

3 The Revolution of Information Economics: The Past and the Future

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The economics of information has constituted a revolution in economics, upsetting longstanding presumptions, including the presumption of market efficiency, with profound implications for economic policy. The central models of information economics, developed almost a half century ago but greatly elaborated on in the intervening years, have proven remarkably robust. At the same time, these advances in the economics of information have shown the lack of robustness of the standard competitive paradigm. The models have provided a deeper understanding of other ways in which actual markets differ from the perfect markets paradigm. For instance, the imperfections of competition and risk-sharing are two features that matter a great deal, and the economics of information provided new insights into both of these.

Early work in the economics of information also showed how it would help us understand better the role of institutions and the form that institutions take; work since then has confirmed the promise. So, too, the economics of information has provided new intellectual underpinnings to branches of the subject that seemed devoid of a theoretical framework, such as accounting, finance, and corporate governance, and has helped us understand better why work in these subfields is so important.

Elaborations of the early models and the adaptation of these models to different market contexts have occupied much of the economics profession's attention in the decades since the first models were presented.

Paper presented at the conference "The State of Economics, The State of the World," World Bank, Washington, DC, June 9, 2016. I acknowledge research assistance from Andrew Kosenko and editorial assistance from Debarati Ghosh.

Not surprisingly, the policies derived from the new paradigm are often markedly different from those derived on the basis of the standard model. Most importantly, as I emphasize below, there is no presumption that markets are efficient; quite the contrary, the presumption is that markets are not efficient. And in those sectors where information and its imperfections play a particularly important role, there is an even greater presumption of the need for public policy. The financial sector is, above all else, about gathering and processing information, on the basis of which capital resources can be efficiently allocated. Information is *central*. And that centrality is at least part of the reason that financial sector regulation is so important.

Markets where information is imperfect are also typically far from perfectly competitive (as that concept is understood, say, in the models of Arrow and Debreu).¹ In markets with some—but imperfect—competition, firms strive to increase their market power and to increase the extraction of rents from existing market power, giving rise to widespread distortions. In such circumstances, institutions and the rules of the game matter. Public policy is critical in setting the rules of the game. Distributive effects of alternative rules may outweigh any efficiency gains.

Undoing the adverse distributive effects created by these market imperfections may be very costly, again, largely because of information imperfections.²

Many recent changes in the rules may have had both adverse efficiency and distributive effects. The economics of information has explained why distributive effects themselves may have efficiency consequences, especially in the presence of macroeconomic externalities.

Looking forward, changes in the structure of demand (that is, as a country gets richer, the mix of goods purchased changes) and in technology may lead to an increased role for information and increased consequences of

1. The market failures referred to in the previous paragraph arise even when firms and households are price takers. I am now describing an important second set of market failures typically arising in markets with imperfect information.

2. In standard economics, the second welfare theorem explains how any Pareto efficient allocation can be achieved simply through the redistribution of initial endowments. When there is imperfect information, the second welfare theorem is in general not true. For an exposition, see Stiglitz (1994).

information imperfections, decreased competition, and increasing inequality. Many key battles will be about information and knowledge (implicitly or explicitly)—and the governance of information. Already, big debates are going on about privacy (the rights of individuals to keep their own information) and transparency (requirements that government and corporations, for instance, reveal critical information about what they are doing). In many sectors, most especially, the financial sector, there are ongoing debates about disclosure—obligations on the part of individuals or firms to reveal certain things about their products. Many of these issues can be framed in terms of property rights—who owns the right to certain pieces of information. But these property rights issues are different from and more complex than those concerning conventional property rights, where it is usually assumed the stronger the better. Here, the ambiguities in the assignment of property rights are apparent, and so-called strong (intellectual) property rights may lead to poorer economic performance.

Globalization has heightened all the associated controversies because now, how the rules are set affects not only distribution among individuals within countries but also the distribution of income between countries. Many in the former colonial world see the attempt by some in the advanced countries to impose their set of rules as not just an attempt to enrich their corporations but also to entrench old inequities.

How we handle these issues will affect inequality, economic performance, and the nature of our polity and society for decades to come.

This paper is divided into seven sections. In the first, we lay out some of the key insights of the New Information Economics, contrasting it with the old paradigm, which assumed perfect information. The central result of the new paradigm is that markets are not, in general, efficient: There is a need for government intervention. Adam Smith's invisible hand failed, simply because it wasn't there. The second section describes several failed but still important attempts to respond—to show that the market was in fact efficient, if not always, at least in relevant cases. The third then describes some of the policy corollaries, and the ongoing policy battles over information. The fourth section sets the Information Revolution in the context of the longstanding battle of how to understand the persistent inequality under capitalism—is it exploitation (as Marx suggested) or just rewards in response to differences in social contribution? We suggest that although Marx had the wrong model of the economy, there is more than a little grain

of truth in his exploitation theories. The fifth section describes the role of the information revolution in promoting broader changes in the economic paradigm. The sixth looks forward—to the implications of the new paradigm for the economy that is evolving in the twenty-first century. I end with a few concluding remarks.

The Information Revolution

Economists had, of course, long recognized the importance of imperfect information. Indeed, some economic discussions actually trumpeted the informational efficiency of the market—arguing that efficiency can be achieved in a decentralized price system, so there is no need for a central planner. All the information that a firm or a household needed to know to make its decisions was to be found in the prices. Prices coordinated all economic activity. Yet these statements were made without any formal models of the economy as an information processor. Resource allocations were once-and-for-all decisions. Moreover, the kinds of information imperfections were limited. There was no uncertainty about the quality of a worker or a product.

By and large, formal models made no mention of information—other than to assume that there was perfect information. The hope was that analyses assuming perfect information would still be relevant so long as information was not *too* imperfect.

Some Chicago school economists thought that one could develop an “economics of information”—based on the analysis of the supply and demand for information (much like the “economics of agriculture”) and focusing on the particular characteristics of the demand for and production of information (just like agriculture economics focuses on the particular characteristics of the demand for and supply of food). But it should have been clear, even before the formal development of the field described below, that such a development was unlikely. Information (knowledge) is fundamentally different from steel, corn, or the other goods on which ordinary economics focuses. Information is a public good³—indeed, more broadly,

3. In the sense defined by Samuelson, as a good characterized by nonrivalrous consumption (the enjoyment of a pure public good by one individual does not detract from its enjoyment by others). Pure public goods are also typically characterized by the impossibility (or at least difficulty) of appropriation. As we discuss below,

knowledge is a global public good (Stiglitz 1999), and markets on their own typically are not efficient in the provision of such goods.

Arrow and Debreu provided the key benchmark model describing the behavior of a competitive economy with perfect information through a model of competitive general equilibrium in which all firms were price takers. Most importantly, Arrow and Debreu provided conditions under which Smith's "invisible hand" conjecture was correct, not just the first welfare theorem (showing that market economies were Pareto efficient) but also the second fundamental theorem. The latter showed that every Pareto-efficient outcome could be obtained through a market mechanism, provided that there was an appropriate initial (lump sum) redistribution of wealth. Arrow and Debreu focused on the technical conditions that were required—such as convexity of production sets (making use of the key economic assumption of diminishing returns)—as well on as the economic conditions: perfect competition, a full set of risk markets (subsequently called Arrow-Debreu "AD" securities), and the absence of externalities. They had provided sufficient conditions for the efficiency of the market. The question was: Would results still be true under more general conditions? Were the sufficient conditions necessary, or almost necessary? After several decades of research, it became clear that Arrow and Debreu had essentially discovered the necessary and sufficient conditions.⁴

Most of the limitations on which Arrow and Debreu had focused had in some sense been widely recognized well before their work. They had put these longstanding understandings on sound footings. And there were well-developed public policies in response: environmental regulation or corrective taxes, for instance, to deal with environmental externalities, and anti-trust policies to deal with imperfect competition. The existence

intellectual property rights are an attempt to enable the partial appropriation of the returns to the production of knowledge. Inherently, such attempts have a social cost, because the usage of the information or knowledge is restricted, though there is no marginal cost associated with usage.

4. There were a few other sets of uninteresting conditions—conditions that, remarkably, came to play a central role in a particular branch of macroeconomics. The economy would be efficient even in the absence of a complete set of risk markets if all individuals were identical—precisely because when they are identical, there would be no insurance. There would be no one else to whom someone could transfer the risk he faces.

of a natural monopoly required either strong regulation or government ownership.

Absence of a Complete Set of Risk Markets

The one “new” market failure to which Arrow and Debreu called attention was the absence of a complete set of risk markets. It was obvious that individuals and firms could not buy insurance against many of the risks that they faced—workers couldn’t buy unemployment insurance, firms couldn’t buy insurance against the risk that the demand for their products declined. But economists had not realized the importance of this failure. For Arrow and Debreu to establish the Pareto efficiency of the economy required the existence of a full set of what came to be called “AD securities”—securities delivering a specific amount of some commodity in a particular state at a particular date, in effect, a *complete* set of insurance markets. It was obvious that this was more than a matter of mere technicalities; there were many *important* risks for which households and firms simply couldn’t obtain insurance at all. One could think of public provision of social protection as having arisen to partially “correct” this market failure.

