

Specialization, fragmentation, and pluralism in economics

Abstract: This paper investigates whether specialization in research is causing economics to become an increasingly fragmented and diverse discipline with a continually rising number of niche-based research programs and a declining role for dominant cross-science research programs. It opens by framing the issue in terms of centrifugal and centripetal forces operating on research in economics, and then distinguishes descriptive from normative pluralism. It reviews recent research regarding the JEL code and the economics' J. B. Clark Award that points towards rising specialization and fragmentation of research in economics. It then reviews five related arguments that might explain increasing specialization and fragmentation in economics: (i) Smith's early division of labor view, (ii) Kuhn's later thinking about the importance of specialization, (iii) Heiner's behavioral burden of knowledge argument, (iv) Ross innovation-diffusion analysis and Arthur's theory of technological change as determinants of specialization in science, and (v) the effects of space and culture or internationalization on innovation appropriation. The paper then discusses what descriptive pluralism implies about normative pluralism, and makes a case for multidisciplinary over interdisciplinarity as a basis for arguments promoting pluralism. The paper closes with comments on specialization and pluralism outside economics and science.

Keywords: specialization, fragmentation, pluralism, innovation-diffusion, internationalization

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1 Introduction: The issue of specialization in economics

Specialization – research on specialized rather than general subjects of investigation – has long been recognized to be a fundamental characteristic of scholarly research. By nature, it involves departures from existing research, and can accordingly be characterized as a centrifugal type of force that tends to produce a more diverse research frontier. Operating against this, scholarly research also exhibits centripetal forces in the form of research that tends to link up disparate research initiatives and produce shared research programs. Thus, to assess the overall development of a discipline such as economics, it seems one ought to ask what the relation is between these two types of forces over time, and particularly whether one or the other might be increasingly dominant since these two possibilities have quite different implications for the evolution of a discipline. Shared research programs produced by centripetal forces broaden understanding but also run the risk of ignoring questions and issues that depart from main lines of research. Diversity in a research frontier produced by centrifugal forces increases innovation in ideas but runs the risk of less disciplinary coherence.

What do we know about the balance between centrifugal and centripetal forces in research in the history of economics? One view is that historically they have alternated cyclically in importance, with periods when unifying research programs dominate economics and more pluralistic periods when competition between many approaches prevails (Davis, 2008). As in many cycle arguments in economics, the conditions of one period give rise to the other. Another view possibly complementary to this is that such cycles, should they exist, are embedded in a long run, secular trend in the development of scholarly research in economics in which centrifugal forces have become increasingly dominant, such that specialization is producing an increasingly diverse, perhaps fragmented economics with a decreasing a role for centralizing research programs (Cedrine and Fontana, 2017). The changing state of science in general associated with the increasing share of resources devoted to science in modern economies, the cumulative development of science over centuries, and transformative effects of advances in the technologies of science all provide grounds for thinking that long-term trends might be producing not just a more diverse economics but a potentially fragmented one as well.

These views raise the issue of the nature and status of pluralism in economics. Both views make pluralism in the descriptive sense regarding the role that diversity plays in research important to understanding the development of economics. They also make pluralism in the normative sense regarding what ought to guide economists' research goals and the organization of research central to understanding the nature of scholarly research in economics. Yet how we look at diversity and pluralism in economics in both senses depends on how we understand the issue of fragmentation in economic research.

Fragmentation in research can be understood in two ways. If we understand the history of economics in terms of cycles that alternate dominant approaches and competition between many approaches, then fragmentation can be thought to refer to a transitional state of affairs associated with dominant programs' declining influence and a temporary phase of competition between many approaches before new dominant programs emerge. However, if we suppose there exists a secular trend in the development of scholarly research in economics associated with increasing specialization, then fragmentation can be thought to refer to a change in the nature and organization of economic research whereby researchers have a decreased understanding of research programs

outside their own, operate in relatively isolated research niches, and it is less and less clear what unites research programs and makes economics a single discipline. This scenario has potentially alarming consequences for economics as a science. Ironically, it might create a new justification and demand for history of economics as a site for the ‘last generalists’ in economics (Trautwein, 2017).

One way, then, in which either scenario might be manifest is in what specialization means for ‘economics relation to other disciplines’ – A12 in the JEL code. If specialization increases economics’ connections to other disciplines through greater borrowing and importation of ideas from other disciplines, as suggested by the post-1980 influences of psychology, evolutionary biology, mathematics, sociology, and other disciplines on economics, then specialization may reduce the disciplinary identity of economics. Whether this occurs as a temporary state of affairs or as an increasingly fundamental characteristic of ‘economics’ research, then affects how we look at pluralism in economics in both its descriptive and normative senses.

