

INFORMATION AND THE CHANGE IN THE PARADIGM IN ECONOMICS, PART 2

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APPLICATIONS OF THE NEW PARADIGM

The new theory of the firm and the foundations of modern macro-economics

Of all the market failures, the extended periods of underutilization of resources—especially human resources—is of the greatest moment, the consequences of which in turn are exacerbated by capital market imperfections, which means that even if future prospects of an unemployed individual are good, he cannot borrow to sustain his standard of living.

We referred earlier to the dissatisfaction with traditional Keynesian explanations, in particular, the lack of micro-foundations. This gave rise to two schools of thought. One sought to use the old perfect market paradigm, relying heavily on representative agent models. While information was not perfect, expectations were rational. But the representative agent model, by construction, ruled out the information asymmetries which are at the heart of macro-economic problems. Only if an individual has a severe case of schizophrenia is it possible for such problems to arise. If one begins with a model that *assumes* that markets clear, it is hard to see how one can get much insight into unemployment (the failure of the labor market to clear).

The construction of a macro-economic model which embraces the consequences of imperfections of information in labor, product, and capital markets has become one of my major preoccupations over the past fifteen years. Given the complexity of *each* of these markets, creating a general equilibrium model—simple enough to be taught to graduate students or used by policy makers—has not proven to be an easy task. At the heart of that model lies a new theory of the firm, for which the theory of

asymmetric information provides the foundations. The modern theory of the firm in turn rests on three pillars, the theory of corporate finance, the theory of corporate governance, and the theory of organizational design.

The theory of corporate finance

Under the older, perfect information theory, it made no difference whether firms raised capital by debt or equity, in the absence of tax distortions.¹⁰² This was the central insight of the Modigliani-Miller theorem.¹⁰³ We have noted how the willingness to hold (or to sell) shares conveys information, so that how firms raise capital does make a difference.¹⁰⁴ Firms rely heavily on debt finance, and bankruptcy, resulting from the failure to meet debt obligations, matters. Both because of the cost of bankruptcies and limitations in the design of managerial incentive schemes,¹⁰⁵ firms typically act in a risk averse manner¹⁰⁶—with risk being more than just a correlation with the business cycle.¹⁰⁷

Moreover, with credit rationing (or the potential of credit rationing) not only does the firm's net worth (the market value of its assets) matter, but so does its asset structure, including its liquidity.¹⁰⁸ While there are many implications of the theory of the risk averse firm facing credit rationing, some of which are elaborated upon in the next section, one example should suffice to highlight the importance of these ideas. In traditional neoclassical investment theory, investment depends on the real interest rate, and the firm's perception of expected returns. The firm's cash flow or its net worth should make no difference. The earliest econometric studies of investment, by Kuh and Meyer [1957], suggested that that was not the case. But under the strength of the theoretical strictures that these variables could not matter, they were excluded from econometric

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analysis for two decades following the work of Hall and Jorgenson [1967]. It was not until work on asymmetric information had restored theoretical respectability to introducing such variables in investment regressions that it was acceptable to do so; and when that was done, it was shown that, especially for small and medium sized enterprises, these variables were crucial.¹⁰⁹

Moreover, in the traditional theory, there is no corporate veil; individuals can see perfectly what is going on inside the firm; it makes no difference whether the firm distributes or retains its profits (other than for taxes).¹¹⁰ But if there is imperfect information about what is going on inside the firm, then there is a corporate veil, which cannot be easily pierced.

Corporate governance

In the traditional theory, firms simply maximized the expected present discounted value of profits (which equaled market value)¹¹¹ and with perfect information, how that was to be done was simply an engineering problem. Disagreements about what the firm should do were of little importance. In that context, corporate governance—how firm decisions were made—mattered little as well. But again, in reality, corporate governance matters a great deal. There *are* disagreements about what the firm should do¹¹²—partly motivated by differences in judgments, partly motivated by differences in objectives. Managers can take actions which advance their interests at the expense of that of shareholders, and majority shareholders can advance their interests at the expense of minority shareholders. The owners (who, in the language of Steve Ross [1973] came to be called the principal) not only could not monitor their workers and managers (the agents), because of asymmetries of information, but also they typically did not even know what these people who were supposed to be acting on their behalf *should* do. That there were important consequences for the theory of the firm of the separation of ownership and control had earlier been noted by Berle and Means [1932],¹¹³ but it was not until information economics that we had a coherent way of thinking about the implications.

The problem of corporate governance, of course, arises both from the problems of information imperfections *and* the public good nature of management/oversight: if a shareholder engages in

expenditures on oversight, and succeeds in improving the firm's performance, all shareholders benefit equally (similarly with creditors.) (See Stiglitz [1985b]).

Some who still held to the view that firms would maximize their market value argued that take-overs (and the threat of take-overs) would ensure that competition in the market for managers would ensure stock market value maximization. (If the firm were not maximizing its stock market value, then it would pay someone to buy the firm, and change its actions so that its value would increase.) Early on in this debate, I raised questions on theoretical grounds about the efficacy of the take-over mechanism (See Stiglitz [1972b]). The most forceful set of arguments were subsequently put forward by Grossman and Hart [1980], who observed that any small shareholder who believed that the takeover would subsequently increase the market value would not be willing to sell his shares. Only take-overs that were expected to be value decreasing would be successful.¹¹⁴ The subsequent work by Edlin and Stiglitz [1995], referred to earlier, showed how existing managers could take actions to reduce the effectiveness of competition for management, i.e. the threat of take-overs, by increasing asymmetries of information.

(Proving that a firm does not maximize their stock market value is, of course, difficult, since it is hard to ascertain its opportunity set and the consequences of alternative actions. However, there are a large number of instances in which it is clear that firms do not maximize market value. For instance, closed end mutual funds regularly sell at a discount; there would be a simple action—dissolution of the firm—which would increase market value. There are a large number of tax paradoxes, (see, e.g. Stiglitz [1973b, 1982d])—actions which firms could take that would reduce the total tax bill (corporate plus individual), though there remains some dispute about the extent to which such paradoxes are due to irrationality on the part of investors or non-value maximizing behavior on the part of managers.)

Organizational design

So far, we have discussed two of the three pillars of the modern theory of the firm: corporate finance and corporate governance. The third is organizational design. In a world with perfect information,

organizational design too is of little moment. In practice, it is of central concern to businesses. We have already extensively discussed the issue of incentives, how, on the one hand, information imperfections limit the extent of efficient decentralizability and how, on the other, organizational design—by having alternative units perform comparable tasks—can enable a firm to glean information on the basis of which better incentive systems can be based. (Nalebuff and Stiglitz [1983a, b]).

But there is another important aspect of organizational design. Even if individuals are well intentioned, with limited information, mistakes get made. To err is human. Raaj Sah and I, in a series of papers [1985, 1986, 1988a, 1988b, 1991] explored the consequences of alternative organizational design and decision making structures for organizational mistakes, for instance, where good projects get rejected or bad projects get accepted. We suggested that in a variety of circumstances, especially when there is a scarcity of good projects, decentralized polyarchical organizational structures have distinct advantages.¹¹⁵

Macro-economics

The central macro-economic issue is that of unemployment. The models I described earlier explained why there could exist unemployment *in equilibrium*. But much of macro-economics is concerned with *dynamics*, with *fluctuations*, with explaining why sometimes the economy, rather than absorbing shocks, seems to amplify them, and why their effects often persist. In joint work with Bruce Greenwald and Andy Weiss, we have shown how the theories of asymmetric information can help provide explanations of these macro-economic phenomena. The imperfections of capital markets—the phenomena of credit and equity rationing which arise because of information asymmetries—are key. They lead to risk averse behavior of firms and to households and firms being affected by cash flow constraints.

Standard interpretations of Keynesian economics emphasized the importance of wage and price rigidities, but without a convincing explanation of those rigidities. For instance, some theories had stressed the importance of costs of adjustment of prices,¹¹⁶ but what was at issue was why markets seemed to adjust quantities rather than prices, and the relative costs of adjustment of quantities

seemed greater than those of prices. The Greenwald-Stiglitz theory of adjustment [1989b] provided an explanation based on capital market¹¹⁷ imperfections arising from information imperfections: it argued that, at least for commodities for which inventory costs were reasonably low, the risks arising from informational imperfections were greater for price and wage adjustments than from quantity adjustments. Risk averse firms would make smaller adjustments to variables, the consequences of which were more uncertain.

