaurin must have been thinking of his work with Alvin Hansen in the Graduate School of Public Administration.
[26] Maclaurin to Bezanson, December 6, 1940, RFP-MIT (1939-41).

> of years the specialists whom we might develop would help to interpret the processes of technological change and their economic and social implications to economists, government officials, labor leaders, and industrialists.[27]

It was an academic research project with practical implications but did not involve businessmen directly and it mentioned no links to the doctoral program.[28] It outlined a narrower list of topics.

The program combined detailed case studies with generic statistical investigations. "Factors in the individual firm influencing technological change involving substantial capital investment" could be tackled by considering the paper industry, of which they already had experience, but given the war, it might be appropriate to consider a defense-related industry, in which case it would be possible to compare technological change under wartime and peacetime conditions. This was presumably the topic Maclaurin intended to investigate himself. "Overall statistical studies of innovation" asked about the evidence for clustering of innovations and variation in the extent of innovation in different phases of the cycle. It also involved considering the character of new investment—how much was due to new industries and innovation, how much to growth in population and land, how much to more intensive use of capital in old industries and did such a bias towards capital saving innovations increase the likelihood of secular stagnation? Though this material appears under Maclaurin's name, it is hard to avoid thinking that these questions, which echoed Alvin Hansen's thinking, must have been ones in which Samuelson, who was at the time very close to Hansen and who was involved in much statistical work, was interested. "Case studies of union-management (or

[27] Maclaurin to Willits, April 3, 1941, RFP-MIT (1939-41).
[28] On the former point, see Memorandum on Letter from W. Rupert Maclaurin, March 21, 1941, RFP-MIT (1939-41).

employee-management) relations and regulations concerning the introduction of technological change", presumably put in by Charles A. Myers, a labor specialist who had arrived at MIT in 1939 after completing a PhD at Chicago, followed on directly from the Section's previous work, involving close examination of individual firms. There were firms where unions had tried to resist innovations and this research would examine the way such resistance happened and the consequence of such resistance for the extent and timing of technological change. Willits and Besanzon were most interested in the first and third studies, which promised to shed light on the process of the diffusion of and resistance against innovation on the level of individual industries or plants, sharing the suspicion felt by institutionalists such as Harold Innis concerning mathematical approaches that had begun to "blight the subject", and that they equated with abstract, speculative economics.[29]

Maclaurin wrote that he would be in charge, concentrating on "company practices concerning technological change" whilst Samuelson "would work on overall statistical studies of innovation," and "case studies of union-management relations concerning the introduction of technical change" would be undertaken by Myers.[30] He promised that he would make the project his "principal assignment over the period of the grant".[31]

Robert G. Caldwell, Dean of Humanities (in which Economics was located) supported the application, explaining that Maclaurin was at last completing the "formative period" for the Industrial Relations Section and was now in a position to devote more consecutive time to

[29] Handwritten note by Bezanson to Willits, October 14, 1943, Rockefeller Foundation RFP-MIT (1942-43). The quote from Innis is from a letter of 1941 to Willits of December 19th 1940 in which he encourages him to "balance" the social sciences against the rise of mathematics in economics. Quoted from Rouvray 2005, 95.
[30] Maclaurin WR, April 1, 1941, Technological change studies: projected annual expenses, RFP-MIT (1939-41).
[31] Maclaurin WR, April 3, 1941, Letter to Joseph H. Willits, RFP-MIT (1939-41).

research. Maclaurin "would welcome the opportunity of being able to develop and stick with a continuing research program in the general area that he has outlined to you."[32] The project could make use of the contacts people at MIT had with industry and the problem being tackled was one that would be very important after the war. Compton confirmed MIT's strong commitment to the project and its interest to many members of the MIT staff.[33]

After consulting Harvard's Sumner Slichter, who thought it a promising project, the Rockefeller Foundation awarded $30,000 over three years, starting July 1, with a possible extension.[34] The Foundation echoed the hope that the program would "aid in interpreting the processes of technological change and their economic and social implications to economists, government officials, labor leaders and industrialists".[35]

4. Technological progress in the American Economy

The technological change project was important for MIT's economists as their only source of research funding.[36] It was also important to Compton, who had been expressing great interest in the relation between science and industrial innovation.[37] Arguing for financial support for universities, he had stressed that even the most "hard-headed, 'practical' businessman" had to admit that "pure research–-of no preconceived practical use whatsoever" had led to "a growing business in manufacture" and that "basic discoveries" in many instances had led to

[32] Caldwell RG, April 1, 1941, Letter to Joseph H. Willits, RFP-MIT (1939-41).
[33] Compton to Willits, April 1, 1941, RFP-MIT (1939-41). He was constrained in what he could say by having become a Trustee of the Rockefeller Foundation.
[34] Memorandum to Willits, May 5, 1941, Rockefeller Foundation, Resolution RF41042 - Research grant to MIT, May 16, 1941, RFP-MIT (1939-41).
[35] ibid.
[36] Funds from Roger Babson had by then been exhausted.
[37] See Backhouse and Maas 2015.