Presumption That Markets Are Not Efficient

Arrow and Debreu had, however, shunted aside the key question of information in all of its dimensions. Earlier, I described how market advocates viewed the informational efficiency of the economy as one of its triumphs. These advocates especially celebrated how much one could achieve without anyone knowing anything about any other firm or household: All relevant information was conveyed by prices.

But this model made extraordinarily strong assumptions that were not even stated: Products were homogeneous, and any individual could tell costlessly any deviation of the product from the “specified” characteristics. Cheating on quality was impossible. Everyone knew fully the “true” probability distribution of returns of every asset. There were no asymmetries of information, where a well-informed individual could take advantage of a less informed one.

In the real world, these quality differences are critical. Workers are not homogeneous. A great deal of effort goes into finding workers who are well matched for the job. Insurance firms worry about the risk profile of those they insure. The entire financial industry is focused on identifying “under-priced” assets.

Obviously, these information problems are important to all market participants. The early literature showed that information asymmetries—where one agent had information not available to another—presented a special set of problems. Attempts to extract that information or to exploit the informational advantages gave rise to multiple distortions. A great deal of activity is concerned with addressing these information problems (both the lack of information and asymmetries in information), improving information and reducing asymmetries, if not eliminating them. At the same time, some market participants realize that opportunities for profit can be enhanced by increasing information asymmetries. They devote their efforts to ensuring the existence and persistence of these information asymmetries, as costly as these asymmetries may be to the economy as a whole.⁵

Some two decades after Arrow and Debreu's work, Greenwald and Stiglitz (1986, 1988) showed that information market failures were much more pervasive and consequential. Whenever there was imperfect and asymmetric information or *incomplete risk markets*—that is, essentially always—the economy was not (constrained) Pareto efficient, taking into account the limitations of information. There were always interventions in the market that could make some individuals better off without making anyone else worse off.⁶ (For brevity, in the discussion below, I refer to this result as the “GS theorem.”) Correcting these market failures is not so easy: They are not isolated,⁷ they are diffuse, and they are an integral part of the market economy. In the presence of asymmetries of information and incomplete markets, there are pervasive pecuniary externalities *that matter*: What one firm or individual does has consequences for others, and that is true even when it is only through the price system. Price changes are more than purely redistributive.⁸

5. With perfect competition there are no pure profits, and firms realize (as already noted) that markets where information is imperfect are likely to be less than perfectly competitive. This principle holds in other contexts, as we discuss below: Managers may take actions that result in greater information asymmetries to entrench themselves.

6. Geanakoplos and Polemarchakis (1986) provided an alternative proof of the inefficiency of market equilibria when there is an incomplete set of markets.

7. This stands in marked contrast to pollution externalities, where at least in principle, one could ascertain the emissions of pollutants and impose a charge.

8. Greenwald and Stiglitz's proof of market inefficiency focused on these pecuniary externalities, showing that in markets with imperfect information or incomplete risk

Consider a group of seemingly similar people buying health insurance in a world in which smoking is not observable. Should one person smoke, it will increase the risk of disease, driving up the health insurance premiums of everyone. There is a real cost to this externality, which the smoker does not take into account. The market response is to limit the amount of insurance that an individual can obtain, so that she has some incentive to behave well. But a real cost results from this restraint; with risk-averse individuals, restricting the purchase of insurance lowers expected utility.

Information market failures obviously affect resources devoted to collecting, processing, and disseminating information. Information is a public good, with no marginal cost associated with the use of an idea by someone else, so normally one would expect an underinvestment in information. Thus, an idea that had some popularity for a while was that markets were informationally efficient, that is, they transmitted through prices all information from the informed to the uninformed. But in a sense, that idea (popularized by Fama (1970, 1991) but totally discredited by Shiller (1990) as well as Grossman and Shiller (1981)), was intellectually incoherent, as Grossman and Stiglitz (1976, 1980) pointed out: If the market fully transmitted information, no one would devote any resources to its collection.

Moreover, private returns to information often can exceed social returns: If I can prove that I am more able than someone else with whom I would otherwise have been grouped (in the absence of information), my wages will go up, but his wages will go down. My gains are at his expense. Much of the returns to information are thus *distributive*.⁹

In addition, firms will attempt to create barriers to the dissemination of information—politically, they try to create property rights (called “intellectual property rights”). These rights are costly to enforce and seldom enable

markets, their effects are markedly different than in the standard model, where such price effects cancel, with the gains of one individual being offset by the losses of others. Arnott, Greenwald, and Stiglitz (1994) explicitly show how changes in prices affect the self-selection constraints with first-order effects. Similar results hold for price effects on incentive compatibility or collateral constraints. The analysis of these effects has been at the center of the macro-externalities literature discussed below.

9. See Hirshleifer (1971) and Stiglitz (1975). While Hirshleifer identified the distributive effects of information, Stiglitz succeeded in analyzing the market equilibria. He showed that there can be multiple equilibria, with a pooling equilibrium (where the two groups are not differentiated) Pareto dominating the “separating” equilibrium (where the two groups are differentiated).

those investing in information to appropriate all the social returns from their information. However, to the extent that they are successful, these rights create a static market inefficiency: Because information, once created, is a public good, any barrier to its free dissemination introduces a distortion in the economy. In practice, the static costs are often increased, because these restrictions create barriers to entry, supporting a less competitive market environment, and yet the incentives provided for the creation of knowledge may be limited. Indeed, because the most important input into the production of knowledge is knowledge, by restricting the use of knowledge, these rights may actually impede innovation itself. More generally, the dynamic benefits are markedly less than the supporters of strong intellectual property rights suggest.¹⁰

Thus, the key insight of information economics—differing from worlds in which there is perfect information where social and private returns are normally the same—is that *social returns to information expenditures typically differ from private returns*, in some cases they are greater, in other cases less. This insight has many implications, including that privately profitable transactions may not be socially desirable. The subsequent literature has exposed a huge number of distortions in specific contexts. They include marginal inefficiencies, where a Pigouvian corrective tax might induce market participants to do more of the things that they are doing too little of and less of the things that they are doing too much of; and structural inefficiencies, associated with multiple equilibria, with the economy sometimes being in a Pareto dominated equilibrium (Stiglitz 1972, 1975).

Sometimes, limited government actions can ensure that the economy is in the “good” equilibrium.¹¹

Information asymmetries can be endogenous Moreover, households and firms have incentives for creating information imperfections (asymmetries)—they may gain from a lack of transparency. So can managers—it can enhance their “market power” by creating an entry barrier to competitive managerial teams (see Edlin and Stiglitz 1995).

Complexity is one way that financial firms in particular introduce opacity. Many financial transactions seem designed more to increase complexity

10. See Stiglitz (2008), Stiglitz (2014a) and Baker, Jayadev, and Stiglitz (2017).

11. For instance, discrimination laws can prevent an equilibrium in which some groups are treated worse than others (Stiglitz 1973, 1974b).

and the associated market power than to solve societal problems. Recent research has shown how complexity increases uncertainty even about systemic stability and the effects of regulatory policy. Although society would like a better functioning, more stable financial system, market participants are simply concerned with maximizing profits. The GS theorem emphasizes the disparity between private returns and social returns arising from information asymmetries and incomplete markets. But this recent work has noted other aspects of the market failures in the financial sector: By becoming too big to fail, too interlinked to fail, or too correlated to fail, financial institutions can ensure a bailout, in effect a transfer of resources from the public to themselves. Firms thus have incentives to become too big, too interlinked, too correlated to fail: There is a *systemic* problem.

With a high probability of a bail-out, they can engage in excessive risk taking, in which they realize the upside (the profits), and the public bears the downside (the losses). Moreover, with financial institutions that are too big to fail, too interconnected to fail, or too correlated to fail, success may not be based on relative efficiency but on relative size and linkages. And the huge excessive complexity that they have brought to the financial system makes the consequences of regulations more uncertain. If, as a result, regulators are discouraged from undertaking necessary regulations—for instance, relying on self-regulation—this provides an opportunity for those in the sector to increase further their profits.

These problems would simply not exist if there were perfect information, in which case private contractual arrangements would internalize these information-related externalities. These market failures clearly provide a rationale for government intervention. Much of the intervention has focused on *behavior* (e.g., restricting excessive risk taking and actions that enhance the risk of conflicts of interest). But this analysis has suggested that government needs to go beyond this focus, for example, to regulate the size of banks (to reduce the risk of being too big to fail), linkages among banks (to reduce the risk of being too interconnected to fail), and contractual arrangements (to reduce the risk of excessive complexity).¹² Recent research has also noted that (in part because government cannot monitor the actions of individual banks) what matters is the entire “ecology,” that is, the diversity (and interconnectedness) of financial institutions. Regulating this ecology (by, for

12. See Battiston et al. (2013, 2016a) and Roukny, Battiston, and Stiglitz (2016).

instance, preventing the creation of universal banks) mitigates the dangers of “too correlated to fail,” and provides part of the rationale for *structural regulations* (e.g., the Glass-Steagall Act, which separated commercial and investment banks).

Production and information are interlinked But the inefficiencies of the market economy go deeper, because production of knowledge and information is intertwined with other activities. Thus, the presumption is that the market is not only inefficient in the production of information/knowledge but also in the production of goods. For instance, knowledge or information is produced as a by-product of the production of goods; if this information leaks out to others, then the value of this information won’t be fully internalized in the determination of the levels of production (Stiglitz and Greenwald 2014).