But even though wages and prices were not perfectly flexible, neither were they perfectly rigid, and indeed in the Great Depression, they fell by a considerable amount. There had been large fluctuations in earlier periods, and in other countries, in which there had been a high degree of wage and price flexibility. Greenwald and I [1987a, 1987b, 1988b, 1988c, 1988d, 1988e, 1989b, 1990b, 1993a, 1993b, 1995] argued that it was other market failures, in particular, the imperfections of capital markets and the incomplete contracting which provided part of the explanation for key observed macro-economic phenomena. In debt contracts, typically not indexed for changes in prices, whenever prices fell below the level expected (or in variable interest rate contracts, when real interest rates rose above the level expected) there were transfers from debtors to creditors. In these circumstances, excessive downward price flexibility (not just price rigidities) could give rise to problems.¹¹⁸ These (and other) redistributive changes had large real effects, and could not be insured against because of imperfections in capital markets. Large shocks could lead to bankruptcy, and with bankruptcy (especially when it results in firm liquidation) there was a loss of organizational and informational capital.¹¹⁹ Even if such large changes could be forestalled, until there was a resolution, the firm's access to credit would be impaired, and for good reason; moreover, without "clear owners" those in control would in general not have incentives to maximize the firm's value.

Even when the shocks were not large enough to lead to bankruptcy, they had impacts on firms' ability and willingness to take risks. Since all production is risky, shocks affect aggregate supply, as well as the demand for investment. Because firm's net worth would only be restored over time, the effects of a shock persisted. By the same token, there were hysteresis effects associated with policy: an increase in interest rates which depleted firm net

worth had impacts even after the interest rates were reduced. If firms were credit rationed, then reductions in liquidity could have particularly marked effects.¹²⁰ Every aspect of macro-economic behavior was affected: the theories helped explain, for instance, the seemingly anomalous behavior of inventories (rather than using inventories to smooth production, which would result in countercyclical changes in inventories, inventories moved procyclically, because of the importance of cash constraints, leading to a high shadow price of money in recessions) and pricing (with the "shadow price" of capital being high in a recession, firms did not invest as much in acquiring new customers and were less concerned about losing workers, so that mark-ups increased, so that real product wages could fall, even though the marginal productivity of labor was rising.)

In short, our analysis emphasized the supply side effects of shocks, the interrelationships between supply and demand side effects, and the importance of *finance* in propagating fluctuations.

*Theory of money*¹²¹

A particularly important aspect of our reformulation of macro-economics is the focus on monetary economics. Traditionally, it was postulated that the interest rate was set to equate the demand and supply for money, with money being largely required for transactions purposes, and with the interest rate representing the opportunity cost of money. In modern economies, however, credit, not money, is required (and used) for most transactions, and most transactions are simply exchanges of assets, and therefore not directly related to DP. Moreover, today, most money is interest bearing, with the difference between the interest rate paid, say on a money market account and T bill rates having little to do with monetary policy, and related solely to transactions costs. What is important is the availability of credit (and the terms at which it is available); this in turn is related to the certification of credit worthiness by banks and other institutions. In short, *information* is at the heart of monetary economics. But banks are like other risk averse firms: their ability and willingness to bear the risks associated with making loans depends on their net worth.¹²² Because of equity rationing, shocks to their net worth cannot be instantaneously undone, and the theory thus explains why such shocks can

have large adverse macro-economic consequences. The theory shows how not only traditional monetary instruments (like reserve requirements) but regulatory instruments (like risk adjusted capital adequacy requirements) can be used to affect the supply of credit, interest rates charged, and the bank's risk portfolio. The analysis also showed how excessive reliance on capital adequacy requirements could be counterproductive.¹²³

The theory has important policy implications. It provides a new basis for a "liquidity trap," explaining why in severe economic downturns, monetary policy may be relatively ineffective. It explains some of the recent policy failures, both in the inability of the Fed to forestall the 1991 recession and the failures of the IMF in East Asia in 1997. It shifts emphasis from looking at the Fed Funds rate, or the money supply, to variables of more direct relevance to economic activity, the level of credit,¹²⁴ and the interest rates charged to firms (and it explains the movement in the spread between that rate and the Federal Funds rate). The theory predicts that there is scope for monetary policy even in the presence of dollarization.¹²⁵

We also analyzed the importance of credit interlinkages. Many firms receive credit from other firms, at the same time that they provide credit to still others (violating Polonius' injunction "neither a lender nor a borrower be" by being both.) The disperse nature of information in the economy provides an explanation of this phenomena, which has important consequences. As a result of these general interlinkages (in some ways, every bit as important as the commodity interlinkages stressed in standard general equilibrium analysis) a shock to one firm gets transmitted to others, and when there is a large enough shock, there can be a cascade of bankruptcies.

*Growth*¹²⁶ and development¹²⁷

While most of the macro-economic analysis focused on exploring the implications of imperfections of credit markets arising out of information problems for cyclical variations, another strand of our research program focused on growth. The importance of capital markets for growth had long been recognized; without capital markets firms have to rely on retained earnings. But how firms raise capital is important for growth. In particular, "equity rationing"—especially important in devel-

oping countries, where informational problems are even greater—impedes firms' willingness to invest and undertake risks, and thus slows down growth. Changes in economic policy which enable firms to bear more risk (e.g. by reducing the size of macro-economic fluctuations, or which enhance firms' equity base, by suppressing interest rates, which result in firm's having larger profits) enhance economic growth. Conversely, policies, such as associated with IMF interventions, in which interest rates are raised to very high levels, discourage the use of debt, forcing firms to rely more heavily on retained earnings.

The most challenging problems for growth lie in economic development. Typically, market failures are more prevalent in less developed countries, and these market failures are often associated with information problems—the very problems that inspired much of the research described in this paper. While these perspectives help explain the failures of policies based on *assuming* perfect or well functioning markets, they also direct attention to policies which might remedy or reduce the consequences of informational imperfections.¹²⁸

Research

One of the most important determinants of the pace of growth is, for developed countries, the investment in research, and for less developed countries, efforts at closing the knowledge gap between themselves and more developed countries. Knowledge is, of course, a particular *form* of information, and many of the issues that are central to the economics of information are also key to understanding research—such as the problems of appropriability, the fixed costs associated with investments in research, which give rise to imperfections in competition, and the public good nature of information. It was thus natural that I turned to explore the implications in a series of papers that looked at both industry equilibrium and the consequences for economic growth.¹²⁹ While it is not possible to summarize briefly the results, two conclusions do stand out: that market economies in which research and innovation play an important role are not well described by the standard competitive model, and that the market equilibrium, without government intervention, is not, in general, efficient.

The fact that when there are asymmetries of information, markets are not, in general, constrained Pareto efficient implies that there is a potentially important role for government. The new paradigm has important implications for policy, going well beyond addressing how to prevent the creation of asymmetries of information and how to overcome them. As we have seen, asymmetries of information give rise to a host of other market failures—such as missing markets, and especially capital market imperfections, leading to firms that are risk averse and cash constrained—and policy has to deal with these indirect consequences as well. An analysis, for instance, of the incidence of taxation which is predicated on perfectly competitive markets with perfectly informed consumers and risk neutral firms, is likely to go astray.

But beyond this, the new information paradigm helps us to think about policy from a new perspective, one which recognizes the pervasiveness of imperfections of information.

*Pareto efficient taxation*¹³⁰

Information asymmetries, of course, arise among all participants in society—including between citizens and their government. In the final section of this paper, I wish to explore one side: the difficulties citizens have of controlling their government. Here, I want to briefly note the other side: the problems posed to government in the conduct of its “business” that arise from information asymmetries, in three key areas, taxation, regulation, and production.