"enormous returns to the public."[38] Maclaurin's project could be seen as filling a gap in his argument through showing in detail how scientific ideas were transmitted from the work of "inventive geniuses" to practical applications, something Compton had never specified. However, though Compton must have hoped that the project would tackle this problem, the proposed research appeared to skirt around it.

Progress on the research proved slow. Samuelson was plucked away to work as a non-residential consultant for the National Resources Planning Board to work on the more pressing problem of what would happen to employment after the war and took on an increased teaching load.[39] Myers was also called to Washington to work at the War Production Board and the War Labor Board. Even Maclaurin himself had little progress to show. In December he organized a session on "The economics of industrial research" at the AEA, to which he invited Willits,[40] but this was a somewhat open-ended brainstorming session, giving no indication of any progress or even how progress would be achieved.[41] The main use of the grant money in the first year was to employ Daniel Vandermeulen, an Instructor at MIT, as a research assistant, with three other research assistants being employed for shorter periods of time.[42] In the summer of 1942, Maclaurin reported that, though the project had got off to a slow start, it was picking up though there remained uncertainty about the draft status of the

[38] Compton 1937, 28.
[39] Maclaurin to Willits, March 11, 1942, RFP-MIT (1942-43). See also Maas 2014.
[40] Maclaurin WR, December 20, 1941, Letter to Joseph H. Willits, RFP-MIT (1939-41).
[41] Maclaurin 1942.
[42] Maclaurin WR, August 18, 1942, Accounts for RF41042, July 1941 to June 30, 1942, RFP-MIT (1942-43).

younger men involved.[43] The result of this increased activity was that in the second year, 1942-3, the rate of spending doubled.[44]

By September 1943, Maclaurin was able report that a study, "Economic Factors Influencing the Development and Introduction of the Fluorescent Lamp" had been accepted for publication in the *Journal of Political Economy*. This paper, written with Arthur Bright, who also had experience working in the research departments of Eastman Kodak and Consolidated Edison, analyzed the development of the fluorescent lighting industry, in relation to the licensing agreements concerning the patents by which products were protected and the competitive structure of the lighting industry as a whole.

In his covering letter sent to both Willits and Bezanson, Maclaurin pointed out the article's limitations—it was "more descriptive and analytical than theoretical"—but he defended the lack of more concrete results:

> As our knowledge and experience in this field grows, I am hopeful that the studies will contribute to a greater understanding of the process of technological change in the industry. I believe that such questions of public policy as patent reform, government subsidy of industrial research and government regulation of monopolistic practices in industry cannot be determined adequately without a greater understanding of the "economics of technological change."[45]

[43] Maclaurin WR, August 29, 1942, Letter to H. M. Gillette, RFP-MIT (1942-43).
[44] Hokanson WA, 1943, Accounts for RF41042, July 1, 1942 to March 31, 1943, RFP-MIT (1942-43).
[45] Maclaurin WR, October, 1943, Economics of technological change - progress report, RFP-MIT (1942-43).

After meeting with Maclaurin, Bezanson reported that he was optimistic about getting four industry studies under way.[46] An uncertainty hanging over the project was whether fathers might be drafted, causing him to lose some of his staff. Of particular concern was Bright who had been working with him on incandescent lighting.[47] Lawrence Klein, working with Samuelson towards a PhD thesis on the Keynesian revolution, worked on the project from August to December 1943.[48] In a further memorandum to Willits, Bezanson hardly concealed her disappointment about the direction in which the project was moving:

> The studies have taken a more over all and official emphasis than first we expected! They now relate to great concepts such as monopoly, government, Patent Laws etc. instead of the effect within an industry of the introduction of new methods, the processes of diffusion, the plants most likely to innovate etc. I have no opinion in favor of one or the other, but note the new emphasis."[49]

A Progress Report, clearly written around this time, describes Maclaurin's methods in more detail, showing how he hoped to reach broader conclusions on the basis of studies such as Bright's.[50] They started with a long list of factors that, *a priori*, might affect innovation.