This paper, then, examines the nature of specialization in recent economics, and argues that centrifugal forces brought about by specialization in research are indeed leading to a fundamental change in the nature and organization of the discipline by producing a more diverse and fragmented research process. Section 2 frames the issue by reviewing what recent research about two influential professional institutions in economics tells us about specialization in economics. Section 3 reviews five related theoretical arguments that might explain increasing specialization and fragmentation as a long-term secular trend of development in economics (and possibly in science in general). Section 4 moves to the implications of fragmentation in economics research for pluralism in economics, and argues for a normative pluralism based on a multidisciplinary view of science rather than an interdisciplinarity view. Section 5 concludes with brief comments on specialization and pluralism in the wider social world beyond economics and science.

2 Specialization as reflected in the JEL code and the Clark Award

One way in which specialization in economics can be investigated is in terms of what changes in the discipline’s professional institutions imply about specialization, since they can be expected to adjust to and reflect the needs and practices of researchers. Here I discuss recent research on two such institutions: the JEL code, the classification system for different kinds of research in economics, and the American Economic Association’s prestigious John Bates Clark Award given to younger economists for ‘significant contributions’ to the field. What this research appears to indicate is that specialization has increased significantly in economics and that offsetting, centralizing forces working against it are weak.

i. The evidence from revisions in the JEL code

Science classification systems tells us how sciences represent specialization since by nature classification systems characterize diversity. The *Journal of Economic Literature* (JEL) EconLit classification system, that distinguishes different kinds of subject matters and research approaches in economics, provides the main means for doing this in economics. It is important, then, that the JEL code has undergone regular revisions over time intended to capture change in the nature and structure of research in economics, as recently shown in considerable detail by Cherrier (2017). What her study demonstrates is that not only has the JEL classification system seen a continual

expansion in its number of categories and sub-categories since its inception, and especially over the last half century, but more importantly that multiple kinds of considerations have gone into this creation of new categories, new sub-categories, as well as their continual re-ordering, including, she emphasizes, the need for identification of new fields of research, new techniques and methods of research, and new domains of application. For this clear trend in increasing specialization not to have led to fragmentation in economics research, one would then need to argue that centrifugal forces in the form of increasing commitment to unifying approaches have offset and accompanied this change. Consider, then, three such possible arguments for the presence of such forces.

First, some might argue that lying behind and unifying this development, economists have nonetheless had the goal of extending and applying the dominant neoclassical approach to new contexts. Neoclassicism certainly exerted a centralizing force in economics in the first half of the postwar period up to around 1980. However, as I have argued (Davis, 2008), the influence of other disciplines on economics since then means that to make this unifying argument one must ignore the non-neoclassical elements in recent economics, and ignore also the fact that even the term ‘neoclassical’ has now largely been replaced by the much looser term ‘mainstream’ in characterizations of economics (Colander, 2000). This suggests that neoclassicism no longer acts as a unifying force offsetting fragmentation in economics, and that the changes in the JEL code that Cherrier identifies are the product of an increasingly diverse research frontier in economics.

Second, it might be argued that the economics classified in the JEL code is not fully representative of economics, and that its representation of a part of economics, even if a large part, constitutes a unifying force in economics. Indeed, heterodox economists and many smaller fields in economics, such as the history and methodology of economics, might well argue they are under-represented in the JEL code. However, possible neglect of such research amounts to an at best weak sort of unifying force since in Cherrier’s history there is little evidence that excluding fields or types of economics has acted as a motivation for revisions to the code. At the same time, it should be noted that heterodox economics and fields such as the history and methodology of economics have themselves also undergone a considerable expansion and diversification, as shown for heterodox economics by Lee (2009) and for the history and methodology of economics by Biddle, Davis, and Samuels (2003). So irrespective of the representativeness of the JEL code, specialization and fragmentation seems to be a dominant process across economics.

Third, it might be claimed that the expansion and reorganization of the JEL classification system itself represents a unifying force in economics offsetting increasing specialization and fragmentation in economics research. That the JEL code is based on a *genus-species* classification system that has become increasingly detailed and specific suggests that economics’ subject matter can be given a comprehensive, hierarchical organization, indicating that it has become a more cohesive discipline than in the past. Specifically, a *genus-species* classification system accomplishes this systematization by ruling out non-hierarchical inheritance relationships between different subjects and research approaches that might imply economics’ expansion as reflected in revisions in the JEL code is a disorderly, unsystematic process.