One of the functions of government is to redistribute income; even if it did not wish to redistribute actively, it has to raise revenues to finance public goods, and there is a concern that the revenue be raised in an equitable manner, e.g. that those who are more able to contribute (or who benefit more) do so. But government has a problem of identifying these individuals. Just as those who a monopolist would like to charge more do not readily disclose that they might be willing to pay more for the product, and just as those who are less able, less likely to pay back a loan, or more likely to have an accident do not readily disclose that information to those with whom they deal, so too in the public sector. And the self-selection mechanisms for informa-

tion revelation that Rothschild and I had explored in our competitive insurance model or that I had explored in my paper on discriminating monopoly can be used here. (The problem of the government, maximizing social "profit" (welfare) subject to the information constraints, is closely analogous to that of the monopolist, maximizing private profit subject to information constraints. This is why Mirrlees' [1971] paper on optimal taxation, though not couched in information-theoretic terms, was an important precursor to the work described here.)

The critical question for the design of a tax system thus becomes *what is observable*. In older theories, in which information was perfect, lump sum taxes and redistributions made sense. If ability is not directly observable, the government had to rely on other observables—like income—to make inferences; but, as in all such models, market participants, as they recognize that inferences are being made, alter their behavior. In Mirrlees [1971] only income was observable. But in different circumstances, either more or less information might be available. It might be possible to observe hours worked, in which case wages would be observable. It might be possible to observe the quantity of each good purchased by *any particular individual* or it might be possible to observe only the aggregate quantity of goods produced.

For each information structure, there is a *Pareto efficient tax structure*, that is, a tax structure such that no one (group) can be made better off without making some other group worse off. The choice among such tax structures depends on the social welfare function (attitudes towards inequality).¹³¹ While this is not the occasion to provide a complete description of the results, two are worth noting: what had been thought of as optimal commodity tax structures (Ramsey [1927]) were shown to be part of a Pareto efficient tax system only under highly restricted conditions, e.g. that there was no income tax (see also Sah and Stiglitz [1992]). On the other hand, it was shown that in a central benchmark case, it was not optimal to tax interest income.

Theory of regulation and privatization

The government faced the same problem posed by information asymmetries in regulation that it faced in taxation. Over the past quarter century, a huge literature has developed making use of self-selection mechanisms,¹³² allowing far better and

more effective systems of regulation than had existed in the past.¹³³

In the 1980s, there was a strong movement towards privatizing state enterprises, even in areas in which there was a natural monopoly, in which case government ownership would be replaced with government regulation. While it was apparent that frequently there were problems with government ownership, the theories of imperfect information also made it clear that even the best designed regulatory systems would work imperfectly. This raised naturally the question of under what circumstances could we be sure that privatization would enhance economic welfare. As Herbert Simon [1991], the 1978 Nobel Prize winner, had earlier emphasized, both public and private sectors face information and incentive problems; there was no compelling theoretical argument for why large private organizations would solve these incentive problems better. In work with David Sappington [1987b] we showed that the conditions under which privatization would necessarily be welfare enhancing were extremely restrictive, and closely akin to those under which competitive markets would yield Pareto efficient outcomes. (See Stiglitz [1993d, 1994c] for an elaboration and applications.)

KEY POLICY DEBATES: APPLYING BASIC IDEAS

The perspectives provided by the new information paradigm not only shaped theoretical approaches to policy, but in innumerable concrete issues also led to markedly different policy stances from those wedded to the old paradigm.

Development and the Washington consensus

Perhaps the most noted were the controversies concerning development strategies, where the Washington consensus policies, based on market fundamentalism—the simplistic view of competitive markets with perfect information, inappropriate even for developed countries, but particularly inappropriate for developing countries—had prevailed since the early 1980s within the international economic institutions. Elsewhere, I have documented the failures of these policies in development,¹³⁴ as well as in managing the transition from Communism to a market economy¹³⁵ and in managing

crises. Ideas matter, and it is not surprising that policies based on models that depart as far from reality as those underlying the Washington Consensus so often led to failure.

Bankruptcy, aggregate supply, and the East Asia crisis

This point was brought home perhaps most forcefully by the management of the East Asia crisis which began in Thailand on July 2, 1997. While I have written extensively on the many dimensions of the failed responses,¹³⁶ here I want to note the close link between these failures and the theories put forward here. Our work had emphasized the importance of maintaining the credit supply and the risks of (especially poorly managed) bankruptcy. Poorly designed policies could lead to an unnecessarily large reduction in credit availability and unnecessary large increases in bankruptcy, both leading to large adverse effects on aggregate supply, exacerbating the economic downturn. But this is precisely what the IMF did: by raising interest rates to extremely high levels in countries where firms were already highly leveraged, it forced massive bankruptcy, and the economies were thus plunged into deep recession and depression; capital was not attracted to the country, but rather fled. Thus, the policies even failed in their stated purpose, which was to stabilize the exchange rate. There were strong hysteresis effects associated with these policies: when the interest rates were subsequently lowered, the firms that had been forced into bankruptcy did not become unbankrupt, and the firms that had seen their net worth depleted did not see an immediate restoration. There were alternative policies available, debt standstills followed by corporate financial restructurings, which, while they might not have avoided a downturn, would have resulted in the downturns being shallower and shorter. Malaysia, whose economic policies conformed much more closely to those that our theories would have suggested, not only recovered more quickly, but was left with less of a legacy of debt to impair its future growth, than did neighboring Thailand, which conformed more closely to the IMF's recommendation.

Corporate governance, open capital markets, and the transition to a market economy

The transition from communism to a market economy represents one of the most important economic experiments of all time, and the failure (so far) in Russia, and the successes in China, shed considerable light on many of the issues which I have been discussing. The full dimension of Russia's failure is hard to fathom. Communism, with its central planning (requiring more information gathering, processing, and dissemination capacity than could be managed with *any* technology), its lack of incentives, and its system rife with distortions, was viewed as highly inefficient. The movement to a market, it was assumed, would bring enormous increases in incomes. Instead, incomes plummeted, a decline confirmed not only by GDP statistics and household surveys, but also by social indicators. The numbers in poverty soared, from 2% to upwards of 50% (depending on the measure used). While there were many dimensions to these failures, one stands out: the privatization strategy, which paid little attention to the issues of corporate governance which we stressed earlier. Empirical work confirms¹³⁷ that countries that privatized rapidly but lacked "good" corporate governance did not grow more rapidly. As Sappington and my paper warned, privatization might not lead to an increase in social welfare; rather than providing a basis for wealth creation, it led to asset stripping and wealth destruction.¹³⁸

BEYOND INFORMATION ECONOMICS

We have seen how the competitive paradigm that dominated economic thinking for two centuries not only was not robust, not only did not explain key economic phenomena, but also led to misguided policy prescriptions.

My research over the past thirty years has focused, however, on only one aspect of my dissatisfaction with that paradigm. It is not easy to change views of the world, and it seemed to me the most effective way of attacking the paradigm was to keep within the standard framework as much as possible. I only varied one assumption—the assumption concerning perfect information—and in ways which

seemed highly plausible. Early on, some objected that opening up the model to the possibilities of imperfect information was opening up a Pandora's box: there were so many ways in which information could be imperfect. But while there might be only one way in which information was perfect, surely it was better to understand the consequences of *different* forms of information imperfections that might exist in the real world. If the competitive model was not robust against all these different forms of information imperfections which existed in the world, surely it was not a model upon which we could rely. As time evolved, it became clear that the imperfect information paradigm itself was highly robust; there were some quite general principles, while the working out of the models in detail in different situations might well differ. We succeeded in showing not only that the standard theory was not robust—changing only one assumption in ways which were totally plausible had drastic consequences—but also that an alternative robust paradigm with great explanatory power could be constructed.

There were other deficiencies in the theory, some of which were closely connected. The standard theory assumed that technology and preferences were fixed. But changes in technology, R & D, are at the heart of capitalism. The new information economics—extended to incorporate changes in knowledge—at last began to address systematically these foundations of a market economy.