> (1) State of the arts and sciences affecting the particular industry. (2) Organization of research within the industry or in university and governmental laboratories serving the

[46] Maclaurin to Bezanson, September 28, 1943. Bezanson, Memorandum on interview with Maclaurin, October 7, 1943, RFP-MIT (1942-43).
[47] Maclaurin WR, December 14, 1943, Letter to Joseph H. Willits, RFP-MIT (1942-43).
[48] Hokanson WA, December 31, 1943, Accounts for RF41042, July 1, 1943 to Dec 31, 1943, RFP-MIT (1942-43). We have not identified what he did.
[49] Bezanson, Handwritten notes, RFP-MIT (1942-43). The year is not indicated but it seems certain to be 1943.
[50] Maclaurin, October, 1943, Economics of technological change - progress report, RFP-MIT (1942-43).

> industry. (3) Degree of competition in the industry. (4) Personalities of the leading entrepreneurs and managers. (5) Business cycles, wars and fortuitous events. (6) Government regulation. (7) Attitude of labor. (8) Changes in consumer demand.[51]

This list of very disparate topics was clearly intended to be comprehensive and did not reflect any well-defined theoretical framework. The goal of the project was to articulate this framework synthetically from the detailed studies undertaken. The list of industries to be studied—electric lamps, Kraft Paper, glass containers, radio manufacturing, plastics, aircraft, cotton textiles, Nylon, automobiles, machine tools, magnesium, chemical drugs—included contrast cases of industries in which technological progress had been rapid and ones where it had been slow, competitive and monopolistic industries, and industries where patents were and were not important. Though he conceded that their method made "significant generalizations difficult and hazardous" he hoped to use the differences between these industries to draw "tentative generalizations of significance". However, in early 1944 the Rockefeller Foundation expressed frustration that Maclaurin was still emphasizing what he hoped to achieve, rather than what he had accomplished.[52]

From December 1944 to April 1945, Maclaurin was taken away from his project to act as secretary to the Bowman Committee, one of the four committees that advised Vannevar Bush in writing *Science: the Endless Frontier* (1945).[53] Whilst Maclaurin may have satisfied Bush,[54] he did not satisfy Bezanson that his own research project was making sufficient

[51] Maclaurin, Economics of technological change - progress report, October, 1943, RFP-MIT (1942-43).
[52] Evans RF, April 17, 1944, Letter to W. Rupert Maclaurin, RFP-MIT (1944-8). Emphasis in original.
[53] This is discussed in detail in Backhouse and Maas 2015.
[54] Carroll L. Wilson to Maclaurin, May 19, 1945. Records of the OSRD, NARA, College Park.

progress.[55] Maclaurin had, Bezanson contended, difficulty in focusing on a single project. He had initially tried to link his project to his earlier work on industrial relations, and then he had tried to link it to a project on economic history.[56] Some of the work had been successful but it had failed to come together overall. Bright's fluorescent light study was good, but contained nothing that could not have been achieved by a scholar working alone. Even worse, Warren Scoville had failed to make progress on his study of the glass industry until he had left MIT and been free to work on his own. She suggested that the reason why the project had not succeeded was that Maclaurin had failed to take advantage of the opportunities provided by MIT: instead, progress came from his "tie-up" with Harvard, recruiting staff from Harvard and drawing on Schumpeter's economic analysis. He had not drawn at all on the technical expertise of MIT's engineers, "which an organization using well its unique resources could do." She and Willits had hoped that he would forget the economic implications of innovation and "give a vivid account of what happened in the introduction of new processes or products in a few industries which they could study intensively" but he had failed to do this. This might have enabled him to find the "really key factor" in a technical innovation that "the economist is unable to isolate." "If the institute had found a way of using the competence of engineers in stating what the crucial problem of its [sic] invention was, I should be happier - even if they had not produced finished studies."[57] Bezanson did not specify how such competences could have been useful for the case studies at hand.

Though staff in the Foundation were inclined not to renew the grant beyond June 1945, they believed Maclaurin deserved a warning and the chance to make his case. On April 23,

[55] Bezanson A, March 22, 1945, Memorandum on MIT - Maclaurin - Industrial Relations, RFP-MIT (1944-8).
[56] This refered to Warren Scoville (1944a, 1944b).
[57] The use of the word "its", in the original, appears to be a typing error.