Macro consequences of informational externalities Keynes provided an explanation of the Great Depression and other deep downturns that had afflicted capitalism from its beginning. But in the 1970s, dissatisfaction grew over the disparity between macroeconomics, as it had developed following Keynes, and standard microeconomics. Information economics provided the necessary underpinnings to reconcile the two. It explained, for instance, why credit and equity rationing occurred,¹³ why this led to risk-averse behavior on the part of firms (Greenwald and Stiglitz 1990), and why wages might not adjust even when unemployment is significant. (See Shapiro and Stiglitz 1984 and other variants of efficiency wage theory [Stiglitz 1987c].) These “financial frictions,” as they came to be called, gave rise to a financial accelerator, whereby small shocks to the net worth of a firm could give rise to large shifts in both the aggregate demand and supply curves.¹⁴ The effects of a shock could persist—the restoration of balance sheets and thus the recovery of the economy to full employment could take a long time. Moreover, the decentralized adjustment of wages and prices meant that in response to a shock, the economy might not instantaneously move to the new equilibrium set of wages and prices consistent with, say, persistent full employment. Indeed, the economy could persist with wages and prices each adjusting, but real wages and unemployment remaining

13. See Greenwald, Stiglitz, and Weiss (1984) and Stiglitz and Greenwald (2003) and the extensive lists of references cited there.

14. See Greenwald and Stiglitz (1993a) and Bernanke and Gertler (1990).

relatively unchanged (Solow and Stiglitz 1968), or even worse, the adjustments might lead to even higher unemployment (Stiglitz 2016).¹⁵

As already mentioned, Greenwald and Stiglitz (1986) noted that one could describe the market failures associated with adverse selection and moral hazard as giving rise to pecuniary externalities that matter. These microeconomic pecuniary externalities have their macroeconomic manifestation, which have been the center of much recent work in macroeconomics. For instance, the market equilibrium may be characterized by excessive foreign-denominated indebtedness (Jeanne and Korinek 2010). More generally, borrowers may not take fully into account the effects of their decisions on prices in the future, say, if they were forced to liquidate their assets. Each small borrower takes the price distribution as given; but of course, if they all borrow more, then if a crisis occurs, next period prices of certain assets will fall as they all are forced to liquidate more of their assets.

One of the implications of the theory is that it may be (in general will be) optimal to treat differently things that are *observably* different. Thus, contrary to prevailing attitudes, taxes and regulations affecting foreign capital and financial institutions should differ from those affecting domestic capital. The “nondiscrimination” provisions of some trade agreements cannot be justified in the context of a model with imperfect information.

Theory of second best Long ago, Meade (1955) and Lipsey and Lancaster (1956) warned the profession about the theory of second best. Just because an economy is inefficient doesn’t mean that moving the economy closer to a perfect model will improve welfare. In the presence of multiple distortions, removing one may worsen economic welfare. Newbery and Stiglitz (1984) demonstrated this idea in the context of a longstanding presumption by economists in favor of free trade. So long as there are imperfect risk markets, trade integration may lower welfare for everyone. But we will never have full information or a complete set of markets, so we are always in a second best

15. This line of work emphasized a quite different aspect of Keynes than that which has been the center of much recent work in macroeconomics, highlighting the consequences of wage and price rigidities. Here, it is price adjustments that give rise to problems (consistent with much of the recent policy concerns over deflation). It can be viewed as reviving Fisher’s debt-deflation theories (1933). Information economics also provided an alternative explanation of the slow pace of wage and price adjustments, associated with differential risk (Greenwald and Stiglitz 1989) and of adjustments in employment (Greenwald and Stiglitz 1995). The contrast between the alternative approaches to macroeconomics is discussed in Greenwald and Stiglitz (1987, 1993b).

world. Hence, we need to tread carefully when using the perfect markets paradigm as a guide to policy reform. Often it gives misleading advice.

One example concerns the absence of a complete set of risk markets. The question is: Will creating new financial instruments/markets increase welfare? The advocates of structured finance seem to have suggested that it will. The answer is far from clear. What is clear is that these new financial products give rise to at least three distinct problems.

The first one we have already noted: the increased complexity of the financial system results in financial fragility and reduces the ability of the regulator to effectively regulate the financial system. Financial interlinkages may lead to an increase in *intrinsic uncertainty*—with the possibility of there being multiple equilibria (even with rational expectations).¹⁶

The second problem is that differences in beliefs give rise to gambling (risk trading) opportunities. In such cases, both sides of the gamble (which is zero-sum) overestimate the probability of gain and react as if their actual wealth has increased. This gives rise to what Guzman and Stiglitz (2016a, 2016d) call pseudo-wealth, the wealth that only exists in the imagination of the gamblers. Changes in pseudo-wealth can give rise to macroeconomic fluctuations. Guzman and Stiglitz suggest that some of the observed increased volatility may be due to these new structured products, which open up new gambling opportunities.

The third problem is that the interlinkage of finance undermines the decentralizability of the economy, one of the main virtues of the market economy. To know the financial position of any firm requires knowing the financial position of all creditors, which requires knowing the financial positions of all creditors of creditors.¹⁷

Financial architecture matters In short, different architectures affect the extent of externalities and the nature of information requirements. There is no evidence that market-driven architectures are efficient: Because of the disparity between private and social incentives, one would not expect efficient outcomes. The design of the architecture can affect the magnitude and

16. Indeed, complex derivatives may even result in the nonexistence of equilibria. That is, without coordination, market participants can sign a set of mutually inconsistent contracts.

17. Requiring trading to go through adequately capitalized clearing houses—adamantly opposed by the financial sector—would go a long way toward resolving this problem.

consequences of the disparity of private and social incentives. Many of the new financial products giving rise to greater complexity may result in more “distorted” architectures, which increase the risk of financial fragility.¹⁸

Structured finance was thus not (as it claimed) really about matching risk.¹⁹ Significant moral hazard can also be associated with increased indebtedness, but there is no presumption that the market-determined contractual bankruptcy provisions are efficient. Indeed, the presumption is to the contrary, as each firm tries to signal that it is better than others. This is one of the reasons bankruptcy laws are necessary. (Advocates of the contractual approach to sovereign debt restructuring seem not to understand this.)²⁰

Information and Other Market Failures

Imperfect competition One of the important insights of the economics of information is that in the absence of good information, typically competition will be imperfect. And with imperfect competition, there is the possibility (likelihood) of firms exploiting market power, and indeed, with imperfect and costly information, of undertaking actions that enhance their market power.

Information is a fixed cost, introducing a natural “nonconvexity” into production. Convexity played a key role in the proofs of Arrow and Debreu. But these mathematical properties have economic implications. The law of diminishing returns long played a central role in economic analysis; but this “law” will not be satisfied when information is endogenous.²¹

With fixed search costs, no matter how small, it pays any firm to raise its price above that of others by a small amount—until the monopoly price is reached, so the only possible equilibrium is the monopoly price (Diamond 1971, Stiglitz 1985). But then it is worthwhile for firms to engage in nonlinear

18. Recent research on credit networks (Battiston et al. 2016a) highlights inefficiencies associated with particular architectures, for example, bankruptcy cascades and increased systemic risk with large/correlated shocks (following on earlier work by Allen and Gale (2000) and Stiglitz and Greenwald (2003)). For analogous results for cross-border financial linkages, see Stiglitz (2010c, 2010d).

19. The information that was collected was markedly different from that which would be needed if markets were engaged in “matching.” For example, see Stiglitz (1982).

20. See Brooks et al. (2015) and Guzman and Stiglitz (2016b, 2016e).

21. See, for example, Radner and Stiglitz (1984) and Arnott and Stiglitz (1988).

pricing, which extracts some of the remaining consumer surplus—to the point that there exists no market equilibrium (see Stiglitz 2013 and the references cited there).

Indeed, the major distortion of monopoly is in fact associated with its trying to extract information to enable it to extract more surplus from consumers (Stiglitz 1977). With perfect information, monopoly extracts all the consumer surplus, and it can do so (in theory) in a nondistortionary way. Distortions arise because the monopolist cannot easily differentiate those who enjoy different levels of surplus from its products: Marketing strategies, which are distortionary, are designed to maximize its ability to extract this surplus from its customers (Salop and Stiglitz 1977).

More generally, small sunk costs—and expenditures on information are always sunk costs—can give rise to persistent monopoly rents with Bertrand competition (Stiglitz 1987b).

Not only does imperfect information lead to imperfect competition, but also firms' attempts to manage information imperfections reduce competition. Efficient management of adverse selection/moral hazard involves intertemporal linkages—contracts extending over multiple periods, where, say, payments in one period are dependent on events/performance in earlier periods (Stiglitz and Weiss 1983). This limits the scope for the usual competitive mechanisms—where contracts are short term, and the threat of leaving acts as an important discipline device—and enhances scope for monopolistic exploitation. It also gives rise to *institutions* (like banks) responding by internalizing some of the information externalities.