As I thought about the problems of development, I similarly became increasingly convinced of the inappropriateness of the assumption of fixed preferences.¹³⁹ I have criticized the Washington consensus development strategies partly on the grounds that they perceived development as nothing more than increasing the stock of capital and reducing economic distortions. But development represents a far more fundamental transformation of society, including a change in “preferences” and attitudes, an acceptance of change and an abandonment of many traditional ways of thinking.¹⁴⁰

Especially during the last few years, as I have become more deeply immersed in the problems of development, I have felt more strongly these and some of the other deficiencies of the standard paradigm, for instance, its attempt to separate out economics from broader social concerns. A major impediment to development in Africa has been the civil strife which has been endemic there, itself in

part a consequence of the economic circumstances.¹⁴¹

These perspectives have strong policy implications. For instance, some policies are more conducive to effecting a development transformation. Many of the policies of the IMF—including the manner in which it interacted with governments, basing loans on conditionality—were counterproductive. A fundamental change in development strategy occurred at the World Bank in the years I was there, one which embraced this more comprehensive approach to development. By contrast, policies which have ignored social consequences have frequently been disastrous. The IMF policies in Indonesia, including the elimination of food and fuel subsidies for the very poor, just as the country was plunging into depression, with wages plummeting and unemployment soaring, predictably led to riots; the economic consequences are still being felt.

In some ways, as I pursued these perspectives, I was returning to a theme I had raised thirty years ago, during my work on the efficiency wage theory in Kenya,¹⁴² where I had suggested how psychological factors—morale, reflecting a sense that one is receiving a fair wage—could affect efforts, an alternative, and in some cases more persuasive reason for the efficiency wage theory, that has subsequently been developed further by Akerlof and Yellen [1990]. It is curious how economists have almost studiously ignored factors, which are not only the center of day to day life, but even of business school education. Surely, if markets were efficient, such attention would not be given to such matters, to issues of corporate culture and extrinsic rewards, unless they were of some considerable importance.¹⁴³ And if such issues are of importance within a firm, they are equally important within a society.

Finally, I have become convinced that the dynamics of change may not be well described by equilibrium models that have long been at the center of economic analysis. Information economics has alerted us to the fact that history matters; there are important hysteresis effects. Random events—the black plague—have consequences that are irreversible. Dynamics may be better described by evolutionary processes and models, than by equilibrium processes. And while it may be difficult to describe fully these evolutionary processes, this much is already clear: there is no reason to believe that they are, in any general sense, “optimal.”¹⁴⁴

Many of the same themes that emerged from our simpler work in information economics applied here. For instance, repeatedly, in the information theoretic models discussed above we showed that multiple equilibria (some of which Pareto dominated others) could easily arise. The same is true in my paper (Stiglitz, [1995b]). This in turn has several important consequences, beyond the observation already made that history matters. First, it means that one cannot simply predict where the economy will be by knowing preferences and technology (and initial endowments). There can be a high level of indeterminacy. Secondly, as in Darwinian ecological models, the major determinant of one's environment is the behavior of others, and their behavior may in turn depend on their beliefs about others' behavior. (Hoff and Stiglitz [2000]). As Darwin noted after his visit to the Galapagos islands:

The plants and animals of the Galapagos differ radically among islands that [have] the same geological nature, the same height, climate, etc. . . . This long appeared to me a great difficulty, but it arises in chief part from the deeply seated error of considering the physical conditions of a country as the most important for its inhabitants; whereas it cannot, I think he disputed that the nature of the other inhabitants, with which each has to compete, is at least as important, and generally a far more important element of success. (Darwin [1959] 1993: 540)

Thirdly, government intervention can sometimes move the economy from one equilibrium to another; and having done that, continued intervention might not be required.

THE POLITICAL ECONOMY OF INFORMATION

Information imperfections, and asymmetries of information, are pervasive in every aspect of life and society. Here, I want to talk about three of the ways in which information affects political processes.

First, we have already noted the distributive consequences of information disclosures. Not surprisingly, then, the "information rules of the game," both for the economy and for political processes, can become a subject of intense political debate.

The United States and the IMF argued strongly that lack of transparency was at the root of the 1997 financial crisis, and said that the East Asian countries had to become more transparent. The recognition that quantitative data concerning capital flows (outstanding loans) by the IMF and the US Treasury could have been taken as a concession of the inappropriateness of the competitive paradigm (in which *prices* convey all the relevant information); but the more appropriate way of viewing the debate was *political*, a point which became clear when it was noted that partial disclosures could be of only limited value, and could possibly be counterproductive, as capital would be induced to move through channels involving less disclosure, channels like off shore banking centers which were also less well regulated. When demands for transparency thus went beyond East Asia to Western hedge funds and off shore banking centers, suddenly the advocates of more transparency became less enthralled, and began praising the advantages of partial secrecy in enhancing incentives to gather information. The United States and the US Treasury then opposed the OECD initiative to combat money laundering through greater transparency of off shore banking centers—these institutions served particular *political and economic* interests—until it became clear that terrorists might be using them to help finance their operations; at that point, the balance of American interests changed, and the US Treasury changed its position.

Political processes inevitably entail asymmetries of information: our political leaders are *supposed* to know more about threats to defense, about our economic situation, etc., than ordinary citizens. There has been a delegation of responsibility for day-to-day decision making, just as there is within a firm. The problem is to provide incentives for those so entrusted to act on behalf of those who they are supposed to be serving—the standard principle agent problem. Democracy—contestability in political processes—provides a check on abuses of the powers that come from delegation just as it does in economic processes; but just as we recognize that the take-over mechanism provides an imperfect check, so too we should recognize that the electoral process provides an imperfect check. Just as we recognize that current management has an incentive to *increase* asymmetries of information in order to enhance its market power, increase its discretion, so too in public life. And just as we recognize that dis-

closure requirements—greater transparency—and specific rules of the game (e.g. related to corporate governance) can affect the effectiveness of the takeover mechanism and the overall quality of corporate governance, so too the same factors can affect political contestability and the quality of public governance. (Stiglitz [2001f].)

In the context of political processes, where “exit” options are limited, one needs to be particularly concerned about abuses. If a firm is mismanaged—if the managers attempt to enrich themselves at the expense of shareholders and customers and entrench themselves against competition—the damage is limited: customers at least can switch. But in political processes, those who see the quality of public services deteriorate cannot do so as easily. If all individuals were as mean spirited and selfish as economists have traditionally modeled them, matters would indeed be bleak: as I have put it elsewhere, ensuring the public good (public management) is itself a public good. But there is a wealth of evidence that the economists’ traditional model of the individual is too narrow—and that indeed intrinsic rewards, e.g. of public service, can be even more effective than extrinsic rewards, e.g. monetary compensation (which is not to say that compensation is not of some importance). This public spiritedness (even if blended with a modicum of self-interest) is manifested in a variety of civil society organizations, through which *voluntarily* individuals work *collectively* to advance their perception of the collective interests.

There are strong forces on the part of those in government to reduce transparency. More transparency reduces their scope for action—it not only exposes mistakes, but also corruption (as the expression goes, sunshine is the strongest antiseptic). Government officials may try to enhance their power, by trying to advance specious arguments for secrecy,¹⁴⁵ and then saying, in effect, to justify their otherwise inexplicable or self-serving behavior, “trust me . . . if you only knew what I knew.”

There is a further rationale for secrecy: secrecy is an artificially created scarcity of information, and like most artificially created scarcities, it gives rise to rents, rents which in some countries are appropriated through outright corruption (selling information), but in others are part of a “gift exchange” in which reporters not only provide puff pieces praising the government official who has given the reporter privileged access to information, particu-

larly in ways which are designed to enhance the officials influence and power, but distort news coverage. I was in the unfortunate position of watching closely this process work, and work quite effectively. Without unbiased information, the effectiveness of the check that can be provided by the citizenry is limited; without good information, the contestability of the political processes can be undermined.

One of the lessons of the economics of information is that these problems cannot be fully resolved, but there are laws and institutions which can decidedly improve matters. Right-to-know laws, demanding transparency, have been part of governance in Sweden for two hundred years; they have become an important if imperfect check on government abuses in the United States over the past quarter century. In the last five years, there has become a growing international movement, with some countries, such as Thailand, going so far as to include them in their new Constitution. Regrettably, these principles have yet to be endorsed by the international economic institutions.