1945, Willits interviewed Maclaurin, Bright, Bishop and Vandermeulen.[58] Bright, they thought, "had competence and insight" and was receiving "good cooperation from government, G.E. and small companies." His work held out the prospect of a good study tackling the problem of "inventions, patents, licensing, Cartels and competition."[59] The problem was that he had been given responsibility for administering a large research project MIT had taken on. He was also impressed with Bishop's work on the glass bottle industry. MIT was the right place for the research but, Willits wrote, "Maclaurin impresses me as being a smart promoter who does not know his limits."[60] The problem, Willits concluded, was that "Maclaurin's men are better than he is." When combined with Bezanson's earlier assessment that Scoville had made more progress after leaving MIT it is hardly surprising that, though he recommended giving an additional $5,000, he noted that "Some way should be found to get around Maclaurin."

On May 10, Maclaurin formally submitted his application for an extension of the grant. His progress report was based on the one written a few months earlier though more specific in listing the outputs of the project: a manuscript on the lighting industry was complete except for a final chapter; a preliminary manuscript on the radio industry was written; Bishop had written two-thirds of a manuscript on the glass-container industry; Vandermeulen had a preliminary version of half a manuscript on the paper industry; and Scoville had finished his work on the glass industry before 1900.[61] Though Maclaurin contended that further work was

[58] Willits JH, April 23, 1945, Memorandum - Interview with MIT Industrial Relations Group, RFP-MIT (1944-8).
[59] Willits, Memorandum - Interview with MIT Industrial Relations Group, April 23, 1945, RFP-MIT (1944-8).
[60] ibid.
[61] Maclaurin, Economics of Technological Change - Progress Report, May 10, 1945, RFP-MIT (1944-8); Maclaurin to Willits, May 10, 1945, RFP-MIT (1944-8); Maclaurin, Members of staff assisting on Rockefeller project, May 10, 1945, RFP-MIT (1944-8).

needed to prove "the effectiveness of the method and of the results of the program", the Rockefeller Foundation was only willing to award a 12-month grant specifically to complete the listed studies.[62]

A year later, on April 18, 1946, Maclaurin reported that these studies were complete and he proposed that he and Willits meet to discuss further studies.[63] The next month he sent Willits a summary of his work on radio in which he drew three conclusions about innovation, the first of which was "the vital importance of fundamental research in laying the foundations for the new industry."[64] He also noted that established industries played a negative role, and that success depended on "a combination of managerial skill and inventive talent, which is not normally found in any one man."

Willit's response to Maclaurin's proposal was that before he considered a new grant, he wanted to see the fruits of the old one. In response, Maclaurin repeated his summary of the state of five book projects saying that he expected that they would have all manuscripts except Vandermeulen's in "reasonably final form" by the fall, and he preferred to send them at that stage.[65] He followed this up with a letter to Willits saying that he had arranged for Macmillan to publish a book series, "MIT Studies of the Economics of Science and Engineering."[66] However, he still faced problems in that the postwar demand for teachers was high, and it had been necessary to release Bright, Vandermeulen and Bishop for teaching, and the first two had now left MIT.

[62] Rockefeller Foundation, June 15, 1945, Resolution amending MIT research grant RF41042, RFP Box 6 (MIT Institute of Industrial Relations 1939-41).
[63] Maclaurin to Willits, April 18, 1946, RFP-MIT (1944-8).
[64] Maclaurin 1946.
[65] Maclaurin WR, May 17, 1946, Letter to Joseph H. Willits, RFP-MIT (1944-8).
[66] Maclaurin WR, October 23, 1946, Letter to Joseph H. Willits, RFP-MIT (1944-8).

Maclaurin's study of the Radio industry was eventually published under the title *Invention and Innovation in the Radio Industry* (Maclaurin 1949) in a series now called "Massachusetts Institute of Technology Studies in Innovation", alongside Bright's *The electric-lamp industry: technological change and economic development from 1800 to 1947* (Bright 1949). Two other studies were not published but were submitted to Harvard as doctoral theses: Vandermeulen's *Technological Change in the Paper Industry; Introduction of the Sulphate Process* (Vandermeulen 1947) and Bishop's *The Mechanization of the Glass-Container Industry: A Study in the Economics of Technical Change* (Bishop 1950). The fact that these were Harvard and not MIT theses would seem to vindicate Bezanson's belief that Maclaurin's project had made progress through taking advantage of connections with Harvard, not through taking advantage of the opportunities offered by MIT, something that was not the Rockefeller Foundation's intention.