However, the *genus-species* classification system likely misrepresents the way in which new categories and subcategories have been added to economics, since its hierarchical structure ignores important inheritance relationships across *species*. A *genus-species* classification system works relatively well for biological science, because *species* DNA identification markers can be used to rule out most inter-*species* relationships. However, in scholarly research new *species* often inherit from more than one

research *genus*, and may possess often multiple, potentially conflicting inheritances, so that the JEL code exaggerates the well-orderedness it appears to attribute to economics. This is nicely captured by Cherrier's history of the code that shows a continual emergence of new categories in economics motivated by considerations other than building directly on the existing JEL code hierarchy. That new categories and sub-categories reflect emergent inter-*species* research relationships means that there can be multiple kinds of economic research clusters with different possibly overlapping foundations with lateral relationships between them potentially as important as vertical ones between categories and sub-categories. Thus, the development of the JEL code itself does not imply there exists single over-arching organization of economics acting as a counter-weight to the evident increasing specialization of research in the discipline.

ii. The evidence from the John Bates Clark Award

A different type of evidence suggesting fragmentation comes from Backhouse and Cherrier's (2014) and Cherrier and Svorenčik's (2017) examinations of the history of American Economic Association John Bates Clark Award winners. The Award, given to economists under age forty, is an important signaling device regarding what senior economists wish to value and encourage in younger economists' research, so the history of Awards provides a record of changing views in the profession regarding research priorities. What Backhouse and Cherrier and Cherrier and Svorenčik show, then, is that since 1970 economics has become increasingly applied and gives decreasing attention to pure theory.¹ A diminished role for theory clearly reduces the importance in economics of over-arching, centralizing interpretations of the whole of economics. It also allows a much more decentralized practical type of common ground to emerge as the identity of economics, namely, shared methods and techniques of investigation, which contrasts with economics' earlier reliance on Robbins' content-based, allocation of scarce resources definition of the field as a common identity. Are there, then, unifying forces operating here that might offset the evidence regarding increasing specialization from the Clark Award?

One might argue that a more applied economics is simply a more applied neoclassical economics. Since neoclassicism remains a significant part of the training and thinking of most economists, this must be the basis on which applied research rests. Nonetheless, a more applied economics, whatever its theoretical foundations, reduces the importance of those foundations and allows space for other theoretical arguments. Indeed, it is conventional in philosophy of science to argue that if the evidence produced in applied research is inconsistent with existing theoretical claims, this provides grounds for revising those claims. On this view, applied research is an engine of theory development. Thus, a more applied economics is an indication that economics is engaged in a process of theory change, and if economics research should continue to be largely applied, that process of theory change should continue. The burden thus falls to those who argue a more applied economics is a more applied neoclassical economics to show that applied research continually confirms neoclassical theory. Yet the history of the Clark Award does not appear to show this. Rather, if there is a continuity to the succession of awards, it seems it rests on recognizing new strategies in research irrespective of their theoretical foundations.

¹ Relatedly, others have emphasized the increasingly empirical nature of recent economics (e.g., Hamermesh, 2013; Rodrik, 2015).

Thus, like the JEL code, the Clark Award shows the importance of increasing specialization in economics, and arguments that unifying forces are also at work in economics appear tenuous. This implies that specialization as a centrifugal type of force in research dominates centripetal forces in research, and that economics research is becoming increasingly fragmented, possibly decreasing economics' identity as a distinct independent discipline. In the following section, then, I review five theoretical arguments which provide a basis for thinking that specialization and fragmentation in research is an enduring secular trend in economics and possibly in science.

3 Theoretical arguments regarding specialization

What the five arguments here share is, first, the view that specialization is a fundamental process associated with and perhaps partly explaining the evolution of society. In effect, were we to identify a handful of major forces explaining the human world, specialization would be among them. This view contrasts with what may be a more common view of specialization, namely, that it is an important process but not one fundamentally responsible for the history and evolution of the human world. Second, what these arguments share is the view that increasing specialization is a secular trend tending to produce a greater fragmentation of human activities. Thus, the phenomena that characterize the human world, including in economics and science, are not only becoming increasingly diverse but the ways in which they are connected and related is becoming less clear. In this section, I focus on specialization and fragmentation in economics and science, but in the closing section I comment briefly on specialization and fragmentation in the wider world outside science.

i. Smith's division of labor explanation of specialization

Smith's *Wealth of Nations* (1776; 1937) analysis of specialization, the most influential early attempt to explain specialization as a distinct process, is the product of his insights regarding the division of labor. In his famous pin factory example, he emphasized the gains to total output made possible by a reorganization of production resulting from a more specialized division of labor. Specialization in this regard means a narrowing of tasks that allows them to be performed in less time, thus producing higher levels of output with the same resources in a given period of time. Smith was critical of the effects of specialization on laborers' well-being associated with their being tied to a highly repetitive, increasingly simple work activities.² Nonetheless, given the cost advantages a greater division of labor produced, he saw increasing specialization in the division of labor sense as an all but inevitable process despite its effects on laborers. The only thing that might slow this process was the marketability of the greater output that specialization made possible, and thus Smith linked the degree to which the division of labor advanced to the extent of the market. Since as a