Explanation of some key market failures The Arrow and Debreu analysis also gave rise to another question: How do we explain key market failures, such as the lack of a complete set of securities markets or limitations in capital markets? Information economics (adverse selection and moral hazard) provides at least part of the answer: Almost surely, the firm knows more about its profits prospects than do possible insurers, and so it would not be expected to buy insurance against a risk of low profit levels unless the terms were favorable—terms that would make it unprofitable for the insurer.²²

22. In the absence of risk aversion, there obviously would be no trade in such securities. This is the implication of the Akerlof (1970) lemons model and the no-trade theorems of Grossman and Stiglitz (1980) and Milgrom and Stokey (1982). See also Stiglitz (1982).

Information economics also provides one of the explanations for why Coasian bargaining would not resolve problems posed by externalities. Coase suggested that through bargaining, an efficient outcome could be achieved only if there were clear property rights. However, bargaining with information asymmetries typically is not efficient, as parties engage in costly actions to convey information about the value of the externality imposed on them.

Responding to Market Failures: The Possibility of Dysfunctional Social Institutions

Information-related externalities are not only pervasive, they are also diffuse, making it difficult to address them with corrective taxation, though corrective taxation should be part of the policy response (see Arnott and Stiglitz 1986).

Sometimes the appropriate response is the public provision of information (or restrictions on withholding information). Thus, when designing systems for leasing oil in different tracts, auctions will suffer greatly if some firm is known to have more information than the others. This provides a rationale for exploratory drilling to be done by the government.

Sometimes the consequences of these market failures are so obvious and severe that society responds through the creation of social institutions. The absence of life insurance led to the creation of burial societies to help families meet the unexpected costs of an untimely death. Such societies, mentioned as early as Ancient Rome, were widespread in Victorian England and still exist today. There was no moral hazard problem here—no one would die just to have his or her family collect burial insurance—and the problem of adverse selection was slight. Perhaps the simplest explanation of this “market failure” is that the transactions costs were high. As a result, it may be more efficient to provide such social protection through the government.

More generally, society responds to market failures by developing institutions and contracts. But there is no presumption that these institutional solutions lead to Pareto efficiency. Indeed, Arnott and Stiglitz (1991) show that institutional interventions may actually be dysfunctional. Imperfect “family” insurance (imperfect because risk is shared only among a few individuals) displaces (“crowds out”) more efficient (but limited) market insurance.

Further Key Insights of the Information Paradigm

Robustness of the standard model As information economics developed, a key question was: How robust is the standard model, which had ignored information imperfections? The answer was: not very, with even slight imperfections of information leading to marked changes in results (e.g., concerning the nature, optimality, and even existence of equilibrium (Rothschild and Stiglitz 1976)). Many of the key characterization results also changed, once information imperfections were recognized. For instance, markets might not clear even in equilibrium, and the Law of Single Price was repealed. Markets could be characterized by a price distribution, even when no source of exogenous noise was present.

Robustness of the new paradigm It was natural, at this point, to ask: How robust are these new models? The key information problems and modes of analysis that were identified early (adverse selection, moral hazard) have remained the central foci of research for almost a half century. At the same time, the precise characterization of the equilibrium turned out to be dependent on details of markets and, in particular, on assumptions about information. The early literature differentiated between a price equilibrium (in which sellers of, say, insurance had no information about the characteristics of the buyers or their actions, such as how much insurance they purchased),²³ as characterized by Akerlof (1970), and the quantity constrained equilibrium (in which insurance firms had such information, with in effect each buyer buying exclusively from one firm). More recently, Stiglitz, Yun, and Kosenko (2017) have shown that if individuals/firms can decide whether to hide or disclose information, then neither Akerlof/price nor Rothschild-Stiglitz/quantity equilibrium can be sustained. An equilibrium always exists (unlike Rothschild-Stiglitz), and the unique equilibrium is a disclosed pooling contract (the one most favored by low-risk individuals) supplemented by an undisclosed price contract at the high-risk individual's odds purchased only by high-risk individuals.

In the presence of adverse selection and moral hazard, a pooling quantity equilibrium may exist (Stiglitz and Yun 2013), something that could not occur if there were only adverse selection.

23. Or, correspondingly, the buyers of cars had no information about the sellers.

One of the significant contributions of information economics was to show the importance of, and to analyze the forms of, contracts (Stiglitz 1974a) and institutions, like banks. Loans are not made through auctions but through institutions like banks, which gather and process information. Information economics also led to a new focus on enforcement and commitment (time consistency). A key issue in contract enforcement, for instance, is verifiability and thus relates to information.

All of this stood in marked contrast to the Arrow-Debreu framework, where not only was the information structure exogenous, with a complete set of markets, but there were also no problems with enforcement and no issues of commitment.

Second fundamental theorem also reversed As noted earlier, Greenwald and Stiglitz (1986) showed that when there was asymmetric information, markets were not efficient, thus undoing the first fundamental welfare theorem of economics. Rather than the presumption being that markets are efficient, now there is a presumption that they are not.

But what about the second fundamental theorem, which asserts that any feasible Pareto efficient distribution of income could be attained through a market mechanism, with the correct initial redistribution of assets? This theorem was enormously important, because it enabled the separation of issues of efficiency from those of distribution. Economists should focus on efficiency, leaving distribution to politics, or so it was argued.

The new paradigm, however, shows that the distribution of wealth (assets) matters, and distributional effects cannot be undone through (lump sum) redistributions—partly because the information required to achieve those lump sum distributions is not available, and the only feasible redistributive taxes are distortionary.²⁴

Key question: What is the critical market failure? Much of the early literature on imperfect information focused on information asymmetries, with some discussions of imperfect information going so far as to suggest that virtually all distortions associated with imperfect information arise from these information asymmetries. But the real issue is not so much asymmetry of information as the endogeneity of information. For instance, the life insurance firm may know far more about the statistics of life expectancies

24. See Mirrlees (1971), Shapiro and Stiglitz (1984), Stiglitz (1987a), and Brito et al. (1990).

than those they are insuring. The individual may not know whether he or she is a high-risk or low-risk individual. The life insurance company may still engage in costly screening activities (including the use of self-selection mechanisms) to identify individuals who have characteristics that are systematically associated with longer life expectancy (see Stiglitz 2002).

Not only is information endogenous but so also are asymmetries of information (in contrast, most of the earlier literature simply assumed that the asymmetries are given exogenously). As already noted, firms and individuals have large incentives to create and enhance market power and to maximize rent extraction through the creation of information asymmetries.

Information and Delegation

Imperfect information implies that the standard analysis of efficient decentralization, based on the AD model with perfect information, is not correct. But it is the costs of collecting and disseminating information that make decentralization necessary and give rise to delegation, with profound implications for economic organization. Delegation means, for instance, that there is a separation of ownership and control: This separation undermines the standard theory of the firm and gives rise to problems of corporate governance.

Among the important market failures are those associated with corporate governance. Managers do not necessarily do what is in the interests of shareholders. Even larger differences arise between social returns and managerial returns, implying that the market solution cannot be presumed to be efficient. There are imperfections in all control mechanisms (e.g., takeovers). That is why the rules of the game—the laws governing corporate governance—matter.²⁵ These issues are particularly relevant in the financial sector.

Economics of Knowledge

Most of the results I have just described have applicability beyond information economics narrowly defined, to the economics of knowledge.²⁶ Indeed, knowledge can be thought of as a particular form of information. Knowledge is, of course, at the center of the theory of innovation. With a modern economy often characterized as a knowledge or an innovation economy, it is clear that understanding the economics of knowledge is

25. Stiglitz (2015).

26. The ideas in this section are developed more fully in Stiglitz and Greenwald (2014).

key. Knowledge, like information, is different from an ordinary commodity. The tools and insights of standard economics, developed for thinking about the demand and supply of pins, steel, oil, and other conventional products, are of only limited relevance to understanding a knowledge economy.

As I have suggested, knowledge is a form of information with many or most of the latter's key properties. Most importantly, knowledge is a quasi-public good—with, as already noted, no marginal cost associated with the use of an idea by someone else. Hence, there is always an inefficiency associated with restricting usage, such as through intellectual property rights. Like many public goods, the appropriation of returns is also difficult. There are typically large spillovers from an important innovation, such as the laser or the transistor, with the innovators typically capturing a small fraction of the social benefits.

The implication is that the insights that we have gleaned from the study of the economics of information apply to innovation and the production of knowledge. Markets on their own are not likely to be efficient, and competition is likely to be imperfect. This runs contrary to a longstanding view that the real strength of a market economy is the drive for innovation through Schumpeterian competition.

Early Attempts to Broaden Perspective—to Recover Previous Results on Market Efficiency—Failed

Arrow and Debreu had provided sufficient conditions for the efficiency of the economy, but not necessary ones. A search ensued for weaker conditions under which the market was still efficient.

The best-known example was that of Diamond (1967), who established the (constrained) efficiency of an economy with a stock market. Even with the highly restricted notion of optimality and highly restrictive assumptions about risk (each firm fell within a risk class and couldn't change the probability distribution of returns; it could only change the scale of production), the result turned out not to be general. With just two commodities, or with bankruptcy costs, or with decisions that affect the pattern of risk distribution, the result was not true: The market was not (constrained) efficient.