Maclaurin's book began with a Foreword by Compton, who focused on the distinction between fundamental science and its practical application: "Professor Maclaurin takes pains to point out the important distinction between advances in fundamental science and their practical applications in new or improved products. … The distinction he draws between the scientist, the inventor, and the business innovator is of major significance to an understanding of the process of technological change" (Maclaurin 1949, p. Ix, xi). This led him to reflect on the need for engineering and business schools to pay greater attention to training people in the management of research and invention. The study would, he hoped, "contribute to the emergence of a corps of scientifically trained innovators who will be continually alert to the possibilities of applying advances in the natural and social sciences to the practical problems

of industry." In addition, he hoped that these studies would feed back into the science of human behavior.

Science: The Endless Frontier (Bush 1960 [1945]) was prominent in the book. Maclaurin placed a quotation from Bush about the importance of "pure research" at the beginning of the Preface, and Compton cited Maclaurin's experience with the Bush report as the reason why he had encouraged Maclaurin to engage in his studies (this was somewhat misleading because the studies had begun three years before the Bush report had been conceived). Indeed, Compton had consistently attached importance to the relation between fundamental research, industrial innovation, and economic progress. He had placed his hopes in Maclaurin to investigate these relations in detail, drawing on the unique possibilities he saw in a collaboration of engineers and social scientists. This all predated the Bush report, rather than following from it.

Maclaurin's book met Compton's expectations. It traced the development of the radio industry from its roots in pure research, via the work of inventors and innovators (whom he carefully distinguished) to commercial applications that would have surprised even Faraday, who had predicted that, one day, electricity would "pay taxes". Maclaurin noted that though the scientific advances on which radio was based were European (Maxwell and Hertz on the study of electro-magnetic waves and J.J. Thompson's discovery of the electron), there had since been great advances in fundamental research in physics in the United States. He reiterated Bush's message on the need for support for fundamental research and discussed the role of new firms, inventors and innovators. Maclaurin showed that few of these new firms were dominated by the inventor.

Taking up a Schumpeterian theme, Maclaurin stressed the importance of monopoly, on the grounds that "No industry which was *perfectly* competitive could conduct research. Some protection against competition is essential if there are to be profits; and profits in turn are needed to sustain a research program concerned with new products" (Maclaurin 1949, p. 251). Outside the Radio Corporation of America (RCA), General Electric (GE), Westinghouse, and the Telephone company, which were large and protected by patents, conditions were so competitive that little research took place. Research careers were not encouraged in smaller companies, where a premium was placed on being able to copy what the large firms did. In contrast, the large companies' laboratories did provide an environment in which research could take place. However, competition between large companies was important, and Maclaurin believed that when, with the formation of RCA, the big four companies agreed to restrict competition by agreeing to share their patents amongst themselves free or charge, innovation was hindered.[67]

At the end of the book, Maclaurin placed the radio industry in a broader economic context. The period he had studied corresponded with one of the long cycles in business activity identified by Schumpeter, dominated by innovation in the electrical industry. Radio was one of the secondary industries that followed on from the spread of the electricity industry, providing a case study against which to test Schumpeter's hypothesis that the entrepreneurs responsible for waves of invention were followed by imitators whose activities caused the invention to spread through the economy. Bezanson's comment that the project had moved on to "great concepts" was completely justified. However, while she saw this as

[67] It was presumably the discussion of such activities that caused RCA's lawyers to challenge the manuscript, causing Maclaurin to ask Compton for support in the event that they raised the matter with MIT. Maclaurin WR, March 22, 1948, Letter to Karl T. Compton, MIT, Office of the President, AC4 Box 142 (Folder 11).

Maclaurin's failure to identify the "really key factor" for technical innovations to succeed, Maclaurin effectively developed the loose set of notions that had guided Bush's report into a coherent theory that explained how pure scientific discoveries in the end spurred economic progress. Historians and sociologists of science and technology came to refer to this theory as the so-called "linear model" of technological progress, a model largely discredited from 1970s onwards (see Edgerton 2004, Godin 2006).

