INFORMATION AND THE CHANGE IN THE PARADIGM IN ECONOMICS

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by

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The research for which George Akerlof, Mike Spence, and I are being recognized is part of a larger research program which, today, embraces hundred, perhaps thousands, of researchers around the world. In this lecture, I want to set the particular work which was sited within this broader agenda, and that agenda within the broader perspective of the history of economic thought. I hope to show that Information Economics represents a fundamental change in the prevailing paradigm within economics. Problems of information are central to understanding not only *market* economics but also *political economy,* and in the last section of this lecture, I explore some of the implications of information imperfections for political processes.

INTRODUCTION

Many years ago Keynes wrote:

> The ideas of economists and political philosophers, both when they are right and when they are wrong, are more powerful than is commonly understood. Indeed, the world is ruled by little else. Practical men, who believe themselves quite exempt from any intellectual influences, are usually the slaves of some defunct economist. Madmen in authority, who hear voices in the air, are distilling their frenzy from some academic scribbler of a few years back. Keynes [1936].

Information economics has already had a profound effect on how we think about economic policy, and are likely to have an even greater influence in the future. The world is, of course, more complicated than our simple – or even our more complicated models – would suggest. Many of the major political debates over the past two decades have centered around one key issue: the efficiency of the market economy, and the appropriate relationship between the market and the government. The argument of Adam Smith [1776], the founder of modern economics, that free markets led to efficient outcomes, "as if by an invisible hand" has played a central role in these debates: it suggested that we could, by and large, rely on markets *without government intervention*. There was, at best, a limited role for government. The set of ideas that

I will present here undermined Smith's theory and the view of government that rested on it. They have suggested that the reason that the hand may be invisible is that it is simply not there – or at least that if is there, it is palsied.

When I began the study of economics some forty one years ago, I was struck by the incongruity between the models that I was taught and the world that I had seen growing up, in Gary Indiana, a city whose rise and fall paralleled the rise and fall of the industrial economy. Founded in 1906 by U.S. Steel, and named after its Chairman of the Board, by the end of the century it had declined to but a shadow of its former self. But even in its heyday, it was marred by poverty, periodic unemployment, and massive racial discrimination. Yet the theories that we were taught paid little attention to poverty, said that all markets cleared – including the labor market, so unemployment must be nothing more than a phantasm, and that the profit motive ensured that there could not be economic discrimination.[1] If the central theorems that argued that the economy was Pareto efficient – that, in some sense, we were living in the best of all possible worlds – were true, it seemed to me that we should be striving to create a different world. As a graduate student, I set out to try to create models with assumptions – and conclusions – closer to those that accorded with the world I saw, with all of its imperfections.

My first visits to the developing world in 1967, and a more extensive stay in Kenya in 1969, made an indelible impression on me. Models of perfect markets, as badly flawed as they might seem for Europe or America, seemed truly inappropriate for these countries. But while many of the key assumptions that went into the competitive equilibrium model seemed not to fit these economies well, the ones that attracted my attention was the imperfection of information, the absence of markets, and the pervasiveness and persistence of seeming dysfunctional institutions, like sharecropping. With workers having to surrender 50% or more of their income to landlords, surely (if conventional economics were correct), incentives were greatly attenuated. Traditional economics said not only that institutions (like sharecropping)[2] did not matter, but neither did the distribution of wealth. But if workers owned their own land, then they would not face what amounted to a 50% tax. Surely, the distribution of wealth did matter.

I had seen cyclical unemployment – sometimes quite large – and the hardship it brought as I grew up, but I had not seen the massive unemployment that characterized African cities, unemployment that could not be explained either by unions or minimum wage laws (which, even when they existed, were regularly circumvented). Again, there was a massive discrepancy between the models we had been taught and what I saw.

[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.

The new ideas and models were not only useful in addressing broad philosophical questions, such as the appropriate role of the state, but also in analyzing concrete policy issues. In the 70s, economists became increasingly critical of traditional Keynesian ideas, partly because of their assumed lack of micro-foundations. The attempts made to construct a new macro-economics based on *traditional* micro-economics, with its assumptions of well functioning markets, was doomed to failure. Recessions and depressions, accompanied by massive unemployment, were symptomatic of massive market failures. The market for labor was clearly not clearing. How could a theory that began with the assumption that all markets clear ever provide an explanation? If individuals could easily smooth their consumption by borrowing at safe rates of interest, then the relatively slight loss of lifetime income caused by an interruption of work of six months or a year would hardly be a problem; but the unemployed do not have access to capital markets, at least not at reasonable terms, and thus unemployment is a cause of enormous stress. If markets were perfect, individuals could buy private insurance against these risks; yet it is obvious that they cannot. Thus, one of the main developments to follow from this line of research into the consequences of information imperfections for the functioning of markets is the construction of *macro economic* models that help explain why the economy amplifies shocks and makes them persistent, and why there may be, even in competitive equilibrium, unemployment and credit rationing.

I believe that some of the huge mistakes which have been made in policy in the last decade, in for instance the management of the East Asia crisis or the transition of the former communist countries to a market, might have been avoided in there had been a better understanding of issues, like bankruptcy and corporate governance, to which the new information economics called attention. And the so-called Washington consensus policies[3], which have predominated in the policy advice of the international financial institutions over the past quarter century, have been based on market fundamentalist policies which ignored the information-theoretic concerns, and this explains at least in part their widespread failures.

Information affects decision making in every context – not just inside firms and households. More recently, I have turned my attention to some aspects of what might be called the *political economy* of information: the role of information in political processes, in collective decision making. For two hundred years, well before the economics of information became a subdiscipline within economics, Sweden had enacted legislation to increase transparency. There are asymmetries of information between those governing and those governed, and just as markets strives to overcome asymmetries of information, we need to look for ways by which the scope for asymmetries of information in political processes can be limited and their consequences mitigated.

[3] See Williamson [1990] for a description. For a critique, see Stiglitz [1998a].

I do not want here to review and described in detail the models that were constructed. In recent years, there have been a number of survey articles[5], even several books[6], and interpretative essays[7]. I do want to highlight some of the dramatic impacts that information economics has had on how economics is approached today, how it has provided explanations to phenomena that were previously unexplained, how it has altered our views about how the economy functions, and, perhaps most importantly, how it has led to a rethinking of the appropriate role for government in our society. In describing the ideas, I want to trace out some of their origins: to a large extent, they were responses to attempts to answer specific policy questions or to explain specific phenomena to which the standard theory provided an inadequate explanation. But any discipline has a life of its own, a prevailing paradigm, with assumptions and conventions. Much of the work was motivated by an attempt to explore the limits of that paradigm – to see how the standard models could embrace problems of information imperfections (which turned out not to be very well.)

For more than a hundred years, formal modeling in economics has focused on models in which information was perfect. Of course, everyone recognized that information was in fact imperfect, but the hope, following Marshall's dictum "Natura non facit saltum" was that economies in which information was not too imperfect would look very much like economies in which information was perfect. One of the main results of our research was to show that this was not true; that even a small amount of information imperfection could have a profound effect on the nature of the equilibrium.