As already noted, this quest for weaker conditions under which markets are efficient ended with the Greenwald-Stiglitz (1986) theorem, which showed that markets were generically inefficient; they would be efficient only in special cases. For instance, the absence of risk markets would make no difference in an economy with a single individual, because there is no one with whom the individual could share or trade risk.²⁷

But there was a second issue—how markets dealt (imperfectly) with the consequences of imperfect information, including the absence of state-contingent commodities. Contracts (with payments dependent on observable state outcomes) provided a way of simultaneously sharing risk and providing incentives (Ross 1973; Stiglitz 1974a).

A huge literature ensued, exploring optimal contract design. One interesting result is that the predicted complexity²⁸ was far greater than what was observed. For instance, because common shocks are among the unobservable variables, optimal contracts should make compensation dependent on others' outcomes: The predicted *forms* of contracts thus are typically different from those which are observed (see Nalebuff and Stiglitz 1983a, 1983b).

New Institutional Economics

Although the contracts that were observed differed markedly from those that were predicted, the information paradigm more generally helped explain many aspects of observed institutions. For instance, sharecropping has long been criticized as attenuating incentives—with half or more of the (marginal) returns going to the landlord. But Stiglitz (1974a) explained sharecropping as balancing out incentives and risk sharing—a “reasonable” contract, given the limitations of information and risk markets.

Although many aspects of contract design are consistent with what theory predicts, the hope that these institutions would lead to Pareto efficiency failed; as already noted, they could even worsen welfare.

27. As already noted, the failure of markets to be efficient can be simply explained: with imperfect information, the key constraints—incentive compatibility constraints, self-selection constraints, and collateral constraints—are all affected by what *other* individuals do; each individual fails to take into account how his or her actions affect these constraints. And these effects are of first-order importance. These externalities matter.

28. Except under special and easily rejected specifications of utility functions.

Policy Corollaries

There are many policy corollaries to the ideas that I have just discussed. In particular, Washington Consensus/neoliberal policies were predicated on the Smithian presumption that markets are efficient and the presumption that moving toward a perfect market would be welfare-enhancing, ignoring second best economics. As already noted, it is wrong to presume that moving the economy toward first best economy is welfare-enhancing. But even if this were not the case, there would be winners and losers, the adverse distributive effects could outweigh any gains, and the cost of undoing distributive effects could be large.

Policy Battles over Information: High-Frequency Trading

Today, a new set of battles has emerged, many directly related to information. It is in this arena that social and private returns are most likely to be large, and therefore the insights of this chapter are most likely to be relevant.

Consider, for instance, the development of high-frequency trading. It was often justified by “price discovery”—uncovering prices to enable the efficient allocation of resources.²⁹ But this was a self-serving justification of the financial sector: No evidence has ever been presented of its importance; no evidence suggests that having slightly more accurate prices a nanosecond earlier than otherwise has led to higher growth or more efficient resource allocations. The reality is that it may be a new form of front-running—those who get information about bids and offers or trades before others can make a profit. Indeed, by extracting some of the rents that would have gone to those who actually do research, high-frequency trading reduces the overall efficiency of the economy à la Grossman-Stiglitz (see Stiglitz 2014b).

Other New Policy Insights: Structured Finance

The new theory changes views about a variety of government policies. For instance, I have already noted how creating additional risk instruments may actually increase risk. So, too, welfare may be increased by requiring

29. High-frequency trading is also justified by “liquidity”—enabling individuals to easily move into or out of assets, enhancing willingness to make real investments. But this also seems largely to be a self-serving argument of the financial sector: The evidence is that liquidity dries up when it’s needed.

disclosures—market equilibrium disclosures do not suffice. And welfare may be increased by requiring trading to occur in markets (through clearing houses), as long as they are adequately capitalized,³⁰ because that improves the decentralizability of the economy.

Securitization The information paradigm helps us understand what went wrong with the securitization market. Before the 2007–2008 financial crisis, there was enormous enthusiasm about securitization because it allowed the dispersion of risk throughout the economy. But securitization entailed the delegation of different aspects of information gathering and analysis to different entities. For securitization to work well required complex contracts (with put backs and warranties). It failed, partly because of massive fraud³¹ but also because of extensive problems in contract enforcement: Mortgage originators and even seemingly reputable investment banks simply refused to honor their contracts. This behavior highlights the issues of contracts and enforcement noted earlier and the important role of government in preventing fraud in information markets (Greenwald and Stiglitz 1992).

These failures of securitization (capital markets) should not come as a surprise. What is a surprise is the failure of both markets and government regulators to understand and anticipate the limitations of capital markets and securitization, including the limitations on informational efficiency of markets (Grossman and Stiglitz 1980) associated with the difficulties of appropriating returns.³²

30. Which can be accomplished by requiring joint and several liability among market participants.

31. That is, the information provided to those who bought the mortgages and mortgage products was massively incorrect—with relatively clear evidence that the sellers did so at least partially intentionally.

32. The credit rating agencies not only were massively wrong in their evaluations of the probability of default of different tranches of the structured products (for which they were paid handsomely); again, there is also evidence of fraudulent behavior. I was privy to the evidence on fraud and the failure to comply with contract provisions as an expert witness in several cases against the rating agencies, the investment banks, and other financial institutions. But the federal government and state governments have brought cases in which some of this evidence has been publicly disclosed. The *Final Report of the National Commission on the Causes of the Financial and Economic Crisis in the United States* (2011) identifies the behavior of the credit rating agencies and the structured financial products as two of the main causes of the financial crisis of 2008–2009. See also Stiglitz (2010b, 2010d).

Banks can be viewed as the alternative institutional solution to these informational problems.³³ It is noteworthy that a decade after the collapse of the mortgage securitization market in the United States, it has not been restored. Evidently, the banks—in spite of their belief in free markets—want a structure that entails unacceptable levels of public risk bearing.

Other aspects of financial sector regulation Much of the profits arising from financial activity is associated with market exploitation (much of which would not arise in the presence of perfect information), including creating and exploiting asymmetries of information and market manipulation. In their book *Phishing for Phools*, Akerlof and Shiller (2015) describe the incentives for exploiting “ignorance,” irrationalities, and market power.³⁴ Predatory lending and abusive credit card practices are only the most obvious examples.

I have also noted banks’ incentives for increasing complexity—and the disparity between social and private returns in increasing complexity. Increased complexity even gives rise to new opportunities for hard-to-detect fraud. Banks availed themselves of these opportunities. High legal costs, statutes of limitations, and political capture all make it difficult to prosecute.

The financial sector has developed new ways of increasing its rents and new justifications for its exploitive activity that have sometimes prevailed in courts. Changes in technology and knowledge (e.g., about individual irrationalities and how to exploit them) and legal frameworks may have also enhanced the ability of the financial sector to exploit others.

Reconciling Two Long-Competing Theories for Describing Market Equilibrium and Explaining Inequalities

For more than 200 years, there have been two basic strands of economic theory. One emphasizes the role of competition (competitive equilibrium theory); the other, market power (exploitation).

33. Advocates of securitization never explained why one could not obtain adequate risk diversification through diversified ownership of banks.

34. Here I am focusing on the consequences of imperfections in information. The financial sector also enjoyed enormous rents from exploiting other sources of market power, for example, from running payment systems (credit and debit cards).

In recent decades, the former theory has dominated in the West. Of course, some constraints are always placed on the exercise of market power, *some* competition exists. But the standard (price-taking) competitive model describes few markets. Many tests of competition are only tests of the presence of some competitive constraints, not tests of how close the economy approximates a perfect competition model.

The imperfect information/imperfect competition model is fundamentally different from either polar case of perfect or no competition. I believe the real world is best described by this mixed model. In an economy that is perfectly competitive, there are, of course, no rents. In an economy where a monopoly exists in each sector, there are no battles over rents: The monopolist simply gets them. In reality, the key battle is over grabbing or limiting rents, over the structuring of markets and the rules of the game, which affect the magnitude and distribution of rents.

The rules of the game matter—markets do not exist in a vacuum. Different rules affect the well-being of different groups; each tries to restrain the feasible set of contracts and actions of others in ways that benefit themselves, and more generally, change the rules to enrich their interests at the expense of others. The public interest, of course, is to create institutional frameworks for corporate and public governance that benefit ordinary citizens and society as a whole. This is why the presumption that markets are basically competitive is a poor starting point for policy analysis, because it shunts aside all issues associated with the grabbing of rents. Governance is crucial—who makes the decisions, and the rules under which the decisions are made. In the AD model, there is no real governance issue—each firm simply maximizes its market value, and all shareholders agree that that is what it should do. With imperfect information and imperfect risk markets, it matters whose judgments are decisive, and how different judgments are “aggregated.” Different individuals will have different views about what the firm should do (Grossman and Stiglitz 1977).

Economists have long recognized that governance matters in the public sector and that there is no simple way of aggregating preferences. That was the essential insight of Arrow (1951). For example, monetary policy made by those representing workers, focusing on unemployment, will be markedly different from that made by those representing bond holders, focusing on inflation. Information economics has made it clear that this is true in the private as well as in the public sector.

Indeed, the rules of the game matter in every aspect of the economy—corporate governance, financial sector, monetary policy, bankruptcy, anti-trust, and labor. Workers will do better with rules that facilitate the formation of unions, encourage union membership, and strengthen their collective bargaining rights, recognizing the “public good” they provide (all workers benefit when wages are increased). All consumers benefit with a strong anti-trust policy that recognizes that when there is market power, prices increase, and an increase in prices lowers standards of living of ordinary citizens just as a decrease in wages would. Even bankruptcy law can have important effects: Laws giving derivatives first priority in bankruptcy, even over workers, encourage derivatives and impose greater risks on workers. Laws saying that student loans cannot be discharged, even in bankruptcy, encourage predatory student lending, lead to the immiseration of those at the bottom, discourage investments in education, and increase inequality overall.