CONCLUDING REMARKS

In this paper I have traced the replacement of one paradigm with another. The deficiencies in the neo-classical paradigm—both the predictions which seemed counter to what was observed, some so glaring that one hardly needed refined econometric testing, and the phenomena that were left unexplained—made it inevitable that it was simply a matter of time before it became challenged. One might ask, how can we explain the persistence of the paradigm for so long? Partly, it must be because, in spite of its deficiencies, it did provide insights into many economic phenomena. There are some markets in which the phenomena which we have discussed are not important—the market for wheat or corn—though even here, pervasive government interventions make the reining competitive paradigm of limited relevance. The underlying forces of demand and supply are still important, though in the new paradigm, they become only part of the analysis; they are not the whole analysis. But one cannot ignore the possibility that the survival of the paradigm was partly because the belief in that paradigm, and the policy prescriptions, has served certain interests.

As a social scientist, I have tried to follow the analysis, wherever it might lead. As any researcher, we know that our ideas can be used or abused—or ignored. Understanding the complex forces that shape our economy is of value in its own right; there is an innate curiosity about how this system works. But “All the world’s a stage, and all the men and women merely players” Shakespeare [1599]. Each of us in our own way, if only as voters, is an actor in this grand drama. And what we do is affected by our perceptions of how this complex system works.

I entered economics with the hope that it might enable me to do something about unemployment, poverty, and discrimination. As an economic researcher, I have been lucky enough to hit upon some ideas that I think do enhance our understanding of these phenomena. As an educator, I have been lucky enough to have had the opportunity to reduce some of the asymmetries of information, especially concerning what the new information paradigm and other developments in modern economic science have to say about these phenomena, and to have had some first rate students who themselves have pushed the research agenda forward.

As an individual, I have, however, not been content just to let others translate these ideas into practice. I have had the good fortune to be able to do so myself, as a public servant both in the American government and at the World Bank. We have the good fortune to live in democracies, in which individuals can fight for their perception of what a better world might be like. We as academics have the good fortune to be further protected by our academic freedom. With freedom comes responsibility: the responsibility to use that freedom to do what we can to ensure that the world of the future be one in which there is not only greater economic prosperity, but also more social justice.

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Notes

1. See, e.g. Becker [1971] The insight was simple: that so long as there were sufficient numbers of, for instance, unprejudiced employers, they would bid up the wage of the discriminated to their marginal productivity.
2. There was one brilliant, valiant attempt to show that sharecropping did not matter, a thesis by

Steven Cheung completed at the University of Chicago, see Cheung [1969]. The unreasonable assumptions, especially concerning information, helped convince me of the need for an alternative theory

3. See Williamson [1990] for a description.
4. For an analysis, see Stiglitz [1998a].
5. See, for instance, Stiglitz [1975b, 1985d, 1987a, 1988b and Riley [2001]. There have also been reviews of particular aspects, some of which are referenced below.
6. See, for instance, Fudenberg, and Tirole [1991], Hirshleifer and Riley [1992], Hart [1995] and Mas-Colell, Whinston and Green [1995].
7. See, in particular, Stiglitz [2000d].
8. “If the legal rate . . . was fixed so high . . . the greater part of the money which was to be lent, would be lent to prodigals and profectors, who alone would be willing to give this higher interest. Sober people, who will give for the use of money no more than a part of what they are likely to make by the use of it, would not venture into the competition.” Smith, 1776. See also Marshall [1890], Sismondi [1814] and Mill [1848], as cited in Stiglitz [1987a].
9. There was so many of these that the *Journal of Economic Perspectives* ran a regular column with each issue highlighting these paradoxes. See Thaler [1987] and Thaler *et al.* [1989, 1990, 1991, 1995, 1997]. The problem of excess volatility of asset prices has recently been highlighted in the work of Shiller [2000].
10. In the discussion below, I elaborate on several of these paradoxes, and show how the new paradigm helps explain them.
11. According to Hall [1978], consumption should be a random walk, responding only to new news. The evidence does not support this conclusion
12. Inventories should be used to smooth the economy, so that they should move in a counter-cyclical manner. In fact, they move pro-cyclically. See for instance Blinder and Fisher [1981], Blinder (1986), Kahn [1987], Blinder and Maccini [1991] Bernanke and Gertler [1995] and Bils and Kahn [2000].
13. If firms operated along their production functions, then when employment fell, the marginal product of labor, and hence the real product wage, should rise. Yet, in cyclical downturns, it

- often does not. For empirical evidence on these and other seeming quandaries, see Greenwald and Stiglitz [1988b].
14. If workers operate along their labor supply curves, and if, as most empirical evidence suggests, labor supply curves, especially for primary workers, is highly inelastic, then when employment goes down, the real consumption wage should go down a great deal. Yet in many cyclical downturns, that does not happen. Though observed behavior can be reconciled with the theory simply by assuming that there is a simultaneous shift in the labor supply schedule, such an explanation is hardly satisfying.
 15. See, e.g. Stiglitz [1995a, 1999a].
 16. Remarkably, Lucas [1987] (won the Nobel prize in 1995) uses the perfect markets model with a representative agent to try to argue that these cyclical fluctuations in fact have a relatively small welfare costs.
 17. See, for instance, Mayer [1990].
 18. Stigler [1967], who won the Nobel Prize in 1982.
 19. See Samuelson [1947]. He won the Nobel Prize in 1970.
 20. Stiglitz [1975c].
 21. Subsequently published as Fields [1972].
 22. See, e.g. Schultz [1960], who won the Nobel Prize in 1979, and Mincer [1974].
 23. At the time, there was other on-going work criticizing the human capital formulation, focusing on the role of education in socialization and credentialization. See, for instance, Bowles and Gintis [1976].
 24. See Harris and Todaro [1970], Todaro [1969]. I developed these ideas further in Stiglitz [1969b].
 25. See Leibenstein [1967]. There were, of course, historical antecedents to this idea (as to many of the other ideas discussed below), see, e.g. Marshall in Marshall [1920] wrote: "... highly paid labour is generally efficient and therefore not dear labour; a fact which though it is more full of hope for the future of the human race than any other that is known us, will be found to exercise a very complicating influence on the theory of distribution."
 26. Others were independently coming to the same insight, in particular Ned Phelps in Phelps [1968]. Phelps and Winter also realized that the same issues applied to product markets, in their theory of customer markets. See Phelps and Winter [1970].
 27. In Nairobi, in 1969, I wrote a long, comprehensive analysis of efficiency wages, entitled "Alternative Theories of Wage Determination and Unemployment in LDC's." Given the custom of writing relatively short papers, focusing on one issue at a time, rather than publishing the paper as a whole, I had to break the paper down into several parts. Each of these had a long gestation period. The labor turnover paper was published as Stiglitz [1974a]; the adverse selection model as Stiglitz [1982a, 1992h (a revision of a 1976 unpublished paper)]. I elaborated on the nutritional efficiency wage theory in Stiglitz [1976c]. Various versions of these ideas have subsequently been elaborated on in a large number of papers, including Weiss [1980], Nalebuff, Rodriguez and Stiglitz [1993], Rodriguez and Stiglitz [1991a, 1991b], Stiglitz [1982f, 1986b, 1987a, 1987i], Sah and Stiglitz [1992], Akerlof and Yellen [1990] and Rey and Stiglitz [1996].
 28. See Arnott and Stiglitz [1985] and Arnott, Hosios, and Stiglitz [1988].
 29. For an early recognition of the importance of this concept in the economics literature, see Arrow [1965].
 30. The idea was recast in a more standard principal agent problem, but embedded within a general equilibrium model of the economy, in unpublished work with Patrick Rey, see Rey and Stiglitz [1996].
 31. In particular, in the context of the economics of discrimination, see Stiglitz [1974d].
 32. This term, like adverse selection, originates in the insurance literature. Insurance firms recognized that the greater the insurance coverage, the less incentive there was for the insured to take care; if a property was insured for more than 100% of its value, there was even an incentive to have an accident (a fire). Not taking appropriate care was thought to be "immoral"; hence the name.
 33. A problem which came to be called the principal-agent problem. See Ross [1973].
 34. For a classic reference see Hart and Holmström (1987). In addition see Stiglitz [1975a], Murphy [1985], Jensen and Murphy [1990],