The reining paradigm of the twentieth century, the neoclassical model, ignored the warnings of the nineteenth century and earlier masters on how information concerns might alter the analyses, perhaps because they could not see how to embrace them in their seemingly precise models, perhaps because doing so would have led to uncomfortable conclusions about the efficiency of markets. For instance, Smith, in anticipating later discussions of adverse selection, wrote that as firms raise interest rates, the best borrowers drop out of the market. *If* lenders know perfectly the risks associated with each borrower, this would matter little; each borrower would be charged an appropriate risk premium. It is because lenders do not know the default probabilities of borrowers perfectly that this process of adverse selection has such important consequences.[8]

[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].

I have already noted in the introduction that *something* was wrong – seriously wrong – with the competitive equilibrium models which represented the prevailing paradigm when we went to graduate school. It seemed to say that unemployment didn't exist, that issues of efficiency and equity could be neatly separated, so that economists could neatly set aside problems of inequality and poverty as they went about their business of designing more efficient economic systems. But there were a host of other predictions, empirical puzzles, that were hard to reconcile with the standard theory: in micro-economics, there were tax paradoxes such as why did firms seemingly not take actions which minimized their tax liabilities, security market paradoxes, such as why did asset prices seem to exhibit such high volatility[9], and behavioral puzzles, such as why did firms respond to risks in ways which were markedly different from that predicted by the theory.[10] In macro-economics, the cyclical movements of many of the key aggregate variables, such as consumption,[11] inventories,[12] real product wages[13], real consumption wages[14], and interest rates[15] are hard to reconcile with the standard theory, and if the perfect market assumptions were even approximately satisfied, the distress caused by cyclical movements in the economy would be much less than seems to be the case.[16]

The problems that we saw with the models that we were taught was not only that they seemed wrong, but that they left a host phenomena and institutions unexplained – why were IPO's typically sold at a discount? Why did equities, which provided far better risk diversification than debt, play such a limited role in financing new investment?[17]

There were, to be sure, some Ptolemaic attempts to defend and elaborate

[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].

on the old model. Some, like George Stigler[18], while recognizing the importance of information, argued that once the real costs of information were taken into account, even with imperfect information, the standard results of economics would still hold. Information was just a transactions cost. In the approach of many Chicago economists, information economics was like any other branch of applied economics; one simply analyzed the special factors determining the demand and supply for information, just as agricultural economics analyzed those factors affecting the market for wheat. For the more mathematically inclined, information could be incorporated into production functions of, say, goods by inserting an "I" for the input "information," and I itself could be produced by inputs, like labor. Our analysis showed that that this approach was wrong, as were the conclusions derived from it.

Practical economists who could not ignore the bouts of unemployment which had plagued capitalism since its inception talked of the neoclassical synthesis: using Keynesian interventions to ensure that the economy remained at full employment, and once that was done, the standard neoclassical propositions would once again be true. But while the neoclassical synthesis[19] had enormous intellectual influence, by the 1970s and 80s it came under attack from two sides. It was an assertion, not based on a coherent view of the economy. One side attacked the underpinnings of Keynesian economics, its micro-foundations; why would rational actors by out of equilibrium – with unemployment persisting – in the way that Keynes had suggested. This side effectively denied the phenomena which Keynes was attempting to explain.

Worse still, some saw unemployment as largely reflecting an interference (e.g. by government in setting minimum wages, or trade unions, in using their monopoly power to set too high wages) with the free workings of the market, with the obvious implication: unemployment would be eliminated if markets were made more *flexible*, that is unions and government interventions were eliminated. Even if wages fell a third in the Great Depression, they should have, in this view, fallen even more.

There was an alternative perspective (articulated more fully in Greenwald and Stiglitz, 1987a, 1988b): why shouldn't we believe that massive unemployment was just the tip of the iceberg, of more pervasive market efficiencies that are harder to detect. If markets seemed to function *so* badly some of the time, certainly they must be malperforming in more subtle ways much of the time. The economics of information bolstered the latter view.

Similarly, given the nature of the debt contracts, the falling wages and prices led to bankruptcy and economic disruptions, actually exacerbating the economic downturn. Had there been more wage and price flexibility, matters might have been even worse. Moreover, neither government nor unions imposed the limitations on wage and price dynamics in many sectors of the economy; at the very least, those who argued that the problem was wage and price rigidities had to look for other *market* imperfections, and any policy

[18] Stigler [1961], who won the Nobel Prize in 1982.
[19] See Samuelson [1947]). He won the Nobel Prize in 1970.

remedy (including a call for greater flexibility) had to take those factors into account.

In the next section, I shall explain how it was not just the discrepancies between the standard competitive model and its predictions which lead to its being questioned. The model was not robust – even slight departures from the underlying assumption of perfect information had large consequences.

But before turning to those issues, it may be useful to describe some of the concrete issues which underlay the beginnings of my research program in this area. Key in my thinking on these issues was the time between 1969 and 1971 I spent at the Institute for Development Studies at the University of Nairobi with the support of the Rockefeller Foundation.

Education as a screening device[20]

The newly independent Kenyan government was asking questions that have never seemingly been raised by their colonial masters, as it attempted to forge policies which would promote their growth and development. How much should it invest in education? It was clear that a better education got one better jobs – the credential put one at the head of the job queue. Gary Fields, a young scholar working at the Institute of Development Studies there, developed a simple model[21] suggesting that the private returns to education – the enhanced probability of getting a good job – differed from the social return; and that it was possible that as more people get educated, the private returns got higher (it was even more necessary to get the credential) even though the social return might decline. Here, education was performing a markedly different function than it did in traditional economics literature, where it simply added to human capital and improved productivity.[22, 23] The analysis had important implications for Kenya's decision about how much to invest in higher education. The problem with Fields' work was that it did not provide a full *equilibrium* analysis: wages were fixed, rather than competitively determined.

This led me to ask, what would the market equilibrium look if wages were set equal to mean marginal products *conditional on the information that was available*. And this in turn forced me to ask: what were the *incentives* and *mechanisms* for employers and employees to acquire or transmit information. Within a group of otherwise similar job applicants (who therefore face the same wage), the employer has an incentive to identify who is the most able, to find some way of *sorting* or *screening* among them, *if he could keep that information private*. But he often can't, and if others find out about the true ability, the wage will be bid up, and he will be unable to *appropriate* the return to the information. At the very beginning of this research program we had thus iden-

[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].

tified one of the key issues in information economics, the difficulty of *appropriating* the returns.

On the other hand, the employee, *if he knew his ability* (that is, if there were *asymmetries of information between the employee and the employer)* and he knew that his abilities were above the average of those in the market, had an incentive to convince the employer of his ability. But someone at the bottom of the ability distribution had an incentive not have the information revealed. Here was a second principle that was to be explored in subsequent years: there are incentives on the part of individuals for information not to be revealed, for secrecy, or, in modern parlance, for a lack of transparency. This raised a question: how did the forces for secrecy and for information disclosure get balanced? What was the equilibrium that emerged? I will postpone until the next section a description of that equilibrium.