² "The man whose whole life is spent in performing a few simple operations, of which the effects are perhaps always the same, or very nearly the same, has no occasion to exert his understanding or to exercise his invention in finding out expedients for removing difficulties which never occur. He naturally loses, therefore, the habit of such exertion, and generally becomes as stupid and ignorant as it is possible for a human creature to become. The torpor of his mind renders him not only incapable of relishing or bearing a part in any rational conversation, but of conceiving any generous, noble, or tender sentiment, and consequently of forming any just judgement concerning many even of the ordinary duties of private life... But in every improved and civilized society this is the state into which the labouring poor, that is, the great body of the people, must necessarily fall, unless government takes some pains to prevent it" (Smith, 1776; 1937, pp. 734-5).

matter of fact the economy of his time was growing, this appeared not to be a constraint, and following Smith an increasing division of labor has come to be regarded a natural part of the market process.

For Smith, therefore, fragmentation is understood only in human terms, and not in economic terms or in scientific terms. A greater division of labor requires more market connections between different production activities, so the economy itself becomes more integrated. This in turn promotes the idea that economics is primarily about markets, which as a unifying vision for generations of later economists also gave greater integration to economics. Indeed, economics' emergence as a distinct science is often associated with Smith's influence, so the fragmentation of economics as a science is not an issue for him. Yet Smith's concern with the undesirable effects of specialization on manual laborers invites us to ask: why are these effects confined to their activity alone? If increases in the division of labor act as a general principle, it seems this principle also ought to produce a narrowing of activity in science just as in economic production. This, in fact, is just the conclusion that Thomas Kuhn comes to in his later thinking about specialization and the development of science.

ii. Kuhn's later focus on specialization

Kuhn is famous for his scientific revolutions interpretation of the history of science (Kuhn, 1962). He characterized much of science as 'normal science' devoted to solving small-scale problems that arise within broad research programs he termed paradigms. Much 'normal science' proceeds uneventfully, but it also encounters problems or puzzles that are resistant to solution within their paradigmatic frameworks – 'anomalies' – and for Kuhn an accumulation of these problems can lead to a *gestalt* switch whereby researchers abandon one paradigm for another in which those problems appear capable of solution. However, in his later thinking Kuhn moved away from his scientific revolutions thinking, leaving him with only his original emphasis on normal science and increasing specialization as fundamental to how sciences develop. "What replaces the one big mind-independent world about which scientists were once said to discover the truth is the variety of niches within which the practitioners of various specialties practice their trade" (2000, p. 120).

Thus, whereas in his earlier thinking an accumulation of anomalies can lead to the abandonment of one paradigm for another, in his later thinking he instead argued that research on perceived anomalies becomes an end in itself for researchers who specialize in their investigation. It follows that the deeper their investigation of these problems, the more detached their research becomes from the wider frameworks from which they arose, so that paradigmatic thinking declines in importance in science as researchers focus on increasingly specialized problems. A mature, well developed science, then, with many such problems and puzzles should be expected to gradually lose its overall paradigmatic identity, and be reconfigured as a "variety of niches within which the practitioners of various specialties practice their trade." If paradigm change constitutes a centralizing force in scientific development in Kuhn's earlier thinking, in his later thinking increasing specialization and niche-based science undermines its unifying effects. Further, whereas his earlier scientific revolutions view suggests paradigms rise and fall in cycles, his later view is framed simply in terms of a long-term or secular pattern of development.

Kuhn's view of fragmentation in scientific activity, then, extends Smith's view that specialization has undesirable effects on manual laborers to scientists since their narrower research activities tend to

lose their meaning in relation to their sciences' larger questions. While Smith's view of specialization makes economics a more cohesive subject, for Kuhn specialization fragments sciences into collections of non-communicating niches in which scientists rather pursue 'local' goals of investigation (Wray, 2011). If his earlier thinking emphasized paradigm-incommensurability and the unification of sciences around paradigms, his later thinking emphasizes niche-incommensurability, so that it become increasingly difficult to say scientists belong to one science. To put this in a more nuanced way, scientists, and economists, might be better off specializing in niche-based science, but worse off in understanding the significance of their work in an increasingly fragmented science. How are we to interpret this combination? A limitation of Kuhn's later thinking is his failure to offer much of an account of scientists' behavior. Consider, then, Ronald Heiner's 'burden of knowledge' analysis of scientists' behavior.