- Haubrich [1994] and Hall and Liebman (1998).
35. Arrow's lectures (See Arrow [1965]) were an important precursor in this area, as they were in the area of adverse selection. See also Arrow [1964].
 36. See Stiglitz [1989g].
 37. See Bator [1958].
 38. For which Kenneth Arrow and Gerard Debreu got the Nobel Prizes in 1972 and 1983, respectively.
 39. A central proposition of standard neoclassical theory was that issues of distribution and efficiency could be separated (the second welfare theorem), and the efficiency of the market outcome did not depend on the distribution of wealth, so long as there were well defined property rights (see Coase [1960], who received the Nobel prize for his work in 1991).
 40. Strictly speaking, this was not an *inevitable* consequence of the neo-classical assumptions (e.g. it would not hold with irreversible investments), but it was a characteristic of the more widely used models.
 41. In the natural "spaces," indifference curves and isoprofit curves were ill behaved. The non-convexities which naturally arose implied, in turn, for instance, that equilibrium might be characterized by randomization (Stiglitz [1975b]), or that Pareto efficient tax and optimal tax policies might be characterized by randomization. See Arnott and Stiglitz [1988a], Brito, Hamilton, Slutsky and Stiglitz [1995] and Stiglitz [1982g]. Even small fixed costs (of search, of finding out about characteristics of different investments, of obtaining information about relevant technology) imply that markets will not be *perfectly* competitive; they will be better described by models of *monopolistic competition* (see Dixit and Stiglitz 1977, Salop, 1987, Stiglitz, 1979a, 1979b, 1989f), though the basis of imperfect competition was markedly different from that originally envisioned by Chamberlain (1933).
 42. To be sure, critics of modern capitalism had argued that in many of its central industries, returns to scale were sufficiently large that many industries would be characterized by either monopolies or oligopolies.
 43. Non-convexities naturally give rise to discontinuities, and discontinuities to problems of existence, but the non-existence problem that Rothschild and I had uncovered was of a different, and more fundamental nature. The problem was in part that a single action of an individual—a choice of one insurance policy over another—discretely changed beliefs, e.g. about his type; and that a slight change in the actions of, say an insurance firm—making available a new insurance policy—could lead to discrete changes in actions, and thereby beliefs. Dasgupta and Maskin [1986] have explored mixed strategy equilibria in game theoretic formulations, but these seem less convincing than the imperfect competition resolutions of the existence problems described below. Other problems of non-existence were explored in the context of moral hazard problems in work with Richard Arnott [1987, 1991b].
 44. This had a particularly inconvenient implication: when there was a continuum of types, such as in the Spence [1973, 1974] -models, a full equilibrium never existed.
 45. See for instance Riley [1979].
 46. See also Shapiro [1983] and Klein and Leffler [1981].
 47. As I noted earlier, the models of imperfect competition were more akin to Chamberlinian monopolistic competition models than other versions of imperfect competition. See, e.g. Stiglitz [1979b].
 48. See, e.g. Fama [1970, 1991].
 49. Similarly, in many of the incentive models, there may be ways of resolving the problem *in the highly simplified models* but these resolutions will not work in more complex models. Below, for instance, we describe a model in which higher interest rates lead individuals to take more risks, and so the expected return to the lender may actually decrease. As a result, the optimal interest rate may be lower than that at which markets clear; they can be credit rationing. In the simplified models, the problem could be resolved by requiring collateral (Bester [1985]); but in models in which there are both adverse selection *and* incentive problems, this is no longer true, since those most willing to provide collateral may be wealthy individuals, more willing to undertake risky projects. See Stiglitz and Weiss [1985].
 50. Some earlier work, especially in general equilibrium theory, by Radner [1972], Hurwicz

- [1972], and Marschak and Radner [1972], among others had recognized the importance of problems of information, and had even identified some of the ways that limited information affected the nature of the market equilibrium (e.g. one could only have contracts that were contingent on states of nature that were observable by both sides to the contract.) But the attempt to modify the abstract theory of general equilibrium to incorporate problems of information imperfects proved, in the end, less fruitful than the alternative approach of beginning with highly simplified, quite concrete models.
51. There are other incentives for the creation of information asymmetries. Individuals might originally not know their abilities, but if the market pays higher wages to an individual who is more able, it may pay an individual to ascertain whether he is or is not more able. See Stiglitz [1984a].
 52. If individual's productivity was the same on all jobs, and there were not other reasons for changing jobs (e.g. non-pecuniary preferences), there would be no labor mobility. The fact that there is *some* labor mobility does not undermine the central result: information asymmetries *reduce* the extent of mobility.
 53. See Stiglitz [1975d], and Leitzinger and Stiglitz [1984]. Of course, in the bidding for the initial leases, bidders know that should they win the lease, they will be able to win auctions on neighboring tracts at more favorable terms, and this will affect the size of the initial bids.
 54. Wilson [1977].
 55. The winners' curse is a manifestation of imperfect information. If different individuals get independent estimates of the amount of oil in a tract, the one with the most positive estimate will bid the highest. He knows that if he wins, others' information is less positive, and he takes this into account in forming his bid. See Cappen, Clapp and Campbell (1971) for the first empirical and very influential study of the winner's curse and Wilson [1969] for a theoretical treatment. In the case of asymmetric information, an uninformed bidder knows that he is more likely to outbid the informed bidder if he bids more than it is worth, and this decreases his willingness to make a bid even further.
 56. See Shleifer and Vishny [1989].
 57. I jokingly referred to this as "Walras' Law of Sorting"—if all but one group sorts itself out from the others, then the last group is also identified.
 58. And there is no reason to believe that the market "balances" these two forms of imperfection optimally.
 59. See Stiglitz [1975b], Jaffee and Stiglitz [1990].—This perhaps helps explain why competition in banking—which is essentially concerned with screening among borrowers—is so imperfect.
 60. Stiglitz [1974a]. Arrow [1973] simultaneously developed a theory of education which looked at it from much of the same perspective.
 61. This point was independently arrived at by Hirschliefer [1971] and is elaborated on in more detail below.
 62. Arrow [1965].
 63. See also Greenwald, Stiglitz, and Weiss [1984] and Myers and Majuf [1984].
 64. See discussion in subsection *Corporate Finance*.
 65. This is the efficiency wage theory discussed earlier. Constructing *equilibrium models* is more difficult than might seem to be the case at first, since each agents' behavior depends on opportunities elsewhere, i.e. the behavior of others. The workers that I attract at a particular wage depend on the wage offers of other firms. Rey and Stiglitz [1996], Shapiro and Stiglitz [1984], and Rodriguez and Stiglitz [1991a, 1991b] represent attempts to come to terms with these general equilibrium problems.
 66. Sorting out empirically the relative importance of human capital and sorting effects turns out to be quite difficult. In arguing that education sorts, I did not argue that it does not, at the same time, enhance productivity. See Weiss [1995]. There are a number of aspects of the education market which are consistent with the "sorting" hypothesis: for instance, wages go up markedly upon graduation. It could be that the knowledge just jells in the final days before graduation, but the more likely hypothesis is that the completion of four years, and the successful passing of all the relevant examinations, conveys a considerable amount of information.
 67. Stiglitz [1977a].
 68. See Stiglitz [1983], Ross [1973] and Leland and Pyle [1977].