Efficiency wage theory

That summer in Kenya I began three other research projects related to information imperfections. At the time I was working in Kenya, there was heavy urban unemployment. My colleagues at the Institute for Development Studies, Michael Todaro and John Harris had formulated a simple model of labor migration from the rural to the urban sector which accounted for the unemployment. High urban wages attracted workers, and they were willing to risk unemployment for the chance of those higher wages.[24] Here was a simple, general equilibrium model of unemployment, but again there was one missing piece: how could you explain the high wages, which were well in excess of the minimum wage. It did not seem as if either government or unions were *forcing* these high wages. One needed an equilibrium theory of wage determination. I recalled, during an earlier stint at Cambridge, discussions with Harvey Leibenstein who had postulated that in very poor countries, higher wages lead to higher productivity[25]. It might not pay firms to cut wages, if productivity was cut more than proportionately, even if there was an excess supply of labor. The key insight was to recognize that there were a variety of other reasons why, when information and contracting were imperfect, productivity might depend on wages.[26] In that case, it might pay firms to pay a higher wage than the minimum necessary to hire labor; such wages I referred to as *efficiency wages.* With efficiency wages, there could exist an equilibrium level of unemployment. I explored four explanations for why productity might depend on wages (besides through nutrition). The simplest was that

[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].

lower wages lead to higher turnover, and therefore higher turnover costs which the firm bore.[27] It was not until some years later than we were able to explain more fully – based on limitations of information – why it was that firms had to bear these turnover costs.[28]

But there was another version of the efficiency wage related to the work I was beginning on asymmetric information. Any manager will tell you that you attract better workers by paying them higher wages. This was just an application of the general notion of adverse selection, which played a central role in earlier insurance literature, where firms had long recognized that as they charge a higher premium, the best risks stopped buying insurance.[29] Firms in a market do not passively have to accept the "market wage". Even in competitive markets, firms could, if they wanted, offered higher wages than others. Market clearing was not a constraint on firms. If all firms were paying the market-clearing wage, it might pay a firm to offer a higher wage, to attract more able workers. The efficiency wage theory meant that there could exist unemployment *in equilibrium*.

It was thus clear that the notion that had underlay much of traditional competitive equilibrium analysis – that markets *had* to clear – was simply not true if information were imperfect.

The formulation of the efficiency wage theory that has received the most attention over the years, however, has been that which has focused on problems of *incentives*. Many firms claim that paying high wages induces their workers to work harder. The problem that Carl Shapiro and I [1984] faced was to try to make sense of this claim. If all workers are identical, and paid workers the same wage, then if it paid one firm to pay a high wage, it would pay all of them. But if a worker was then fired for shirking, and there was full employment, he could immediately get another job, at the same wage. The high wage would provide no incentive. But if there was unemployment, then there was a price for shirking. We showed that *in equilibrium* there *had* to be unemployment: unemployment was the discipline device that forced workers to work.[30] The model had strong policy implications, some of which I shall describe below. Our work illustrated the use of highly simplified models to help

[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 [1986] 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 principle agent problem, but embedded within a general equilibrium model of the economy, in unpublished work with Patrick Rey, see Rey and Stiglitz [1996].

clarify thinking about quite complicated matters. In practice, of course, workers are not identical, so problems of adverse selection become intertwined with those of incentives; being fired does convey information – there is typically a stigma.

(There was a fourth version of the efficiency wage, where productivity was related to *morale* effects, perceptions about how *fairly* they were being treated. While I briefly discussed this version in my earlier work[31], it was not until almost twenty years later that the idea was fully developed, in the important work of Akerlof and Yellen [1986].)

Sharecropping and the general theory of incentives

This work on the economics of incentives in labor markets was closely related to the third research project that I began in Kenya. In traditional economic theory, while considerable lip service was paid to incentives, there was no real incentive issue. With perfect information, individuals are paid to perform a particular service; if they perform it they receive the contracted for amount; if they do not, they do not. With imperfect information, firms have to motivate and monitor, rewarding them for observed good performance and punishing them for bad. My interest in the issues was first aroused by thinking about sharecropping, a common form of land tenancy in developing country, where the worker surrenders half (sometimes two thirds) of the produce to the landlord in return for the use of his land. At first blush, this seemed a highly inefficient arrangement; it was equivalent to a 50% tax on workers' labor. But what were the alternatives. The worker could rent the land, but that meant he had to bear all the risk of fluctuations in output; and beside, he often did not have the requisite capital. He could work as wage labor, but that meant that the landlord would have to monitor him, to ensure that he worked. Sharecropping represented a compromise, between risk bearing and incentives. The underlying *information* problem was that the input of the worker could not be observed, but only his output, and his output was not perfectly correlated with his input. The sharecropping contract could be thought of as a combination of a rental contract *plus* an insurance contract, in which the landlord "rebates" part of the rent if crops turn out badly. There is not full insurance (which would be equivalent to a wage contract) because such insurance would attenuate all incentives. The adverse effect of insurance on incentives to avoid the insured against contingency is referred to as *moral hazard*.[32] In Stiglitz [1974b] I analyzed the *equilibrium* sharecropping contract. In that paper, I recognized that the incentive problems I explored there were isomorphic to those facing modern corporations, e.g. in providing incentives

[31] In particular, in the context of the economics of discrimination 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. Arrow's work in moral hazard [1963, 1965] was among the most important precursors, as it was in the economics of adverse selection.

to their managers,[33] and there followed a large literature on optimal and equilibrium incentive schemes[34], in labor, capital, and insurance markets. Contracts had to be based on observables, like processes (or which crops were grown) and *observable* inputs (like fertilizers). Many of the results obtained earlier in the work on adverse selection had their parallel in this area of "adverse incentives."[35] For instance, with Richard Arnott I analyzed the equilibrium [1988a, 1988b], which entail partial insurance.

Equilibrium wage and price distributions

The fourth strand of research looked at the issue of wage differentials that I had observed from a different perspective. The work on labor turnover had suggested that firms that faced higher wages might pay higher wages. But one of the reasons that individuals quit was to obtain a higher paying job. The turnover rate depended on the wage distribution. The challenge was to formulate an *equilibrium* model, in which there was a wage distribution, which led firms to charge different wages – the distribution of wages that had originally been postulated.

More generally, efficiency wage theory said that it paid firms to pay a higher wage than necessary to obtain workers; but the level of the efficiency wage could vary across firms; for instance, firms with higher turnover costs, or where worker inefficiency could lead to large losses of capital, or where monitoring was more difficult, might find it desirable to pay higher wages. The implication was that similar labor might receive quite different compensation; wage discrepancies might not be explicable solely in terms of differences in abilities.

I was to return to these four themes repeatedly in my research over the following three decades.

FROM THE COMPETITIVE EQUILIBRIUM PARADIGM TO THE INFORMATION PARADIGM

In the previous section, I described how my experiences, especially in Kenya – the disparities between the models used and the world that I saw – had motivated a search for an alternative paradigm. But there was another motivation, driven more by the internal logic and structure of the competitive model itself, which was the dominant paradigm thirty years ago.

The model virtually made economics a branch of engineering (with no aspersions to that noble profession), and the participants in the economy better or worse engineers. Each was solving a maximization problem, with full information: households maximizing utility subject to budget constraints, firms maximizing profits (market value), and the two interacting in competitive product, labor, and capital markets. One of the peculiar implications was that

[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], Haubrisch [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].

there never were disagreements about what the firm should do: alternative management teams would presumably come up with the same solution to the maximization problems. Another peculiar implication was the meaning of risk: when a firm said that a project was risky, that (should have) meant that it was highly correlated with the business cycle, not that it had a high chance of failure.[36] I have already described some of the other peculiar implications of the model: the fact that there was no unemployment or credit rationing, that it focused on only a limited subset of the information problems facing society, that it seemed not to address key issues – like incentives and motivation.