5. Maclaurin's project and MIT Economics

From the start, Maclaurin had planned to use his research project on technological change to build up economics at MIT. In October 1942, after discussion with Harold Moulton and Edwin Nourse, of the Brookings Institution, he submitted a proposal to the Falk Foundation, for a project that would complement the Rockefeller study.[68] The key element in his strategy was, as his early draft proposal made clear, the integration of research with the new PhD program. The latter was introduced in 1941. There was interaction between the doctoral training and the technology research program in that a succession of students worked as research assistants: Klein (1942), Garritsen (1944-6), Gilbert (1944). However, as Table 1 makes clear, *none* of these wrote theses related to innovations and neither were any of the theses supervised by Maclaurin. Three economics theses were supervised by Samuelson, and the remaining eight were almost all on industrial relations, supervised by Brown and Myers (see Svorencik 2014). Bright's book was published, but it was not a doctoral dissertation.

[68] Compton KT, October 9, 1942, Letter to W. Rupert Maclaurin, MIT, Office of the President, AC4 Box 142 (Folder 6, Maclaurin); Compton KT, January 9, 1943, Letter to W. Rupert Maclaurin, MIT, Office of the President, AC4 Box 142 (Folder 6, Maclaurin). Details of this proposal are not known. There is no evidence that the application was successful.

For most of the 1940s, the faculty members were heavily concentrated in the fields of industrial relations and management (see Cherrier 2014). Two of the first two faculty appointments after Samuelson, Paul Pigors and Myers, were in these fields. Richard Bissell, also appointed in 1942, published on what would now be called macroeconomics. Scoville was made an assistant professor in 1943 but soon left. Bishop had been involved with the technological change project, but his publications were on microeconomic theory, and Cary Brown, also appointed in 1946, specialized in fiscal policy. Appointments in 1948-9 broadened the department still further, their work having no connection with Maclaurin's: George Schultz (labor economics), Charles Kindleberger (international finance), Robert Solow (economic theory). Max Millikan's appointment heralded the rising importance for MIT of the Center for International Studies, with which he became associated. Morris Adelman's work on industrial economics might have implied engagement with Maclaurin, but it did not. The department hardly became "neoclassical" during this period but it was expanding in ways that made Maclaurin less central. By the end of the decade, Samuelson, whose *Foundations of Economic Analysis* (1947) and *Economics: An Introductory Analysis* (1948) had firmly established his reputation, had become a full professor and became the dominant figure. Mathematical model building became an increasingly important part of the department's activities in relation to economic history (see Maas 2014; Halsmayer 2014; Thomas 2014; Temin 2014). Maclaurin's interdisciplinary mode of research represented what was increasingly seen as an old-fashioned way of doing economics.

Maclaurin continued to publish on technological progress. An article in the *American Economic Review* (Maclaurin 1950b) developed themes from his book, focusing on the lives of a series of inventors: Marconi, Fessenden and De Forest. The conclusions about the

importance of fundamental science, the need for engineers as well as scientists, and the relationship between industrial structure and innovation were woven into an argument about the role of entrepreneurial leadership in innovation. An article on television (Maclaurin 1950a) used RCA's use of patents to sustain a monopoly position to defend the need for some monopoly power. These themes were developed, drawing on a wider range of industries, several years later (Maclaurin 1954).

In 1948, Maclaurin applied to the Merrill Foundation to fund another large project, this time for innovation in housing construction, obtaining $25,000 in February 1949 with a further $25,000 in July 1951.[69] This followed the same pattern of developing contacts with specific companies—building companies of different sizes but all concerned to innovate—from which they obtained data. This turned out to be beset by some of the same problems as the previous project. Various innovations were studied, ranging from providing more land, using prefabricated components, and organizing housing as a cooperative in which people could pay over forty rather than twenty years. It is hard to see any theory underlying the conclusions, nor did the studies build up to theory. By August 1954, Maclaurin had revised six out of fifteen chapters but he recognized that there might be legal problems publishing material about private-sector firms, two of which had become bankrupt during the study. It appears not to have been published. The main audience for Maclaurin's work in the 1950s appears to have been economic historians. His book on radio was reviewed favorably in the

[69] Compton to Fox, March 29, 1948; Maclaurin to Compton, March 25, 1948, MIT Office of the President, AC4, Box 142, Folder 11. The account of the project is based on Progress reports to the Merrill Foundation, MIT Office of the Dean of Humanities, Box 3, Economics Department.