Broader Theoretical Impacts of Information Economics

The information revolution played a critical role in some broader changes in economics, beyond those just described, including giving rise to new subfields like contract theory. As noted in the Introduction, it provided for the first time intellectual foundations for fields like accounting. In finance, it created tensions between two branches, one focusing on the benefits of risk diversification, the other on the collection, processing, and dissemination of information. As noted, these branches are often in tension: securitization and structured financial products allegedly led to better risk diversification and matching of risk profiles with individuals’ preferences and situations, but they also reduced the incentives for the collection and processing of information. The financial crisis demonstrated that the latter effect dominated the former.

But among the greatest legacies of information economics is its contribution to the growth of behavioral economics. Although models with imperfect and asymmetric information were able to explain many previously unexplained phenomena, models with rational behavior with imperfect information still could not explain some of what was going on (e.g., in financial markets). This provided the impetus for the development of behavioral economics.

The original work (e.g., Kahneman and Tversky 1979; Tversky and Kahneman 1974, 1981) incorporated insights from psychology. Individual decision-making, especially when decisions were made quickly, involved a myriad of biases, such as confirmatory bias, where individuals weight more heavily evidence that is consistent with their priors (Kahneman 2011).

More recent work, focusing on endogenous preferences and beliefs, and emphasizing the role of “mental models” (the lens through which we see the world), has incorporated insights from sociology and social psychology. Both fields have helped provide insights into societal rigidities and social change (Hoff and Stiglitz 2010, 2016). They have provided new instruments for policy, especially in the context of development, as illustrated by the World Development Report, *Mind, Society, and Behavior* (World Bank 2015).

A Look Forward

At one time, it was hoped that advances in technology, including the Internet, would increase competition by lowering search costs. This is true in some areas, which have homogeneous or well-specified commodities and manufactured goods. But new technology has also increased the ability to exploit—increasing asymmetries of information and market power of those who have differential access to information.

More broadly, some of the changes in our economy—in technology, in demand structure, and in our regulatory framework—have exacerbated the disparity between private and social returns to information (knowledge) and enhanced rent seeking and the capacity for rent extraction. These changes in underlying fundamentals will require changes in policy to prevent increasing market power and inequality. There is a risk that the move to the “information economy” may give market power to those who dominate in grabbing information (such as Google and Facebook), distorting both the markets for goods and services (increasing the ability to price discriminate)³⁵ and innovation. Innovation will be encouraged in areas with high potential for grabbing rents based on information, thereby moving scarce research resources away from areas where social

35. Recall our earlier discussion that imperfections in information have fundamental effects on production.

benefits would be higher. The extent to which this occurs will be determined by the rules of the game, for instance, about privacy, transparency, ownership rights of information (data) transmitted over a platform, and constraints on the ability of individuals to give up their rights. This is an area rife with externalities and other market imperfections, so government cannot shy away from taking a role; it cannot just “leave it to the market.”

Moreover, partly because of the network externalities, it is hard to displace incumbents or change structures: Decisions today will have long-lasting effects, with the market characterized by having one or at most a few dominant firms whose dominance persists for long periods.

New Technology

The new technologies of the past two decades have played a particularly important role in forcing these issues on us. They are responsible for the creation of the information economy. Network effects and the increasing role of knowledge may naturally lead to more scale economies. When network effects are strong, there is a natural monopoly. The classical literature on natural monopolies states that they either have to be closely regulated or nationalized. Until recently, these new natural monopolies have managed to fend off even the recognition of their market power, and therefore of any serious attempt at regulation. As Europe has taken a closer look at their practices and found them anticompetitive, the United States has complained about the European Union taking an anti-American position. This is wrong. European anti-trust authorities are doing what they should, trying to ensure that market power is not abused. It is partially because of the political influence of these American near-monopolies that the United States has not taken actions.

The abuse of their market power is especially likely and troublesome. I noted earlier that the real distortion associated with monopoly arose from the attempt to differentiate among customers, to extract more of each individual's consumer surplus for the monopoly itself. An understanding of behavioral economics and the theory of discrimination (based on the economics of asymmetric information) plus access to enormous amounts of new data enhance their ability to exploit their market power. Even more troublesome is that their access to and ability to exploit data on

individuals raises deep questions about rights to privacy and the nature of our society.

Schumpeter argued that we should not be much worried about monopolies. One monopoly will be succeeded by another, and competition to be that monopolist incentivizes innovation. Those ideas have now been discredited.³⁶ But the special features of these new technologies, with their access to large amounts of data that cannot be replicated, may have enhanced the ability of incumbents to persist, in spite of some instances of disruptive technology.

The Changing Structure of the Economy

Other changes in the economy may have changed the role of information—again in ways that make the economy less competitive. It is widely noted that we are moving from a manufacturing economy to a service economy. Manufactured goods are produced and sold globally. Thus, it is relatively easy to obtain and transmit information about these products.

By contrast, many of the services that will constitute an increasing fraction of gross domestic product are produced and provided locally. Consumers care about the quality of the services provided, and therefore information about quality is key and reputation effects are critical. But all of this gives rise to local market power.

Interplay between Increased Market Power and Politics

Increased economic inequality arising from the natural market forces I have just described leads to increased political inequality—which in turn leads to restructuring the rules of the game (e.g., rules governing privacy and transparency) to enhance market power and increase inequality. But as the rules of the game are shaped to enhance the incomes of those with market power, not only is inequality increased but also economic performance is likely weakened.

36. Dasgupta and Stiglitz (1980) showed that incumbents have the power and incentive to persist, and Fudenberg et al. (1983) showed that they could persist with a low level of expenditures on research, and thus a low level of innovation. For a more general and updated discussion, see Stiglitz and Greenwald (2014), especially chapters 5 and 6 of the 2015 revision.

Concluding Comments

Information economics has had a transformative effect on economics and economic policy, directly giving rise to new sub-branches of economics, such as contract theory, which have developed enormous literatures of their own.

It has provided explanations of phenomena that previously had been unexplained. A century ago, there was a conflict between institutional economics and “theoretical” economics, derived from the work of Smith, Ricardo, Walras, and Cournot. Information economics has, in a sense, united these two schools by highlighting the importance of institutions, at the same time that it has demonstrated the limits of markets. In many cases, it has been able to explain not only the existence of certain institutions but also their structure.

It was also noted that some phenomena could not be explained in a framework of rational individuals making decisions with imperfect information. These “failures” were important in encouraging the development of behavioral economics.

Information economics, together with other work derived from advances in game theory, has strongly suggested that the economy is best viewed through models that highlight market imperfections rather than through the lens of the competitive equilibrium model. These imperfections include imperfect and asymmetric information and the other market failures to which they give rise: incomplete risk markets, market power, and the possibilities for enhanced rent seeking and exploitation.

Most importantly, information economics has questioned—and in many cases reversed—longstanding presumptions of economic policy. The presumption is that market economies are *not* efficient. In the case of pervasive market power, there are interventions that can simultaneously increase efficiency and equity.

These ideas are particularly important for an institution like the World Bank, attempting to promote development in some of the poorest countries of the world. In these countries, markets are often weak or nonexistent, and the institutions that promote the gathering, production, and dissemination of information are particularly weak. For a long time, the Bank predicated its advice on an economic model that ignored the role of imperfect information. Fortunately, for the past two decades, the Bank has been at the

forefront in raising questions about that model and enhancing our understanding of the implications of alternative frameworks—like those discussed here—for development policy.³⁷

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37. See, for example, the 1998 World Development Report, *Knowledge for Development* (World Bank 1998), and the 2015 World Development Report already cited (World Bank 2015).

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Comment: Ravi Kanbur

Left Field Observations on the Information Revolution in Economics

There is no question that an information revolution has occurred in economics. And there is no question that Joe Stiglitz is a revolutionary leader. The classic papers in this literature bear the names of Stiglitz, Rothschild-Stiglitz, Stiglitz-Weiss, Shapiro-Stiglitz, Grossman-Stiglitz, Greenwald-Stiglitz, Newbery-Stiglitz, and so on.

And there is no question that development economics is closely entwined with the information revolution. The development context provided the spur for the theorizing and conceptualizing of Stiglitz, Akerlof, and others. The information revolution in turn has implications for development economics and development policy, including, for example: (1) share cropping and agrarian relations; (2) credit rationing, moneylenders, and micro-finance; (3) asymmetric information and efficiency wages; (4) migration models; (5) commodity price stabilization; and (6) free trade and uncertainty, and many other topics.

So what can you say after Joe Stiglitz has given his account of the information revolution in economics? It is a bit like critiquing Fidel Castro's account of the Cuban Revolution, or taking issue with Dwight Eisenhower's narration of the D-Day landings. Commentary is particularly difficult when you agree with the revolution and the revolutionary on almost everything, and consider yourself to have been a foot soldier, having fought in the "risk taking and inequality" detachment of the revolutionary brigades.¹ So,

1. See, for example, Kanbur (1979).

what to do? To make the commentary somewhat interesting, I will come at the revolution from left field and pose some methodological questions for myself, for Joe, and for all of us to ponder.