But much of the research in the profession is directed not at these big lacunae, but at seemingly more technical issues – at the mathematical structures. The underlying *mathematics* required assumptions of convexity and continuity, and with these assumptions one could prove the *existence* of equilibrium and its (Pareto) efficiency. The standard proofs of these fundamental theorems of welfare economics did not even list in their enumerated assumptions those concerning information: the perfect information assumption was so ingrained it did not have to be explicitly stated. The *economic* assumptions to which the proofs of efficiency called attention concerned the absence of externalities and public goods. The market failures approach to the economics of the public sector[37] discussed alternative approaches by which these market failures could be corrected, but these market failures were highly circumscribed.

There was, moreover, a curious disjunction between the language economists used to explain markets and the models they constructed. They talked about the information efficiency of the market economy, though they focused on a single information problem, that of scarcity. But there are a myriad of other information problems faced by consumers and firms every day, concerning for instance the prices and qualities of the various objects that are for sale in the market, the quality and efforts of the workers they hire, the returns of investment projects. In the standard paradigm, the competitive general equilibrium model[38], there were no shocks, no unanticipated events: at the beginning of time, the full equilibrium was solved, and everything from then on was an unfolding over time of what had been planned in each of the contingencies. In the real world, the critical question was how, and how well, do markets handle these information problems?

There were other aspects of the standard paradigm which seemed hard to accept. It argued that institutions did not matter – markets could see through them, and equilibrium was simply determined by the laws of supply and demand. It said that the distribution of wealth did not matter.[39] And it said that

[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).

(by and large) history did not matter – knowing preferences and technology and initial endowments, one could describe the time path of the economy.[40]

Work on the economics of information began by questioning each of the underlying premises, each of the central theorems. Consider, to begin with, the mathematical structures that had underlay some much of the formalization of economics of the latter half of the twentieth century, the convexity assumptions which corresponded to long standing principles of diminishing returns. With imperfect information (and the costs of acquiring it) these assumptions were no longer plausible. It was not just that the cost of acquiring information could be viewed as fixed costs.[41] Work with Roy Radner (Radner and Stiglitz [1984] showed that there was a *fundamental non-concavity in the value of information*, that is, under quite general conditions, it never paid to buy just a little bit of information. Work with Richard Arnott (Arnott and Stiglitz [1988a]) showed that such problems were pervasive in even the simplest of moral hazard problems (where individuals had a choice of alternative actions, e.g. the amount of risk taking to undertake.) While we had not repealed the law of diminishing returns, we had shown its domain to be more limited than had previously been realized.[42]

Michael Rothschild and I showed that under natural formulations of what might be meant by a competitive market with imperfect information, equilibrium often did not exist[43] – even when there was an arbitrarily small amount of information imperfection.[44] While subsequent research has looked for alternative definitions of equilibrium,[45] we remain unconvinced; most of

[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 iso profit 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].

them violate the natural meaning of competition, i.e. where each participant in the market is so small that he believes that he will have no effect on the behavior of others. (Rothschild and Stiglitz [1997]).

The new information paradigm went further in undermining the foundations of competitive equilibrium analysis, the basic "laws" of economics, which include: the law of demand and supply (holding that market equilibrium was characterized by market clearing), the law of the single price, holding that the same good sold for a single price throughout the market, the law of the competitive price, holding that in equilibrium price equaled marginal cost, the efficient markets hypothesis, holding that in stock markets prices convey all the relevant information from the informed to the uninformed. Each of these cornerstones was rejected, or was shown to hold under much more restrictive conditions.

- We have shown how, when prices affect "quality" – either because of incentive or selection effects – equilibrium may be characterized by demand not equaling supply; firms will not pay lower wages to workers, even when they can obtain such workers, because doing so will raise their labor costs; firms will not charge higher interest rates, even when they can do so, because of an excess demand for credit, because doing so will increase the average default rate, and thus lower expected returns.
- We have shown that the market will be characterized by wage and price distributions, even when there is no exogenous source of "noise" in the economy, even when all firms and workers are (otherwise) identical.
- We have shown that in equilibrium, firms will charge a price in excess of the marginal costs, or workers are paid a wage in excess of their reservation wage. The "surplus" is required to provide the *incentive* for maintaining a reputation.[46] Even in situations where reputation rents were not required, information imperfections gave rise to market power – there is *imperfect competition* –, which resulted in firms charging prices in excess of marginal cost.[47]
- The efficient markets hypothesis[48] held that prices in the stock market fully reflected all information. But if that were the case, then there would be no incentive for anyone to expend money to collect information. Work with Sanford Grossman [1976, 1980] showed that the price system both imperfectly aggregated information and that there was an equilibrium amount of "disequilibrium."

The most fundamental reason why markets with imperfect information differ from those in which it does is that *actions (including choices) convey information, market participants know this, and this affects their behavior.*

A decision by a firm to provide a guarantee is not just a matter that the firm is better able to absorb the risk of a product failure; his willingness to provide

[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].

a guarantee conveys information about his confidence in the product. An insured is willing to take a policy with a large deductible not because he is not risk averse, but because this action conveys information to the insurance company, that he is willing to bear the risk because he thinks the likelihood of an accident is low. A firm may, at the same time, not assign an employee to a highly visible job, because it knows that the assignment will be interpreted as an indication that the employee is good, making it more likely that a rival will try to hire the person away. Even if he fails, the current employer will have to pay a higher salary.

One of the early insights (Akerlof, 1971) was that markets may be thin or absent. One of the standard assumptions of the old paradigm was that there was a complete set of markets – including intertemporal markets (capital markets) and risk markets. The absence of particular markets, e.g. for risk, has profound implications for how *other* markets function. The fact that workers and firms cannot by insurance against many of the risks which they face affects labor and capital markets; it leads, for instance, to labor contracts in which the employer provides *some* insurance. But the design of these more complicated, but still imperfect and incomplete, contracts, affects the efficiency, and overall performance, of the economy.

Perhaps most importantly, under the standard paradigm, markets are Pareto efficient, except when there one of a limited number of market failures occurs. Under the imperfect information paradigm, markets are almost never Pareto efficient.

While information economics thus undermined these long standing principles of economics, it also provided explanations for many phenomena that had long been unexplained. Earlier, I mentioned the seemingly inefficient institution of sharecropping, for which information economics provided an explanation. Before turning to these *applications*, I want to present a somewhat a more systematic account of the *principles* of the economics of information.

Some problems in constructing an alternative paradigm

The fact that information was imperfect was, of course, well recognized by all economists. While they may have *hoped* that economies with imperfect information behaved much like economies with perfect information, they real reason that models with imperfect information were not developed was that it was not obvious how do to so. There were several problems that had to be overcome: while there was a single way in which information is perfect, there are an infinite number of ways in which information can be imperfect. One of the keys to success was formulating simple models in which the set of relevant information could be fully specified – and so the precise ways in which information was imperfect could also be fully specified. But there was a danger in this methodology, as useful as it was: in these over simplistic models, there were sometimes ways in which there could be full information revelation; the information problems could be fully resolved. In the real world, of course, this never happens, which is why in some of the later work (e.g.