iii. Heiner's burden of knowledge argument regarding specialization

Heiner (1983) goes beyond Smith's idea that it is the extent of the market and the growth in markets that drives specialization, and argues that specialization in science itself creates incentives for scientists to further specialize, thus making specialization a self-reinforcing dynamical process. He accordingly provides us with the outlines of an argument for seeing specialization as a secular trend independent of such things as the state of the economy or the resources committed to science. Further, in contrast to Kuhn, Heiner has an even less favorable view of the situation of individual scientists. If Kuhn sees specialization and deeper investigation of research anomalies as an opportunity for individual scientists, Heiner sees increasing specialization as a rational response to the increasing burden that scientists encounter in the need to be knowledgeable about an ever-accumulating body of scientific knowledge. He explains this in terms of what he calls a 'competence-difficulty gap' whereby scientists are more and more uncertain about how to allocate scarce research time to research subjects. As a result, their choices become less motivated by the content of science and more driven by adoption of a simple rule of investigative behavior: whether or not an issue is scientifically interesting, if one is competent by training to investigate it, one should pursue it in order to reduce the likelihood that one's investment of research time will fail and damage one's professional reputation (cf. Cedrini and Fontana, 2017).

Greater specialization thus generates greater uncertainty for scientists, this produces the 'competence-difficulty gap,' and this drives research in a self-sustaining way toward even further specialization. In regard to fragmentation, to the extent that scientific activity is driven by behavioral rules independent of the goals of science, Heiner's understanding of scientists approaches Smith's view of manual laborers. Scientists' work may not be reduced to the simple repetitive activities of Smith's manual laborers, but it still loses much of its intrinsic meaning as it becomes more driven by livelihood rather than by the nature of the activity itself. However, Heiner departs from Smith's view that specialization has integrative effects on economics as a science, and instead agrees with Kuhn that a niche-based science is a less integrated science. Thus, in answer to the questions Smith does not address – why should the ill effects of specialization be confined to manual laborers and why should an economics framed in terms of an increasing division of labor become more cohesive – Heiner's conclusions are that specialization produces fragmentation in both scientists' work and in science.

While Heiner thus explains specialization as a fundamental secular process, he leaves open the rate at which it operates. Suppose that specialization in science proceeds only gradually. It would then

at least be possible to argue that there might exist centripetal forces of some sort that might counteract its effects, so that fragmentation is not an issue in the long run. I will not speculate on what those forces might be, but turn in the next section to reasons to think that, on the contrary, the rate of specialization is likely to be increasing, making it less likely that other forces offset fragmentation in science. This entails looking at technological change as one important driver of specialization since technological change creates conditions which make specialization possible, and is thus a key factor affecting the rate of specialization.

iv. Technological change as a driver of specialization and fragmentation in science

Specialization driven by technological change in science results when scientists adopt new techniques in their research. How significant the adoption of new techniques is depends on how extensive their adoption is, which is generally understood in terms of their diffusion among potential adopters. Diffusion of innovations analysis was originally developed in communications theory in terms of the idea of innovation diffusion cycles by Rogers (1962; 2003). Rogers distinguished four successive groups of adopters – early adopters, early majority, late majority, and laggard adopters – according to their motivations and the nature of the social system involved, and produced a diffusion curve representation of the overall pattern of innovation adoption that over time increased as the number of adopters rose to a maximum and then declined with the fewer number of remaining potential adopters.³ The fall in the number of adopters, then, is associated with the innovation becoming standardized and losing its status as an innovation. Thus, on the assumption that the adoption of innovative new techniques is an important driver of specialization, it follows that episodes of specialization in science should follow a similar pattern of increase and decline, and an innovation first has a rising impact on specialization and then a declining impact.

What does this imply about fragmentation? Rogers' cycle analysis is framed in terms of there being a given population of potential adopters, so that the declining impact of an innovation is determined by there being a decreasing population of potential adopters. This means that the fragmentation effects of innovation adoption expressed in the form of new specialization are offset by its generalization in that population. As an innovation approaches universal adoption, it becomes standard as the population of adopters unifies around it. From this diffusion cycle perspective, then, innovations and their attendant specializations operate in a self-defeating way, producing centripetal forces in response to their centrifugal ones.

However, this cycle analysis ignores how interdependence between distinct innovations may affect overall rates of innovation, and how this may affect individual innovation cycles. For simplicity, consider two possibilities: either increasing interdependence between innovations increases the overall rates of innovation or it decreases those rates. The latter possibility allows us to imagine that the overall rate of innovation is sufficiently slow that change in science through specialization is generally assimilated, such that centripetal forces tend to dominate centrifugal ones in science, essentially replicating Rogers' standardization model of a single innovation. However, there is a strong argument in technology studies that increasing interdependence between innovations increases the overall rate of innovation, which may shorten innovation diffusion cycles reducing

³ Rogers' analysis was subsequently formalized in differential equation terms by Bass (1969), and diffusion curves are now conventionally referred to as Bass diffusion curves. See Rogers *et al.* (2005) for a complex adaptive systems network theory model of a diffusion process employing his four main phases of appropriation.

their standardization phases. What basis is there for thinking there might be an increasing interdependence between innovations and rising overall rates of innovation?