Journal of Economic History and the *Economic History Review* (Rezneck 1949; Tew 1950) but in no other economics journal.[70]

6. Conclusions

By 1950, Maclaurin was becoming marginalized. The Rockefeller Foundation had come to believe that his younger colleagues were better than he was and that he had not managed to give focus to his project. He had failed to produce a research program that took advantage of the situation of an economics department located in the country's leading engineering school. This failure was to a large extent a matter of perception. Willits and Bezanson shared Maclaurin's interest in industrial-relations research but were more skeptical about the use of statistical and mathematical methods. They favored theory that was grounded in fine grained case studies and, even though such studies were part of Maclaurin's program, they could not see how these all added up to the sort of result they envisaged. Neither could they see how the project's location at MIT had contributed in any positive way to its results. Instead, they took the presence of two Harvard theses among the project's outputs as evidence that Maclaurin was relying on old ties with Harvard. The lack of focus they perceived in Maclaurin's research partly resulted from circumstances; wartime demands caused for substantial shifts in his team, and though his work as secretary on one of the committees for Vannevar Bush's report *Science: The Endless Frontier* was in fact helpful for Maclaurin's

[70] It was also reviewed in the *Harvard Law Review* and the *Public Opinion Quarterly* (Condon 1949; Anonymous 1950).

own work on innovation in the radio industry, Willits and Bezanson saw this activity as a digression from his Rockefeller project (see Backhouse and Maas 2015).

Personalities, circumstances, methods, and prestige all matter. Samuelson's work on his textbook placed him at the center of the department, and his receipt at the age of thirty two of the first Clark Medal (awarded by the AEA to the economist under the age of forty who was judged to have made the most significant contribution to economics) acknowledged his role in economics more widely. Prestige was not associated with successful grant applications as it would be nowadays. The department expanded during the 1940s but new hires flocked around Samuelson rather than Maclaurin. Maclaurin continued submitting grant proposals to foundations but his interdisciplinary and case-based research remained peripheral to the department's activities. His proposals never became an on-going program that studied the institutional processes of invention and innovation. MIT became associated with the technical modelling associated with Samuelson and later Solow. Maclaurin's research project might have become the center around which a more interdisciplinary economics could have been built but it did not. The use of interdisciplinary methods, much favored by Willits, Bezanson and institutionalists like Innis (Rouvray 2005), became relegated to the field of Economic History and moved to the margins of the discipline. Though Compton still supported Maclaurin after the war, the economics department could increasingly manage without him. Maclaurin's work, potentially central to a department focused on service teaching for engineers, became peripheral to a department that was increasingly focused on its own students. Much later, Samuelson described Maclaurin as having wanted to create a great

department but with no notion of what a great department would look like.[71] In the same year that Maclaurin published his most-cited article (1953), Samuelson and Solow published an article that, despite being on a relatively abstract theoretical topic, highly mathematical and published in a more specialized journal, "Balanced growth under constant returns to scale" (1953), and despite not being one of their most-cited articles, was cited almost four times as often.[72]

Maclaurin was thus marginalized at several levels. The withdrawal of support by the Rockefeller Foundation seems crucial and it is natural to wonder whether a different assessment of his research by the Rockefeller Foundation could have led to a different outcome. Willits and Bezanson could have seen the outcome of the project, which produced two books, two theses, and several journal articles, as a substantial success, even though it did not target the issue in which Bezanson was most interested (the concrete conditions for acceptance of technical chance within firms) and they could have extended the grant, as Maclaurin wanted. However, it seems unlikely this would have made a substantial difference. His ideas resonated mainly with scientists who were seeking ways to establish the principle of government support for pure science in the post-Second World War era, most notably Compton. Before the war, Samuelson had written that institutional generalizations could only be done in terms of a theory of history "(in itself a contradiction in terms)" for which "the powerful tools of mathematical abstraction will little serve our turn, and direct study of such institutional data would seem in order" (Samuelson 1937, 160). Such transdisciplinary and

[71] Stanley Fischer, "Conversations with Paul Samuelson", 1991, [location in archive to be provided later]. In that interview, Samuelson was also critical of Maclaurin's elitist attitudes to graduate student recruitment, favoring personal characteristics and social status of students' families over pure academic merit.

[72] Maclaurin's article was cited 18 times, Samuelson and Solow's, 60 times (Web of Science, accessed August 28, 2014).

case-based research was no longer attractive to economists who were beginning to explore the internal logic and possibilities of a largely mono-disciplinary method and theory.

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