Grossman and Stiglitz [1976, 1980a], we worked with models with an infinite number of states.[49]

Perhaps the hardest problem was modeling equilibrium. It was important to think about both sides of the market – employers and employees, insurance company and the insured, lender and borrower. Each had to be modeled as "rational," in some sense, making inferences on the basis of available information. Each side's behavior too had to be rational, based on beliefs about the consequences of their actions; and those consequences in turn depended on what inferences others would draw from those actions. I wanted to model *competitive* behavior, where each actor in the economy was small, and believed he was small – and so his actions could not or would not affect the equilibrium (though others' inferences about himself might be affected). Finally, one had to think carefully about what was the feasible set of actions: what might each side do to extract or convey information to others.

As we shall see, the variety of results obtained (and much of the confusion in the early literature) arose partly from a failure to be as clear as one might about the assumptions. For instance, the standard adverse selection model had the quality of the good offered in the market (say of used cars, or riskiness of the insured) depending on price. The car buyer (the seller of insurance) knows the *statistical* relationship between price and quality, and this affects his demand. The market equilibrium is the price at which demand equals supply. But that is an equilibrium if and only if there is no way by which the seller of a good car can convey that information to the buyer – so that he can earn a quality premium – and if there is no way by which the buyer can sort out good cars from bad cars. Typically, there are such ways, and it is the attempt to elicit that information which has profound effects on how markets function. To develop a new paradigm, we had to break out from long established premises, to ask what should be taken as *assumptions* and what should be derived from the analysis. Market clearing could not be taken as an assumption; neither could the premise that a firm sells a good at a particular price to all comers. One could not *begin* the analysis even by assuming that in competitive equilibrium there would be zero profits. In the standard theory, if there were positive profits, a firm might enter, bidding away existing customers. In the new theory, the attempt to bid away new customers by slightly lowering prices might lead to marked changes in their behavior or in the mix of customers, in such a way that the profits of the new entrant actually became negative. One had to rethink all the conclusions from first premises.

We made progress in our analyses because we began with highly simplified

[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].

models of *particular* markets, that allowed us to think through carefully each of the assumptions and conclusions. From the analysis of particular markets (whether the insurance market, as in Rothschild Stiglitz, the education market, the labor market, or the land tenancy/sharecropping market), we attempted to identify general principles, to explore how these principles operated in each of the other markets. In doing so, we identified particular features, particular *informational assumptions,* which seemed to be more relevant in one market or another. The nature of competition in the labor market is different than that in the insurance market or the capital market, though they have much in common. This interplay, between looking at the ways in which such markets are similar and dissimilar, proved to be a fruitful research strategy.[50]

SOURCES OF ASYMMETRIES OF INFORMATION

Information imperfections are pervasive in the economy: indeed, it is hard to imagine what a world with perfect information would be like. Much of the research I will describe below focuses on *asymmetries* of information, that fact that different people know different things: workers know more about their ability than does the firm; the person buying insurance knows more about his health, whether he smokes and drinks immoderately, than the insurance firm; the owner of a car knows more about the car than potential buyers; the owner of a firm knows more about the firm that a potential investor; the borrower knows more about his risk and risk taking than the lender.

The essential feature of a decentralized market economy is that different people know different things; in this sense, economists had long been thinking of markets with information asymmetries. But the earlier literature had neither thought about how they were created, or what their consequences might be. Moreover, while much of the earlier literature focused on simple situations of information asymmetry – such as those described in the previous paragraphs, the problems of information *imperfections* run deeper, and the research described below discusses some of these more general results. The individual may know little about his true health condition; the insurance company, through a simple examination, might even become more informed (at least concerning relevant aspects, e.g. implications for life expectancy).

Some of these information asymmetries are inherent: the individual naturally knows more about himself than does anyone else. Some of the asymmetries arise naturally out of economic processes. The current employer knows more about the employee than other potential employers; a firm knows may

[50] Some earlier work, especially in general equilibrium theory, by Radner [1972], Hurwicz [1972], and Marschak [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.

find out a great deal of information in the process of dealing with his supplier that others may not know; the owner of a car naturally knows the faults of the car better than others – and in particular, he knows whether or not he has a lemon. While such information asymmetries inevitably arise, the extent to which they do so and their consequences depend on how the market is structured, and the recognition that they will arise affects market behavior. For instance, one of the important insights of work in this area is to show how information asymmetries lead to thin or non-existent markets (Akerlof [1970]). But this means that even if an individual has no more information about his ability than potential employers, the moment he goes to work for an employer, an information asymmetry has been created – the employer may know more about the individual's ability than others. The consequence is that the "used labor" market does not work well. Others will be more tame in bidding for his services, knowing that they will succeed in luring him away from his current employer only if they bid too much. If they bid less than his productivity, his current employer will match. Labor mobility is impeded. But that gives market power to the first employer, which he will be tempted to exercise. The recognition of this naturally affects even the "new labor" market. Because an individual is locked into a job, he will be more risk averse in accepting an offer. The terms of the initial contract have to be designed to reflect the diminution of the workers' bargaining power and his reduced labor mobility that occurs immediately after signing.[51, 52]

To take another example, it is natural that in the process of oil exploration, a company finds out information that is relevant for the likelihood that there will be oil in a neighboring tract. There is an informational externality.[53] The existence of this asymmetric information affects the nature of the bidding for oil rights on the neighboring tract. Bidding where there is known to be asymmetries of information will be markedly different from that where such asymmetries do not exist.[54] Those who are uninformed will presume that they will win only if they bid too much – information asymmetries exacerbate the problem of the winners' curse.[55] The government (or other owners of large

[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 were 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 *same* labor productivity 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 individual's 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.

tracts to be developed) should take this into account in its leasing strategy. And the bidders in the initial leases too will take this into account: part of the value of winning in the initial auction is the information rent that will accrue in later rounds.

Creating asymmetries and imperfections of information

While early work in the economics of information dealt with how markets overcame problems of information asymmetries, and information imperfections more generally, later worked turned to how markets *create* information problems, partly in an attempt to exploit market power. Managers of firms attempt to *entrench* themselves, increasing their bargaining power, e.g. vis a vis alternative management teams[58], and one of the ways that they do this is to take actions which *increase* information asymmetries. (Edlin and Stiglitz [1995]). Doing so effectively reduces competition in the market for management. This is an example of the general problem of corporate governance, to which I alluded earlier, and to which I will return later.

Similarly, the presence of information imperfections give rise to market power; and firms can exploit this market power through "sales" and other ways of differentiating among individuals who have different search costs. (Salop, 1977, Salop and Stiglitz, 1976, 1982, Stiglitz 1979a). The price dispersions which exist in the market are *created* by the market – they are not just the failure of markets to arbitrage fully price differences *caused* by shocks that affect different markets differently.

OVERCOMING INFORMATION ASYMMETRIES

I now want to discuss briefly the ways by which information asymmetries are dealt with, how they can be (partially) overcome.