Consider Brian Arthur's investigation of the evolutionary nature of technology change (Arthur, 2009). Historians of technology generally agree, he notes, that innovations are interdependent in the sense that new technologies build upon previous technologies. Why, then, might they might be increasingly interdependent over time is a matter of how they build upon one another. This raises the question of the nature of descent or the pathway by which new technologies build on earlier ones. One possibility is that descent proceeds naturalistically in Darwinian fashion such that new technologies build on old ones along *genus-species* pathways, so that it is random variation (accidental discoveries) and natural selection (the suitability of new technologies to human needs) that explains overall rates of innovation. On this view, every new technology growth is, pillar-like, the product of a hierarchical chain of related antecedents, and new technologies share something akin in biology to the same DNA structure as their antecedent technologies.

However, based on his study of the history of new technology introduction, Arthur argues that new technologies commonly possess sets of technical structures that are often largely unrelated to one another (except at the broadest level of science). Technology evolution thus appears to proceed in a what he terms a combinatorial manner, whereby new technologies unexpectedly combine different, unrelated technology modules, so that new technology *species* are in effect descended from more than one *genus*. The argument is parallel to the point made above regarding interpreting revisions in the JEL code. In both cases, inter-*species* relationships are fundamental to the evolutionary process, and a new type of uncertainty (beyond random variation and natural selection) associated with human imagination needs to be included in the explanation of technology change.⁴

Thus, if the rate of growth of new *species* in the natural world is constant, as determined by constant rates of random variation and given conditions governing natural selection, in the world of technology growth is exponential and the overall rate of innovation continually increases in proportion to the increasing number of potentially interdependent new technologies made possible by inter-*species* innovation. Assuming, then, that innovation drives specialization, the rate of specialization should also always be increasing, overcoming the centripetal effects of innovation standardization that Ross describes.⁵ Thus, should change in science reflect wider innovation and specialization processes, we should expect this to produce increasing fragmentation in science. This leaves us with the question: what centripetal forces might there be offsetting the fragmentation effects on science this all involves?

One suggestion comes from Arthur, whose foremost principle is that “technology is *a means to fulfill a human purpose*” (2009, p. 28). Thus, unity in the purposes for which new technologies are

⁴ One example Arthur uses is the development of the U.S. F-35 Lightning II fighter aircraft (2009, pp. 39ff). How decisions were made that combined very different technologies was the result of designers needing to address problems they encountered in making use of individual technologies when the aircraft had to meet certain main design objectives (speed, maneuverability, etc.). In this way, human problem solving replaces natural selection as the determinant of technology evolution.

⁵ In effect, the increasing rate of innovation reduces the standardization time in Ross's cycle so that new innovations begin to become obsolete and adoption stalls before they become standard. An interesting macroeconomic question is: does this tend to suppress business investment?

developed, in science as well as in the wider world, could potentially offset the fragmentation effects their exponential expansion involve. However, Heiner's argument makes this unlikely, because on his view scientists' need to specialize reduces their concern with the broad goals of science. At the best, then, if unifying forces somehow operate in science in connection with shared goals for science, it is unclear how they operate. I consequently put this matter aside, and turn in the next section to how the spatial distribution of scientific activity adds a further factor affecting specialization and fragmentation.

v. Internationalization: The effects of space and culture on specialization

The analysis in the last section is framed entirely in terms of time and ignores the effects of space on the diffusion of innovations and specialization. More specifically, since spatial extent in the social world needs to be understood in terms of cultural variation, this analysis ignores how cultural differences in language, history, social practices, and populations' relative positions vis-à-vis other populations affect the appropriation and adoption of innovations. In this section, then, I add in this dimension to the explanation developed thus far regarding increasing specialization in science, and argue that cultural differences in the development of science add a further factor causing fragmentation in science.

There are multiple theories and models of what drives the appropriation of innovations in economics ideas internationally across different cultures (c.f., Coats and Colander, 1989; Cardoso, 2003; Neves, 2017), but what they share is the assumption that ideas are changed in meaning and significance as they move from their place of inception to their place of appropriation. For a given innovation, then, we may distinguish between a diffusion-appropriation process in which ideas travel across a homogeneous cultural space, as in Rogers' cycle analysis of innovation diffusion, and a diffusion-appropriation process in which ideas travel across a heterogeneous cultural space. The difference is clear. For Rogers, increasing appropriation is driven by standardization as an innovation is adopted by a larger and larger number of adopters, while in a heterogeneous cultural space increasing appropriation instead increases the differentiation of ideas as adopters add new meanings and interpretations to the ideas being adopted.