Expected Utility Analysis

The core analytical tool in the information revolution armory has been expected utility (EU) analysis. As we all know, questions have been raised about the independence axiom that undergirds the EU representation of preference orderings. It is this axiom that allows the representation to be separable in a specific way between the utility of an outcome with certainty and the probability of that outcome. But individuals do not appear to behave according to this axiom, with research on this going back at least as far as the Allais paradox.

At one level, it is remarkable that so many features of the real world, like credit rationing or insurance market failures, can be explained with models in which agents are assumed to behave in a manner that they do not actually behave like in practice. And it may not matter methodologically, so long as the predictions of the models are not falsified by observations. But it does raise the question: How exactly would the iconic results of the classic models in the revolution survive without EU?

In all of the well-known exercises that establish the iconic results of the imperfect information revolution, we use EU. For example, in the classic Rothschild and Stiglitz (1976) paper on insurance, when we show that a pooling equilibrium can be broken by a separating insurance contract, and a separating equilibrium can be broken by a pooling contract, we use EU comparisons. In another classic (Stiglitz and Weiss 1981), when we show that credit rationing is an equilibrium for lenders, we use EU. And so on.

Could we construct these equilibria, or show nonexistence of equilibrium, if agents did not behave according to EU? My instinct is that we could. In the insurance context, for example, non-EU preferences might allow a wider range of contract offers, which could break an existing equilibrium. But the twist is that the candidate equilibrium would first have to be described in a non-EU frame. This is an open and interesting area for research. And note that it is not enough to argue, as Machina (1982) does in a famous paper, that EU works locally as a linearization—many of the results require global comparisons.

Radical Uncertainty and Behavioral Economics

EU analysis, the foundation of Stiglitzian imperfect information analysis, is also confined to risk, where probabilities of outcomes are well defined and known, as opposed to uncertainty, where this is not the case (also known as Knightian uncertainty). Such radical uncertainty was well described by Keynes (1937, 213–214), in an article that introduced the conceptual foundations of the General Theory to American audiences:

By “uncertain” knowledge, let me explain, I do not mean merely to distinguish what is known for certain from what is only probable. The game of roulette is not subject, in this sense, to uncertainty.... The sense in which I am using the term is that in which the prospect of a European war is uncertain, or the price of copper and the rate of interest twenty years hence.... About these matters there is no scientific basis on which to form any calculable probability whatever. We simply do not know.

Keynes (1937, 214–215) then goes on to develop the argument further, especially the implications of such radical uncertainty for behavior. Summarizing somewhat:

How do we manage in such circumstances to behave in a manner which saves our faces as rational, economic men? We have devised for the purpose a variety of techniques, of which much the most important are the three following: (1).... (2).... (3) Knowing that our own individual judgment is worthless, we endeavor to fall back on the judgment of the rest of the world which is perhaps better informed.... Now a practical theory of the future based on these three principles has certain marked characteristics. In particular, being based on so flimsy a foundation, it is subject to sudden and violent changes.... At all times the vague panic fears and equally vague and unreasoned hopes are not really lulled, and lie but a little way below the surface.

These “behavioral considerations,” as they would now be called, are not present in Rothschild-Stiglitz, Stiglitz-Weiss, Grossman-Stiglitz, and so forth. In all of those models, agents are rational choice EU maximizers with risk rather than uncertainty. This leads to a set of questions.

Does it matter that the models that describe so well outcomes in actual markets have models of individual behavior that are so far removed from reality? How different would the outcomes of those models be if agents in them followed the precepts of recent developments in behavioral economics rather than rational choice EU analysis? And would it matter for policy? I believe these are open questions for research and debate.

Keynesian Interventionism or Burkean Conservatism?

Does imperfect information, particularly of the radical uncertainty variety (“We simply do not know”), make one tend towards Keynesian interventionism or Burkean conservatism? Keynes himself was greatly influenced by Edmund Burke. In an as yet unpublished² undergraduate essay (Keynes, 1904, 4–15), he lauds Burke’s conservatism in considerations of war and other momentous decisions:

Burke ever held, and held rightly, that it can seldom be right ... to sacrifice a present benefit for a doubtful advantage in the future ...; we should be very chary of sacrificing large numbers of people for the sake of a contingent end, however advantageous that may appear.... We can never know enough to make the chance worth taking.

The direct descendant of this line of thinking is Keynes’s famous 1923 statement from his *Tract on Monetary Reform*: “But this *long run* is a misleading guide to current affairs. *In the long run* we are all dead.” (Keynes, quoted in Skidelsky, 2013).

Skidelsky (2013) argues that “Keynes would have rejected the claim of today’s austerity champions that short-term pain, in the form of budget cuts, is the price we need to pay for long-term economic growth. The pain is real, he would say, while the benefit is conjecture.”

So far, so good. Radical uncertainty appears to favor such progressive positions as caution in launching wars and austerity programs. But from Burke’s prudence principle also flowed an institutional conservatism, as made clear in a famous passage (quoted in Edlin 2017, 50) from Burke’s *Reflections on the Revolution in France*:

You see, Sir, that in this enlightened age I am bold enough to confess that we [the English] ... instead of casting away all our old prejudices, we cherish them ... and, to take more shame on ourselves, we cherish them because they are prejudices; and the longer they have lasted, and the more generally they have prevailed, the more we cherish them.

A modern version of this argument for conservatism is provided by Edlin (2017, 49):

Decision makers suffer from switcher’s curse if they forget the reason that they maintained incumbent policies in the past and if they naively compare rival and

2. Brief extracts from it are published in Skidelsky (2016).

incumbent policies with no bias for incumbent policies. I find that conservatism emerges as a heuristic to avoid switcher's curse. The longer a process or policy has been in place, the more conservative one should be. On the other hand, the more conservative were past decision makers, the more progressive one should be today.

Keynes (1904, 15) interpreted the Burkean recoil from revolution in his 1904 undergraduate essay: "We can never know enough to make the chance worth taking, and the fact that cataclysms in the past have sometimes inaugurated lasting benefits is no argument for cataclysms in general. These fellows, says Burke, have 'glorified in making a Revolution, as if revolutions were good things in themselves'."

This is not the place to develop the argument, and others have developed it as well, that an institutional conservatism was also deeply ingrained in Keynes, who wanted to save capitalism, not end it. Actually, what Keynes really wanted was to save the world of late Victorian and Edwardian England, which came to an end in 1914.

Conclusion

So, imperfect information in the form of radical uncertainty, and its consequent undermining of EU analysis, opens up a wide area of research, asking whether the classic Stiglitzian propositions will still hold in this brave new world.

Further, radical uncertainty can be the basis for either Keynesian interventionism or Burkean conservatism or, in Keynes's mind, both! In any event, so far as Joe Stiglitz is concerned, to paraphrase Keynes on Burke, "This fellow has glorified in making a revolution, as if a revolution was a good thing in itself." And there is no question that the information revolution has indeed been a good thing in itself. As a foot soldier in the information revolution, I salute our leader!

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Comment: Hamid Rashid*

Information Asymmetry, Conflicts of Interest, and the Financial Crisis: Lessons Learned and the Way Forward

Information asymmetry is often the main cause of market failures, as Joe explains earlier in the chapter. Firms, especially financial firms, have incentives to exploit information asymmetries, hiding critical information about their incentives, behavior, and performance. Conflicts of interests—with information asymmetry hiding their existence—can allow financial firms to ignore, misprice, and under-report risks, triggering devastating market failures. This is what we saw in the run up to the financial crisis, the most significant market failure of our lifetime. One lesson from the crisis is that regulators, rating agencies, and investors largely failed to detect widespread conflicts of interest in the mortgage market, when some large banks comingled appraisal, origination, servicing, securitization, underwriting, and even rating functions. A bank originating a mortgage typically relies on an independent third party to appraise the value of the property and thus avoid potential conflicts of interest in the valuation. But this practice changed during the boom years before the financial crisis. If a bank stood to gain more from a higher valuation of the property—earning hefty commissions and fees, as we saw during the mortgage boom—it would use a complicit appraiser willing to inflate the property value. By 2006, 90 percent of the property appraisers felt pressured—often by the originating bank or its agents—to inflate home values.¹ The independent appraiser was supposed

*The views expressed here do not reflect the views of the United Nations or its Member States.

1. Financial Crisis Inquiry Commission (2011).

to protect the lender (and by extension, the banks' depositors) against the risk of a mortgage default. But during the mortgage boom, the appraiser and mortgage originator worked together—a clear conflict of interest—to inflate property values and originate as many mortgages as quickly as possible, which exacerbated the risk of a crisis.

Conflicts of interest were also pervasive in transactions between the originator and the mortgage securitizer. Both often worked for the same bank, and the originator knew that the securitizer would buy whatever mortgages she would originate, without raising any question about the quality of the mortgages. In addition, the securitizer knew that he would be able to package any mortgage into AAA-rated securities and sell them to the investor clients of the same bank, then neither the originator nor the securitizer had an incentive to assess underlying risks accurately and price the mortgage-backed securities correctly. With all transactions taking place among related parties and no consequences for ignoring conflicts, due diligence became a waste of time for our banks.