Incentives for gathering and disclosing information

There are two key issues: what are the *incentives* for obtaining information, and what are the *mechanisms*. My brief discussion of the analysis of education as a screening device suggested the fundamental incentives: more able individuals (lower risk individuals, firms with better products) will receive a higher wage (will have to pay a lower premium, will receive a higher price for their products) if they can establish that they are more productive (lower risk, higher quality).

We noted earlier that while some individuals have an incentive to disclose information, those who are less able have an incentive not to have the information disclosed. Was it possible that in market equilibrium, only *some* of the information would be revealed? One of the early important results was that, if the more able are able (costlessly) to establish that they are more able, then the market will be fully revealing, even though all of those who are below average would prefer that no information be revealed. In the simplest mo-

[58] See Shleifer and Vishny [1989].

dels, I described a process of unraveling: if the most able could establish his ability, he would; but then all but the most able would be grouped together, receiving the mean marginal product of that group; and the most able of that group would have an incentive to reveal his ability. And so on down the line, until there was full revelation.[57]

What happens if those who are more able cannot credibly convince potential employers of their ability (or if those who are low risk cannot convince potential insurance companies)? The other side of the market has an incentive too to gather information: an employer that can find a worker that is better than is recognized by others will have found a bargain; his wage will be determined by what others think of him. The problem, as we noted, is that if what he knows becomes known to others, the wage will be bid up, and he will be unable to appropriate the returns on his investment in information acquisition.

The fact that if there was competition, it would be difficult for the *screener* to appropriate the returns had an important implication: in markets where, for one reason or another, the more able (the firms with the better investment projects, the more able workers) cannot (fully) convey their attributes, *if* there is to be investment in screening *there must be imperfect competition in screening*. The economy, in effect, has to choose between two different imperfections: imperfections of information or imperfections of competition. Of course, in the end, there will be both forms of imperfection.[58, 59]

This is but one of many examples of the *interplay* between market imperfections. Earlier, for instance, we discussed the incentive problems associated with sharecropping, which arise when workers do not own the land that they till. This problem could be overcome if individuals could borrow money, to buy their land. But capital market imperfections – limiations on the ability to borrow, which themselves arise from information imperfections – explain why this "solution" does not work.

There is another important consequence: if markets were fully informationally efficient – that is, if information disseminated instantaneously and perfectly throughout the economy – then no one would have any incentive to gather information, so long as there was any cost of doing so. That is why markets cannot be fully informationally efficient. (See Grossman and Stiglitz, 1976, 1980a.)

Mechanisms for elimination of reducing information asymmetries

In simple models where individuals know their own ability, or the insured knows his own risk, or the borrower knows his own likelihood of repaying, there might seem an easy way to resolve the problem of information asym-

[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.

metry: let each person tell his true characteristic. The underlying problem arose from the fact that individuals did not necessarily have the incentive to tell the truth. Assume employees knew their abilities. An employer might ask, what is your ability? The more able might answer honestly. As we have seen, the least able would have an incentive to lie, to say that he was more able than he was. Talk was cheap. There had to be some other ways by which information could be credibly conveyed.

Screening by examination

The simplest way by which that could be done was an exam. As I constructed a simple competitive equilibrium model[60], two further general principles became apparent: *the gains of the more able were largely at the expense of the less able*; by establishing that an individual is of higher ability, thereby leading, in equilibrium, to higher wages, he simultaneously establishes that others are of lower ability. The private returns to expenditures on education exceed the social returns. It was clear that there were important *externalities* associated with information, a theme which was to recur in later work.

But a more striking result emerged: there could exist multiple equilibria, one in which information was fully revealed (the market identified the high and low ability people) and the other of which it was not (called a pooling equilibrium). The pooling equilibrium Pareto dominated the equilibrium with full revelation. This work, done some thirty years ago, established two results of important policy import, which remarkably have not been fully absorbed into policy discussions even today. First, markets do not provide appropriate incentives for information disclosure. There is, in principle a role for government. And secondly, expenditures on information may be too great.[61]

The simplest adverse selection model

But much of the information firms glean about their employees, banks about their borrowers, insurance companies about their insured comes not from examinations but from making *inferences* based on their behavior. This was a commonplace in life – but not in our economic models. As I have already noted, the early discussions of adverse selection in insurance markets recognized that as an insurance company raised its premiums, those who were least likely to have an accident decided not to purchase the insurance; the willingness to purchase insurance at a particular price conveyed information to the insurance company.[62] George Akerlof recognized that this phenomenon was far more general: the willingness to sell a used car, for instance, conveyed information about whether the car was or was not a lemon.

Bruce Greenwald [1979, 1986] took the idea one important step further,

[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 elabofratged on inl more detail below.

[62] Arrow [1965].

showing how adverse selection applied to labor and capital markets[63]: the willingness of an employer not to match the bid of a competitor conveyed information about the current employer's judgment of that individual's ability; the willingness of insiders in a firm to sell stock at a particular price conveyed information about the insider's view of the price relative to the expected return. Akerlof's insight that the result of these information asymmetries was that markets would be thin or absent helped explain why labor and capital markets often did not function well. It provided part of the explanation for why firms raised so little of their funds through equity (Mayer, 1990). Stigler was wrong: imperfect information was not just like a transactions costs.

The consequences go well beyond just an absent or missing market. Weak equity markets meant that risks could not be divested, leading firms to act in a risk averse manner, explaining some of what would otherwise seem to be anomalous aspects of firm behavior[64]. These capital market imperfections, in turn, played a central role in the macro-economic theories to be described below. We have already described how the labor market imperfections – the limited mobility of labor and the firm's market power that results – affects the labor market, both *before* the asymmetry of information is created in the process of hiring and after.

The simplest adverse incentive model

In the adverse selection model, individuals differed. There was a single action which conveyed information: they either entered or did not enter the particular market. But information imperfections also relate to *what people do*. A worker can work harder, a borrower can undertake greater risk and the insured can undertake greater care. The employer would like to know how hard his worker is working; if he could, he would specify that in the contract; the lender would like to know the actions which borrower will undertake; if he could, we would specify that in the contract. These asymmetries of information about *actions* are as important as the earlier discussed asymmetries. Just as in the adverse selection model, the seller of insurance may try to overcome the problems posed by information asymmetries by *examination*, so too in the adverse incentive model, he may try to *monitor* the actions of the insured. But examinations and monitoring are costly, and while they yield some information, typically there remains a high level of residual information imperfection. Just as in the adverse selection model, the seller of insurance recognizes that the average riskiness of the insurance applicants is affected by the terms of the insurance contract, so too the level of risk taking can be affected. And similar results hold in other markets. Borrowers' risk taking is affected by the interest rate charged. (Stiglitz and Weiss [1981]).

[63] See also Greenwald, Stiglitz, and Weiss [1984] and Myers and Maljuf [1984].
[64] See discussion in subsection The Theory of Corporate Finance.

Efficiency wage theory, credit rationing

While the early work in adverse selection explored the equilibrium in markets where the seller of insurance (the employer, the buyer of used cars, the lender) was rational enough to recognize the dependence of quality on price, he was not rational enough to exploit as fully as he could the information. While the law of supply and demand had been assumed to be a law of economics, there is in fact no law that require the insurance firm to sell to all who apply at the premium he announces, the lender to lend to all who apply at the interest rate he announces, the employer to employ all those who apply at the wage he announces. So ingrained was the competitive equilibrium model in the mindset of economists that they simply assumed price-taking behavior. With perfect information and perfect competition, any firm that charged a price higher than the others would lose all of his customers; and at the going price, one faced a perfectly elastic supply of customers. In adverse selection and incentive models, what mattered was not just the supply of customers or employees or borrowers, but their "quality" – the riskiness of the insured or the borrower, the returns on the investment, the productivity of the worker.