I argued in the last section that Rogers' standardization view of individual innovations needs to be integrated with an account of how the interdependence between innovations affects the overall rates of innovation and specialization. Rogers' standardization view identifies centripetal forces working against the centrifugal ones that specialization produces, but Arthur's explanation of the increasing rate of technological change implies that these centripetal forces are overcome by how innovations build upon one another. In this larger framework, the overall rate of innovation continually increases in proportion to the growing number of interdependent new technologies, and assuming innovation drives specialization, the rate of specialization should always be increasing. When we then add in to this that innovation diffusion in a heterogeneous cultural space also works against standardization by producing changes in meaning, the overall account of innovation and specialization implies further fragmentation in science.

Needless to say, there are many potentially conflicting and overlapping ways in which cultural differences in language, history, social practices, and populations' relative positions vis-à-vis each

other can produce differences in the appropriation and adoption of innovations in science.⁶ Is there a general framework, then, which might help organize our thinking about this? One approach that has been employed to characterize a world exhibiting uneven development economically, socially, and scientifically is to use a core-periphery distinction (Almodovar and Cardoso, 1998; Fourcade, 2006). Thus, scientific communities might share science goals according to whether they occupy core or periphery. This suggests a sort of dual development process and the possibility that multiple sets of centripetal forces might work against fragmentation in science. However, this is beyond what can be discussed here, and accordingly I turn to what fragmentation in economics research implies about arguments for pluralism in economics.

4 Assessing arguments for normative pluralism in economics

At the outset, I distinguished descriptive pluralism and normative pluralism. Descriptive pluralism concerns the actual state of diversity in the approaches and content in economics research, and normative pluralism concerns arguments for promoting pluralism in economics regarding what ought to guide economists' research goals and the organization of research in economics. My view is that the former determines the grounds for the latter, that proceeding in the opposite way – the idea that normative arguments by themselves can produce greater diversity in economics – is likely to be unsuccessful, and that in any event much of the current discussion of normative pluralism in economics mistakenly proceeds apart from any significant consideration of the actual state of and trends affecting diversity in economics research.

I frame my discussion of pluralism in terms of 'economics' relation to other disciplines' (JEL code A12), since increasing specialization and a more niche-based economics may reduce economics' distinct identity as a discipline by fostering more borrowing from other disciplines, and this is one way in which pluralism in economics can be investigated. Previously, then, two views of how disciplines relate to one another, interdisciplinarity and multidisciplinary, have been distinguished, and it argued that the latter provides a better foundation for normative pluralism (Davis, 2017). Interdisciplinarity was explained in terms of relationships between autonomous disciplines, where these relationships may involve the export of ideas to other disciplines (often characterized in economics as imperialism) and their import and the borrowing of ideas from other disciplines (sometimes characterized in economics as reverse imperialism). This interdisciplinarity conception of economics' relation to other disciplines was in fact central to neoclassical economics' original defense of economics imperialism grounded in standard trade theory (Lazear, 2000).⁷

Interdisciplinarity, then, provides an obvious basis for promoting pluralism in economics in that it allows one to argue that, just as different disciplines should operate autonomously, so by extension different approaches within economics should operate autonomously. One problem with this argument, however, is that it says nothing about the extent of diversity that ought to exist within a discipline. Thus, the argument can be satisfied selectively by advocating pluralism for only some approaches in a discipline, say, approaches in mainstream economics, as for example when one

⁶ Three important dimensions are: how science texts are translated across languages, how national policy contexts selectively emphasize some dimensions of ideas and de-emphasize others, and how disciplines vary historically in importance across countries.

⁷ Essentially, disciplines' autonomy stems, as in trade theory's treatment of nations' autonomy, from given resource endowment differences, where 'given' is treated statically and in an ahistorical manner.

argues that there ought to be both behavioral and standard approaches in economics for explaining choice. That is, there is nothing in the interdisciplinarity defense of pluralism that implies *all* different approaches in economics ought to be promoted. A second problem with the interdisciplinarity defense of pluralism is that it also encourages an instrumentalist defense of pluralism, that is a defense pursued only if it helps one defend one's own approach. Defending one's own approach on pluralist grounds, however, tells us nothing about whether other approaches in a discipline ought to also be promoted.