During the mortgage boom, our banks routinely hid conflicts of interest and originated trillions of dollars of subprime mortgages that did not meet minimum underwriting standards. In a “issuer pays” rating model—with manifest conflicts of interest—more than 80 percent of subprime mortgage-backed securities received the highest-possible AAA ratings,² making many below-investment-grade securities highly attractive to investors. Had the investors been fully aware of the extent of the conflicts of interests—and how these conflicts contributed to the mispricing of mortgage-backed securities—the mortgage bubble that precipitated a global financial crisis might have been avoided.

It is surprising that the pervasive conflicts of interest that led us to the crisis did not attract the attention of our regulators, given that only 7 years earlier, the Enron scandal exposed widespread and harmful conflicts of interest in corporate America. Drawing on the Enron lessons, the US Congress passed the Sarbanes-Oxley Act in 2002, with the stated objective: “to protect investors by improving the accuracy and reliability of corporate disclosures.” Title V of the Act deals with conflicts of interest, requiring a clear separation between the securities analysts and

2. Ashcraft, Goldsmith-Pinkham, and Vickery (2010).

underwriting functions of a financial firm. Large banks blatantly disregarded the separation and exploited conflicts of interest in securitization deals. Yet no banker was charged for violating the Sarbanes-Oxley Act, although it contained provisions for holding senior management personally responsible for a breach.

As the issuers of billions of dollars of Alt-A and subprime private-label mortgage-backed securities, our largest banks were fully aware of the quality of underlying assets that backed the securities and yet hid that information from their investors. The banks put their own interests ahead of the interests of their investors to make a quick profit on risky bets. The sheer size and complexity of these banks—financial supermarkets—that combined mortgage, retail, and investment banking activities, allowed them to exploit conflicts of interest with impunity. Their status as “too big to supervise” allowed them to evade regulatory oversight, while being “too big to fail” meant they faced no consequences of a devastating financial crisis.

Aiming to address the root causes of the financial crisis, the US Congress passed the Dodd-Frank Wall Street Reform and Consumer Protection Act in 2010. The Act was intended to mitigate, among other issues, the inherent conflicts of interests in securitization. Section 621 of the Act, for example, prohibits any transaction that could create a conflict of interest with an investor in a securitization transaction. The subsequent rule issued by the Securities and Exchange Commission (SEC) included a negative list of conflicts of interest in securitization that is laden with exceptions and loopholes. For example, the rule provided that a securitization transaction would not represent a conflict of interest if it is for hedging, market-making, or for providing liquidity. This leaves room for subjective interpretation, requiring the regulator to differentiate *ex ante* between hedging and speculation. There is a growing recognition that it is hard, if not impossible, to detect conflicts of interest in securitization, especially when it involves many parts of a large and complex financial firm.

The Dodd-Frank Act, even if implemented fully, is unlikely to mitigate conflicts of interest in securitization, largely because of its reliance on a narrow set of rules and a long list of exceptions. Instead of prohibiting a limited number of activities, the Dodd-Frank Act needed to effectively address the structural causes of the crisis, such as the “too big to fail” criterion or stock-option based executive compensations, which incentivize banks to hide conflicts of interests and take excessive risks. Conflicts of

interest—material, perceived, or potential—are often unobservable until their adverse effects become apparent. But organizational structures, such as bank size and compensation packages of senior executives, are clearly observable. The regulators need to target and regulate the observables instead of trying to regulate unobservable behavior. The Federal Reserve Board, for example, recently imposed a limit on the growth of the assets of a large bank that engaged in inappropriate behavior.³ This is clearly a bold step in the right direction.

For nearly 70 years, the Glass-Steagall Act managed to keep conflicts of interest under control by enforcing a clear and structural separation between commercial and investment banking activities and making sure—albeit indirectly—that banks were not too big to supervise and regulate. Unlike the Dodd-Frank Act, it incorporated specific measures to address the problems of information asymmetry and conflicts of interest in the financial sector. Although Dodd-Frank recognizes the “too big to fail” problem, it has not prevented the growth of our largest banks. The large banks have since become even larger. In fact, the market share of the top 10 or 15 largest banks has increased relative to the pre-crisis level (figure 3.1). The largest bank in the United States was 57 percent larger in 2014 than it was in 2007.

Dodd-Frank also does not adequately address the problems of incentive structures in large banks. The stock-option based compensation schemes create a conflict of interest, as they encourage managers to act more like investors or speculators and to take excessive risks that boost short-term stock price of the firm, even if doing so undermines the financial stability and interests of the firm. In the run-up to the crisis, large financial firms offered significant amounts of stock options to their senior managers, ostensibly to incentivize best performance. Stock-based compensation also contributes to the “too big to fail” problem, encouraging top managers to aggressively increase size and market share. Although Dodd-Frank introduces certain prohibitions, time-limits, and claw-back provisions, stock-based compensation remains as pervasive as it was before the crisis. If this practice continues unabated, financial firms will continue to find ways to

3. See <https://www.reuters.com/article/us-usa-wells-fargo-fed/fed-orders-wells-fargo-to-halt-growth-over-compliance-issues-idUSKBN1FM2V9>.

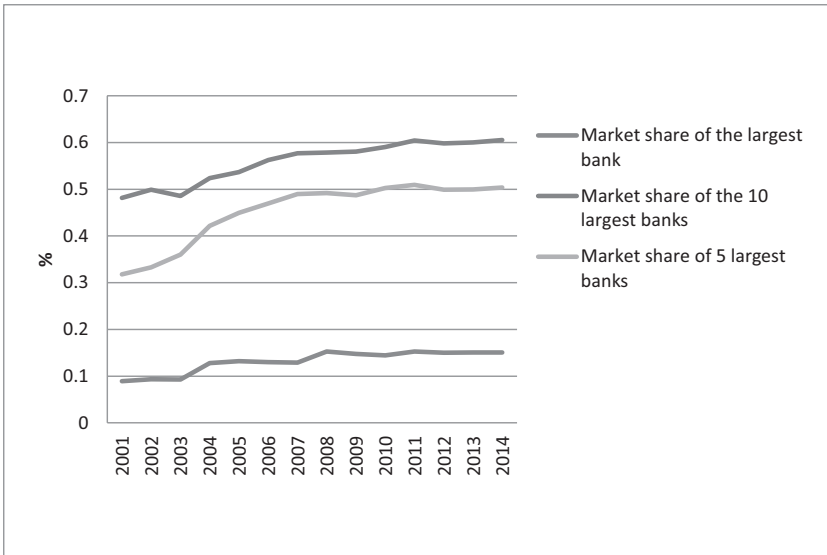


Figure 3.1

Market share of large US banks: 2001–2014

Percentage of total assets of banks with more than \$300 million in assets

Source: Author’s compilation of data from <https://www.federalreserve.gov/releases/lbr/>.

make risky bets and boost short-term profits and market valuation. This also perhaps explains the spectacular growth of the market valuation of US financial firms since the crisis, increasing from \$2.8 trillion in 2008 to \$7.3 trillion in 2015 (figure 3.2).

The financial crisis is a sad testimony to the failure of the revolution in information economics that Joe spearheaded, which should have fostered and enabled effective regulation of our financial sector, where information asymmetry matters the most. The advances in our thinking and understanding of how information shapes market behavior and the scope and intensity of financial regulations have moved in the opposite direction during the past few decades. We now see a starker, and more disconcerting, disconnect between the lessons of information economics and the state of financial regulation. Financial regulation of the past few decades has relied on the imaginary narrative of perfectly competitive financial markets with perfect information. The Dodd-Frank Act is no exception. The revolution

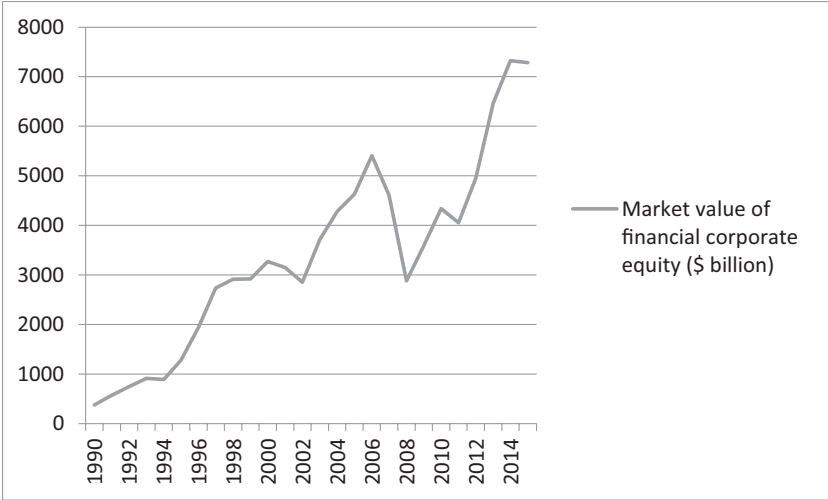


Figure 3.2

Market value of US financial corporate equity (\$ billion)

Source: US financial accounts, <https://www.federalreserve.gov/releases/Z1/Current/data.htm>.

in information economics will remain incomplete until the economics of information guides and shapes financial regulation. Unless we bridge the gap between what we know and how we regulate financial markets, another financial crisis is just around the corner.

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