69. Spence [1973].
70. See, in particular, Stiglitz and Weiss [1983a, 1994] and Yabushita [1983]. As we point out, in the real world, who moves first ought to be viewed as an endogenous variable. In such a context, it appears that the screening equilibria are more robust than the signaling equilibrium. Assume, for instance, that there were some signaling equilibrium that differed from the screening equilibrium, e.g. there were a pooling equilibrium, sustained because of the out-of-equilibrium beliefs of firms. Then such equilibrium could be broken by a prior or later move of firms.
71. More accurately, the level of education of the more able is the minimum of that and the level of education which maximizes the individual's net income (discounted income minus expenditures on education).
72. Moreover, even where the educational system not dominated by the government, there would be a coordination problem: a single firm cannot propose an alternative set of "contracts"—different wages corresponding to different levels of education—to "break" an inefficient separating equilibrium, because the employee does not know that he will necessarily remain with the firm for his entire working life.
73. In particular, when there is a continuum of types (as in the Spence (1973) model,) there never exists a screening equilibrium. The intuition is provided by Rothschild and Stiglitz, who showed then when the types were "close" to each other, then the equilibrium, would not exist; the costs of separating exceed the benefits; a pooling equilibrium could always "break" the separating equilibrium. With a continuum of types, there are always types that are arbitrarily close to each other. At the "bottom" (the highest risk individuals), it is always possible to find a contract which made a profit and attracted the worst types.
74. There was, in this sense, a close relationship between the equilibrium analysis of Rothschild and Stiglitz [1976] and Stiglitz [1974b]. Both explored equilibria in the space of contracts, where contracts imposed stipulations on actions and payments that were based on observables.
75. For a survey see Hart and Holmström [1987] and Salanié [1997].
76. Though even here, there were subtleties, e.g. whether individuals exerted their efforts before they knew the realization of the state of nature, and whether there were bounds on the penalties that could be imposed in the event of bad outcomes (Stiglitz [1975a], Mirrlees [1975b], Mirrlees [1976]).
77. In Stiglitz [1974b] the contracts were highly linear. In principle, generalizing payment structures to non-linear functions was simple. The literature has not fully resolved the reason that contracts are often much simpler than the theory would have predicted (e.g. payments are linear functions of output), and do not adjust to changes in circumstances. See, e.g. Allen [1985], Gale [1991] and Stiglitz [1987g, 1989h].
78. In work with Avi Braverman [1982, 1986a, 1986b, 1989], we explored, for instance, stipulations concerning what was to be grown and the use of inputs like fertilizers, and the interlinkages between credit, land, and labor contracts. For an earlier survey of sharecropping, see Stiglitz [1987g]. For a more recent survey see Chuma, Hayami and Otsuka [1992].
79. Venture capital firms represent an interlinkage of capital and "management" markets. See Hellmann [1998].
80. See, in particular, Braverman, Hoff, and Stiglitz [1993].
81. See Stiglitz [1975a, 1987c].
82. Most of the work was partial equilibrium and did not pay much attention to the problem of interactions among different contract forms. Rey and Stiglitz [1996] provide a general equilibrium analysis for the labor market, Stiglitz [1992] discuss the interactions between banks and capital markets, and Hellman and Stiglitz [2000] that between credit and equity.
83. See, for instance, Stiglitz and Weiss [1983b, 1986, 1987]. Even with these additional instruments there could still be non-market clearing equilibria. Bester's [1985] conclusion that by increasing collateral requirements one can eliminate credit rationing is wrong, simply because he ignores the interaction between selection and incentive effect in this seemingly simple context.
84. As another application, "contracting"—including provisions for risk sharing—came to play an important role in explaining macro-econom-

- ic rigidities. See, for instance, *Werin, and Wijkander (1992)*, the papers of the symposium in *Quarterly Journal of Economics [1983]*, and the survey article by *Rosen [1985]*, *Azariadis and Stiglitz [1983]*, and *Arnott, Hosios, and Stiglitz [1988]*.
85. This is not quite accurate: if individuals can post a bond, then they can be forced to forfeit the bond. But individuals may not have the wealth to post a bond, and there may be “moral hazard” issues—with a good bond, the firm may have an incentive to say the worker shirked when he did not.
 86. For a survey, see *Stiglitz [1989c]*.
 87. Though even here, some economists suggested that in the absence of transactions costs, the market could handle the problem efficiently. See *Coase [1960]*. But this analysis too depended on assumptions of perfect information, as *Farrell [1987]* forcefully showed.
 88. See *Stiglitz [1989k]*.
 89. For a discussion in the context of the East Asia crisis, see *Furman and Stiglitz [1998]*.
 90. See, e.g. *Rothschild and Stiglitz [1982, 1997]*. For models of statistical discrimination and some of their implications, see *Stiglitz [1973a, 1974d]*, *Arrow [1972]*, and *Phelps [1972]*.
 91. At first blush, the result might seem obvious, but interestingly, a number of economists had tried to show that the Arrow-Debreu results on the efficiency of the market were more robust than they seemed, that is even if there were not a complete set of securities markets, the market was constrained Pareto efficiency. See, e.g. *Diamond [1967]*. But these results were shown to depend on the overly simplistic nature of the models, e.g. involving a single commodity. See *Stiglitz [1972a, 1982b]*, *Newbery and Stiglitz [1982, 1984]*, *Grossman and Stiglitz [1977, 1980b]*.
 92. *Greenwald and Stiglitz [1986]* focus on models with adverse selection and incentive problems. *Greenwald and Stiglitz [1988a]* showed that similar results hold in the context of search and other models with imperfect information. Earlier work, with *Shapiro [1984]* had shown, in the context of a specific model, that equilibria in an economy with an agency or principal agent problem were not (constrained) Pareto efficient. Later work, with *Arnott [1990]* explored in more detail the market failures that arise with moral hazard.
 93. *Arnott, Greenwald, and Stiglitz [1994]* provide a simple exposition using the standard self-selection and incentive compatibility constraints.
 94. These ideas are extended and generalized in *Arnott and Stiglitz [1986, 1990, and 1991b]*. In *Stiglitz [1998c]*, I explore the role of corrective taxation (correcting for externalities) in the presence of imperfect information.
 95. See *Stiglitz and Weiss [1983b]*.
 96. See, for instance, *Stiglitz [1987h]*.
 97. A point that had also been made earlier in *Shapiro and Stiglitz [1984]*.
 98. See *Stiglitz [1998c]*.
 99. The second welfare theorem also requires other mathematical assumptions, e.g. concerning convexity, which typically may not be satisfied in models with imperfect and endogenous information. Other problems with decentralizability were raised in *Arnott and Stiglitz [1991b]*.
 100. For a more extensive discussion of the economic role of the state, see *Stiglitz [1989a]*.
 101. Whether non-market insurance increased or decreased welfare depended on what was observable (monitorable) by other members of the family. If they had no more information than did the insurance company, then the non-market insurance lowered welfare; if they had access to more information, then, in effect, the insurance company could free ride on this information, and welfare could actually be enhanced.
 102. For early explorations of the implications of taxes for corporate finance, see *Stiglitz [1973b, 1976a]*.
 103. See *Modigliani and Miller [1958]*. They won the Nobel Prize in 1985 and 1990, respectively. In *Stiglitz [1969a]*, I showed that their result was, in some respects, considerably more general than their proof would have led one to believe (it did not require, for instance, risk classes and held in general equilibrium), but there was one critical assumption: bankruptcy, which they had ignored.
 104. The term “equity rationing” is used loosely to refer to the fact that firms do not rely on the issuance of equity to divest themselves of the risks which they face, in the way that perfect