In contrast, multidisciplinary is a complex systems conception. On this view, different disciplines exhibit many overlapping, cross-cutting relationships, have many different links to one another, and are consequently dependent upon and influence one another in multiple ways. What determines their individual identities can change over time as they change how they draw upon one another and reconfigure themselves, as for example in the shift from nineteenth century political economy with its ties to history and emphasis of the importance of economic classes to twentieth century marginalist economics with its turn to calculus and emphasis on individuals. Disciplines are only nominally autonomous, and do not retain unchanging identities over time.

Note, then, what type of argument for pluralism a multidisciplinary conception of disciplines implies. If different disciplines are dependent upon one another in complex ways, then by extension different approaches within disciplines should also be thought dependent on one another in complex ways. Like natural ecosystems, disciplines operate like complex systems that require the active functioning of all a system's interconnected specialized activities to maintain their overall functioning. That is, the specialization of activity in a complex system is both a function of a system's overall diversity and productive of the stability of that system. In contrast to the interdisciplinarity argument for pluralism, then, no approaches within a discipline can be ignored since it is never clear how the interconnectedness of a complex system secures that system. That is, rather than argue in interdisciplinarity terms – the perspective of proponents of individual approaches – and provide only an instrumentally defense of pluralism, what is more likely to promote pluralism is the argument that any discipline depends on sustaining its internal diversity – the perspective of the discipline as a whole – and the idea that diversity is intrinsic to entire systems.

Does what we appear to know about the state of diversity in economics then support this argument? What this paper has argued is that increasing specialization in economics has produced a fragmented, more niche-based economics research frontier. In complex systems theory, systems exhibiting high degrees of activity specialization are often more fragile than systems with lower degrees of activity specialization, because high degrees of interdependence increase the risks of system-wide disruption. Thus, it seems that what we appear to know about the state of diversity in economics provides good grounds for a multidisciplinary defense of pluralism, and a descriptive and normative pluralism in line with one another.

Interestingly, the multidisciplinary conception of disciplines, arguably underlies Trautwein's recent argument that the historians of economics are potentially the 'last generalists' able to counteract increasing fragmentation through specialization in economics (Trautwein, 2017). Trautwein enumerates a number of forms of reasoning historians engage in that could act to counter the centrifugal forces operating in economics research. Whether economics might come to re-value the history of economics after many years of dis-valuing it, however, is certainly an open question.

5 Concluding comments on specialization in the wider social and economic world

The arguments in this paper were focused on economics and science, but we might also ask in closing whether there is reason to believe that specialization is a fundamental process in the wider world that the development of economics and science simply reflects. Smith, then, tied increasing specialization to the growing extent of human activity, as captured by the growth of markets, so the steady growth of markets over hundreds of years alone implies specialization is a fundamental process in the human world. However, this does not tell us whether it is the growth in markets that makes greater specialization possible or whether some human impulse to specialize makes the greater extent of the market possible. I focus on the latter case because it offers us opportunities regarding how we might respond to increasing specialization via consideration of what motivates it. Two possible interpretations of people's possible motivations, then, were advanced above. Heiner explains the impulse to specialize as a rational response to the burden of our growing knowledge about the world. The accumulation of knowledge over time compels individuals, whether in science or elsewhere in the world, to specialize to protect their individual livelihoods. In contrast, Arthur explains the impulse to specialize in terms of human imagination. People simply see possible combinations of existing ideas that others do not, and seek to actualize their effects to achieve shared social goals.

These explanations could of course be complementary and both correct, or perhaps they might have alternating importance in the world according to how social organization supports individuals' specialization activities in science and the world. I suggest, however, that these two different ways in which specialization might develop have two different sorts of outcomes with respect to the fragmentation of human activity. Heiner's path is one framed in terms of human isolation – an extension of Smith's view of manual labor. Arthur's path is one framed in terms of shared social goals, however elusive they may be. How, then, should we look upon these two possibilities?

This paper examined the arguments for pluralism in terms of how research in economics and science should be organized. Yet those arguments also have more general meaning, and can be applied to how we think we ought to address diversity in the world, whether the result of specialization or due to given differences between people. Thus, carrying over the conclusions above, the basis for pluralism that seems preferable is one rooted in the multidisciplinary idea, or in general terms the idea that social systems are like ecosystems that prosper when diversity is regarded as intrinsically valuable. The interdisciplinarity idea that emphasizes autonomy, and which in general terms recalls traditional liberal values, also offers a basis for defenses of pluralism, but may offer defenses more suited to Heiner's world than Arthur's.

Assuming, then, that specialization is a fundamental human process, a pluralist response based on the idea that the world is a complex system seems the best response. Specialization does not make the fragmentation of human activity inevitable, but it does make it possible, leaving what will actually occur a matter of how it is addressed.

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