Since "quality" may increase with price, it may pay to pay a higher wage than the market clearing wage, for the lender to lend at an interest rate which exceeds the market clearing interest rate. This is true whether the dependence on quality arises from adverse selection or adverse incentive effects (or, in the labor market, because of morale or nutritional effects). And what matters is that there be imperfect information, not asymmetries of information. The healthy who decide not to buy insurance at a high premium do not need to *know* that they are healthy; they could be as uninformed as the insurance company, but simply – perhaps because of their health – have different preferences, e.g. they prefer to spend more of their money on recreational sports.

The consequence, as we have noted, is that market equilibrium may be characterized by demand not equaling supply: in equilibrium, the interest rate is lower than that at which the demand for loans equals the supply – there is credit rationing (Stiglitz and Weiss [1981], Keeton [1979]); the wage rate is higher than that at which the demand for labor equals the supply – there is unemployment.[65]

Conveying information through actions

There is a much richer set of actions which convey information beyond those on which traditional adverse selection models have focused. An insurance company wants to attract healthy applicants. It might realize that by locating

[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.

itself on the fifth floor of a walk up building, only those with a strong heart would apply. The willingness or ability to walk up five floors conveys information. More subtly, it might recognize that how far up it needs to locate itself, if it only wants to get healthy applicants, depends both on the premium charged and how high it locates itself. Or it may decide to throw in for free a membership in a health club, but charge a higher premium. Those who value a health club – because they will use it – willingly pay the higher premium. But these individuals are likely to be healthier.

There are a host of other actions which convey information. The quality of the guarantee offered by a firm can convey information about the quality of the product; only firms that believe that their product is reliable will be willing to offer a good guarantee. The guarantee is desirable not just because it reduces risk, but because it conveys information. The number of years of schooling may convey information about the ability of an individual. More able individuals may go to school longer, in which case the increase in wages associated with an increase in schooling may not be a consequence of the human capital that has been added, but rather simply be a result of the sorting that occurs.[66] The size of the deductible that an individual chooses in an insurance policy may convey information about his view about the likelihood of an accident or the size of the accidents he anticipates – *on average*, those who are less likely to have an accident may be more willing to accept high deductibles. The willingness of an entrepreneur to hold large fractions of his wealth in a firm (or to retain large fractions of the shares of the firm) conveys information about his beliefs in the firm's future performance. If a firm promotes an individual to a particular job, it may convey information about the firm's assessment of his ability.

The fact that these actions may convey information affects behavior. In some cases, the action will be designed to obfuscate, to limit information disclosure. The firm that knows that others are looking at who it promotes, and that it will compete more vigorously for those, may affect the willingness of the firm to promote some individuals or assign them to particular jobs. (Waldman, 1984.) In others, the action will be designed to convey information in a credible way, to alter beliefs. The fact that customers will treat a firm that issues a better guarantee as if its product is better – and therefore be willing to pay a higher price – may affect the guarantee that the firm is willing to issue. Knowing that his selling his shares will convey a negative signal concerning his views of the future prospects of his firm, an entrepreneur may retain more of the shares of the firm; he will be less diversified than he otherwise would have been (and accordingly, he may act in a more risk averse manner).

A simple lesson emerges: some individuals wish to convey information;

[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.

some individuals wish not to have information conveyed (either because such information might lead others to think less well of them, or because conveying information may interfere with their ability to appropriate rents). In either case, the fact that actions convey information leads people to alter their behavior, and changes how markets function. This is why information imperfections have such profound effects.

Once one recognizes that actions convey information, two results follow. First, in making decisions about what to do, individuals will not only think about what they like (as in traditional economics) but how it will affect others' beliefs about them. If I choose to go to school longer, it may lead others to believe that I am more able, and I will therefore decide to stay in school longer, not because I value what is being taught, but because I value how it changes others' beliefs concerning my ability. This means, of course, that we have to rethink completely firm and household decision making.

Secondly, we noted earlier that individuals have an incentive to "lie" – the less able to say that they are more able. Similarly, if it becomes recognized that those who walk up to the fifth floor to apply for insurance are more healthy, then I might be willing to do so even if I am not so healthy, simply to fool the insurance company. If it becomes recognized that those who stay in school longer are more able, then I might be willing to do so, even if I am less able, simply to fool the employers. Recognizing this, one needs to look for ways by which information is conveyed *in equilibrium*. The critical insight in how that could occur was provided in a paper with Michael Rothschild [1976]. If those who were more able, less risk prone, more credit worthy *acted* in some observable way (had different preferences) than those who were less able, less risk prone, less credit worthy, then it might be possible to design a set of *choices*, which would result in those with different characteristics in effect *identifying* themselves through their *self-selection*. One of the reasons that they might behave differently is that they *know* they are more able, less risk prone, more creditworthy – that is there is asymmetric information. But it is only one of the bases for self-selection.

The particular mechanism which we explored in our insurance model illustrates how self-selection mechanisms work. People who know they are less likely to have an accident will be more willing to accept an insurance policy with a high deductible, so that an insurance company that offered two policies, one at a high premium and no deductible, one with a low premium and high deductible, would be able to sort out who were high risk and who low. It is an easy matter to construct choices which thus *separate*.

Monopoly and self-selection

Analyzing the choices which arise in *full* equilibrium behavior turned out, however, to be a difficult task. The easiest situation to analyze was that of a monopolist.[67] He could construct a set of choices that would *differentiate* among different types of individuals, and analyzed whether it was profit max-

[67] Stiglitz [1977a].

imizing for him to do so fully, or to (partially) "pool" – that is, offer a set of contracts such that several types might choose the same one. This work laid the foundations of a *general theory of price discrimination*. Under standard theories of monopoly, *with perfect information*, firms would have an incentive to price discriminate perfectly (extracting the full consumer surplus from each). If they did this, then monopoly would in fact be non-distortionary. Yet most models assumed no price discrimination (that is, the monopolist offered the same price to all customers), without explaining why they did not do so, and argued that monopoly was distortionary. This work showed how, given limited information, firms could price discriminate, but could do so only imperfectly. Subsequent work by a variety of authors (such as Salop [1977] and Adams and Yellen [1976]) explored a variety of ways by which a monopolist might find out relevant characteristics of his customers – the extent of discrimination limited by his ability to identify each person's "surplus", the maximum they would be willing to pay. (For an insurance company, the relevant characteristics are not only the likelihood of having an accident, but also the degree of risk averse, the premium that an individual would be willing to pay to divest himself of risk.) The economics of information thus provided the first coherent theory of monopoly.

Self-selection and competitive equilibrium

The reason that analyzing monopoly was easy is that the monopolist could structure the entire choice set facing his customers. The hard question is to describe the full competitive equilibrium, that is a set of insurance contracts such that no one can offer an alternative set which would be profitable. Each firm could control the choices that he offered, but not the choices offered by others; and the decisions made by customers depended on the entire set of choices available. In our 1976 paper, Rothschild and I succeeded in analyzing this case.