- information theories predict; the issuance of equity, as we have noted, sends a signal that the owners/managers of the firm think the market has overvalued the shares, and the market responds by lowering price. Thus, the cost of raising funds through equity is extremely high. For empirical evidence showing that relatively little new investment is financed by equity, see Mayer [1990]; for empirical evidence concerning the adverse price effects of share issuance, see Asquith and Mullins [1986]; for the general theory, see Greenwald, Stiglitz, and Weiss [1984] and Myers and Majluf [1984]. Other information based theories that help explain the limited use of equity markets, in spite of their advantages in risk sharing, are derived from signaling/self-selection models referred to earlier, and on models of "costly state verification." (Townsend [1979]). Equity markets give each shareholder a pro-rata share of the profits, but this requires that profits be observable. There are a variety of ways by which profits can be diverted to managers and dominant shareholders. Legal structures and accounting practices are designed to circumscribe such behavior (Greenwald and Stiglitz [1992]), and only where these have become well developed have strong equity markets with diversified share ownership developed. (Shleifer and Vishny [1997]).
105. That is, we noted earlier that optimal incentive schemes typically involve the worker/manager bearing some risk. In some cases, incentive schemes can actually lead managers to act in a risk-loving way.
106. See, in particular, Greenwald and Stiglitz [1991].
107. For an elaboration of this point, see Stiglitz [1987c, 1989g].
108. The very concept of liquidity—and the distinction between lack of liquidity and insolvency—rests on information asymmetries. If there were perfect information, any firm that was solvent would be able to obtain finance, and thus would not face a liquidity problem.
109. There is now a vast literature in this area. See, for instance, Blanchard, Lopez-de-Silanes and Schliefer [1994], Hubbard [1990], Calomiris and Hubbard [1990] and Fazzari, Hubbard and Peterson [1988]. For a survey of this literature see Hubbard [1998].
110. Modigliani and Miller [1961]. In Stiglitz [1974c], I again showed that the result was, in some respects, far more general than their analysis suggested, but that it was, in fact, undermined by the capital market imperfections which arose from imperfect information.
111. It was also assumed that firm value maximization would lead to efficient outcomes. When there is not a complete set of Arrow-Debreu securities, this is in general not the case. See Stiglitz [1972a, 1982b], Newbery and Stiglitz [1982], Grossman and Stiglitz [1977, 1980b].
112. For an early analysis of these issues, see Stiglitz [1972b]. For a general theorem, see Grossman and Stiglitz [1977].
113. That the standard model of the theory of the firm—where there was a single owner concerned with maximizing the firm's value—did not fit well the modern theory of the corporation had been noted even earlier by Alfred Marshall [1897]. There was a large subsequent literature on the managerial theory of the firm. See, e.g. Marris [1964], Baumol [1959], and March and Simon [1958]. Even earlier, Adam Smith [1776] had noted the problem of corporate governance: "The directors of such companies, however, being the managers rather of other people's money than their own, it cannot well be expected that they should watch over it with the same anxious vigilance with which the partners in a private company frequently watch over their own. Like the stewards of a rich man, they are apt to consider attention to small matters as not for their master's honour, and very easily give themselves a dispensation from having it. Negligence and profusion, therefore, must always prevail, more or less, in the management of the affairs of such a company." pp. 264–265. Marshall [1897], in his review of the advances of economics in the nineteenth century; and the challenges facing the discipline, cited the problems of (in modern parlance) corporate governance, of what motivates a manager to act in the interests of the owners of the firm.
114. There has subsequently developed a large theoretical and empirical literature on take-overs. See, for instance, Manne [1965], Jensen and Rubac [1983], Stulz [1988] and Singh [1998]. For a surveys of the literature on take-over, see Hirshleifer [1995]. For a survey of the broader

- literature on corporate governance, see Shleifer and Vishny [1997].
115. In addition, see Sah [1991]. These papers are just beginning to spawn a body of research. See, for instance, Bhidé [2001], Viser [1998] and Christensen and Knudsen [2002].
 116. See Mankiw [1985] and Akerlof and Yellen [1985].
 117. Our theories did not provide a complete explanation for such incomplete contracting. While part of the explanation may lie in the lack of observability (verifiability) of the relevant variables on which contracts should be contingent, still it seems that there should be more indexing than is observed. Theories of asymmetric information did, however, provide part of the explanation for why inefficient contractual arrangements might persist. In a complex economy, if one party proposes a change to a standard contract, the other party might reasonably infer that the alteration benefits the party proposing the change; in a world which is close to zero sum, the gains for that party are at the expense of the other, and so he will be reluctant to concur with the change, unless he can be persuaded that there is scope for a Pareto improvement. Because of limitations on information (knowledge), this may be hard to do. See Stiglitz [1992c].
 118. The importance of these phenomena had been emphasized earlier by Irving Fisher [1933]. Stiglitz [1999d] emphasizes the consequences of *difference* in the speeds of adjustments of different prices.
 119. In traditional economic theories bankruptcy played little role, partly because control (who made decisions) did not matter, and so the change in control that was consequent to bankruptcy was of little moment, partly because with perfect information, there would be little reason for lenders to lend to someone, rather than extending funds through equity (especially if there were significant probabilities of, and costs to, bankruptcy). For an insightful discussion about control rights see Hart [1995].
 120. For discussions of credit rationing and macroeconomic activity, see Stiglitz and Weiss [1992].
 121. The ideas set forth in this section are developed at greater length in Greenwald and Stiglitz [1990b, 1991, 2003].
 122. The special nature of information also helps explain the link between the acquisition and processing of information and the provision of funds. If information were like any other good, "information" firms could sell their information to providers of funds, so that shocks which adversely affect the net worth of the information processors would have minimal effects on credit supply. While there is some sale of information, in most lending markets, such information constitutes only a small part of the information that affects lending decisions.
 123. See also Hellman, Murdoch, and Stiglitz [2000].
 124. There is now a large literature arguing that these are the crucial variables of concern. For an early discussion, see Blinder and Stiglitz [1983].
 125. See Stiglitz [2001d].
 126. This section is based in part on Greenwald, Kohn, and Stiglitz [1990] and Stiglitz [1992e, 1994a, 1994b].
 127. This section is based on Stiglitz [1986a, 1987d, 1988a, 1988e, 1989, 1990b, 1993b, 1995b, 1996a, 1997a, 1997b, 1998a, 1999b, 2001a, b], Hoff and Stiglitz [1997, 2000], Stern and Stiglitz [1997], and Stiglitz and Yusuf [2000] in addition to the work on the theory of rural organization (with Braverman and Hoff cited earlier).
 128. See, in particular, the discussion in the World Bank [1999].
 129. There were, of course, several precursors to what has come to be called endogenous growth theory. See in particular, the collection of essays in Shell [1967], and Atkinson and Stiglitz [1969]. For later work, see, in particular, Dasgupta and Stiglitz [1980a, 1980b, 1981, 1988], Dasgupta, Gilbert, and Stiglitz, [1982], Stiglitz, [1987e, 1990a].
 130. The discussion of this section draws upon Atkinson and Stiglitz [1976], Stiglitz [1982e, 1987f], and Mirrlees [1971, 1975a], and Brito et al. [1990, 1991, 1995].
 131. In that sense, Mirrlees' work confounded the two stages of the analysis. He described the point along the Pareto frontier that would be chosen by a government with a utilitarian social welfare function. Some of the critical properties, e.g. the zero marginal tax rate at the top, were, however, characteristics of *any* Pare-

to efficient tax structure, though that particular property was not *robust*, that is, it depended strongly on his assumption that relative wages between individuals of different abilities were fixed. See Stiglitz [2002] and the papers cited there.

132. See, e.g. Laffont and Tirole [1993] and Sapington and Stiglitz [1987a].
133. A sector in which government regulation was of particular importance is banking. We noted earlier that information problems are at the heart of financial markets, and it is thus not surprising that market failures be more pervasive, and the role of the government more important. See, e.g. Stiglitz [1993a]. Regulatory design needs to take into account explicitly the limitations in information. See, e.g. Stiglitz [2001c], Honahan and Stiglitz [2001], Greenwald and Stiglitz [1999] and Hellman, Murdoch and Stiglitz [2000].
134. See, for instance, Stiglitz [1998a].
135. See, for instance, Stiglitz [2001e, 2000a], Hussein, Stern, and Stiglitz [2000].
136. See, in particular, Furman and Stiglitz [1998] and Stiglitz [1999c].
137. See Stiglitz [2001e].
138. For fuller discussions of these issues, see Hussein, Stern, and Stiglitz [2000] and Stiglitz [2000a].
139. In addition, much of recent economic theory has assumed that *beliefs* are, in some sense, rational. As noted earlier, there are many aspects of economic behavior that seem hard to reconcile with this hypothesis.
140. See, e.g. Stiglitz [1995b, 1998a].
141. See Collier and Gunning [1999], Collier [1998] and Collier [2000].
142. Stiglitz [1973a, 1974d].
143. For a discussion with references to the literature, see Stiglitz [2000d, 2000e].
144. There is a large and growing literature on evolutionary economics. See, for instance, Maynard Smith and Price [1973], Nelson and Winter [1982, 1990], Weibull [1996], Mailath [1992], Aoki and Feldman [1999], Stiglitz [1975b, 1992i] and Sah and Stiglitz [1991]. Some of this work emphasized the importance of capital constraints for evolutionary processes.
145. Senator Patrick Moynihan, in his powerful book Moynihan [1998], shows how secrecy

was abused during the Cold War, in ways which led to unnecessarily large military expenditures.

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