Three striking results emerged from this analysis. The first I have already mentioned: under plausible conditions, given the natural definition of equilibrium, equilibrium might not exist. There were two possible forms of equilibria, pooling equilibria, in which the market is not able to distinguish among the types, and separating equilibria, in which it is. The different groups "separate out" by taking different actions. We showed that there never could be a pooling equilibrium – if there were a single contract that everyone bought, there was another contract that another firm could offer which would "break" the pooling equilibrium. On the other hand, there might not exist a separating equilibrium. The cost of separation was too great. Any putative separating equilibrium could be broken by a profitable pooling contract, a contract which would be bought by both low risk and high risk types.

Second, even small amounts of imperfections of information can change the standard results, concerning the existence and characterization of equilibrium. Equilibrium, for instance, never exists when the two types are very near each other. As we have seen, the competitive equilibrium model is simply not robust.

Thirdly, and relatedly, we now can see how the fact that actions convey information affects the *equilibrium*. In particular, our analysis here reinforced

the earlier analysis of adverse selection about markets not functioning well. In perfect information models, individuals would fully divest themselves of the risks which they face, and accordingly would act in a risk neutral manner. We explained why insurance markets would not work well – why most risk averse individuals would buy only partial insurance. There were numerous subsequent applications to other markets, reinforcing, for instance, the earlier conclusions concerning the limitations on equity markets. (The reason that the original owners of a firm might want to sell his shares was to "insure" himself against the risk of a bad outcome; an owner that believed that there was a smaller probability of a bad outcome would be willing to buy less insurance, i.e. to divest himself of fewer of his shares. Retention of shares can thus be thought of as a market sorting mechanism, the willingness to keep these shares a "signal" of the owners' confidence.[68])

The result was important not only for the insights it provided in the workings of an important set of markets in the economy, but because there are important elements of insurance in many transactions and the general principle that actions convey information, and that market transactions are greatly affected by this fact, has implications in a still wider variety of contexts. The relationship between the landlord and his tenant, or the employer and his employee, can be viewed as containing in it an insurance component; limitations on the ability to divest oneself of risk are important in explaining a host of contractual relationships.

Sorting, screening, and signaling

In equilibrium, both buyers and sellers, employers and employees, insurance company and insured, lender and creditor are aware of the informational consequences of their actions. Each side of the market needs to consider the consequences, e.g. of acting in a different way, or of confronting the other side of the market with different choices. In the case where say, the insurance company or employer or employee takes the initiative for sorting out applicants, self-selection is an alternative to examinations as a sorting device. In the case where the insured, or employee, or borrower, takes the initiative for identifying himself as a better risk, a better employee, a borrower more likely to repay, then we say he is *signaling*.[69] But of course, in equilibrium both sides are aware of the consequences of alternative actions, and the differences between signaling and self-selection screening models lie in the technicalities of game theory, and in particular whether the informed or uninformed (employee or employer, insured or insurance company) moves first.[70]

Still, some of the seeming differences between signaling and screeing

[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 equilibirum. 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 an equilibrium could be broken by a prior or later move of firms.

models arise because of a failure to specify a *full* equilibrium We noted earlier that there were many separating contracts, but a unique separating equilibrium. We argued that if one considered any other separating set of contracts, then, say, in the insurance market, a firm could come in and offer an alternative set of contracts and make a profit; the original set of separating contracts could not have been an equilibrium The same is true in, say, the education signaling model. There are many educational systems which "separate" – that is, the more able choose to go to school longer, and the wages at each level of education correspond to the productivity of those who go to school for that length of time. But all except one are not *full equilibrium*. Assume, for instance, there were two types of individuals, a low ability and a high ability. Then if the low ability goes to 12 years of schooling, then any education system in which the high ability went *sufficiently* long – say more than 14 years – might separate. But the low ability would recognize that if it went to school for 11 years, it would still be treated as low ability. The unique equilibrium level of education for the low ability is that which maximizes his net income (taking into account the productivity gains and costs of education); and the unique equilibrium level of education for the high ability is the lowest level of education such that, if his wage corresponds to his productivity at that level of education, the low ability will still prefer to remain at his low level of education rather than pretend to be more able by staying in school longer.[71]

The education system, of course, was particularly infelicitous for studying *market* equilibrium. The structure of the education system is largely a matter of public choice, not of market processes. Different countries have chosen markedly different systems. The minimum level of education is typically not a matter of choice, but set by the government. Within educational systems, examinations play as important a role as self-selection or signaling, though *given* a certain standard of testing, there is a process of self-selection involved in deciding whether to stay in school, to try to pass the examination.[72] For the same reason, the problems of existence which arise in the insurance market are not relevant in the education market – the "competitive" supply side of the market is simply absent. But when the signaling concepts are translated into contexts in which there is a robust competitive market, the problems of existence cannot be so easily ignored.[73]

[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 were 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.

Existence of equilibrium in the insurance market

What are we to make of the problem of that problem? Clearly, insurance markets *exist,* even if they are far from complete. To some extent, the market does exhibit instability. Rates vacillate enormously; as rates sometimes skyrocket and coverage is curtailed, the public clamors for reforms, Such periods are often followed by periods of relative stability, to be followed by another "crisis" in the market. Most states regulate rate setting, though at least partly for prudential reasons and this may help stabilize the market.

Moreover, though there is considerable evidence for the kinds of selection processes discussed above, there is also considerable evidence that the market is far from as rational as the theory would suggest. Most health insurance policies do not base premia on the number of children, though that is an easily observable variable which clearly affects the risk exposure. Many insurance companies do not use past experience as heavily as one would have expected in setting premia, i.e. there is less experience rating.

My own suspicion, however, is that the major limitation of Rothschild-Stiglitz is its assumption of perfect competition; competition is far more limited than we postulated; there are, for instance, significant search costs, and considerable uncertainty about how easiy it is to get the insurance firm to pay on a claim. Self-selection is still relevant, but the model of monopoly, or some version of monopolistic competition, may be more relevant than the model of perfect competition.

Theory of contracts and incentives

The work with Rothschild was, related to the earlier work that I had done on incentives (sharecropping), besides in the obvious way that both were concerned with problems of limited information. One focusing on selection effects, one on incentives. Both entailed an equilibrium in "contracts." The contracts that had characterized economic relations in the standard competitive model were extraordinarily simple: I will pay you a certain amount if you do such and such. If you did not perform as promised, the pay was not given. But with perfect information, individuals simply didn't sign contracts that they did not intend to fulfill. Insurance contracts were similarly simple: a payment occurred if and only if particular specified events occurred.

The work on sharecropping and on equilibrium with competitive insurance markets showed that with imperfect information, a far richer set of contracts would be employed, and thus began a large literature on the theory of contracting.[74]

In the simple sharecropping contracts of Stiglitz [1974b], the contracts involved shares, fixed payments, and plot sizes, and[75] more generally, optimal

[74] See, for instance, Stiglitz and Weiss [1983b, 1986, 1987]. Even with these additional instruments there could still be non-market clearing equilibria. Bester [1985] concludes that by increasing collateral requirements one can eliminate credit ratioining is wrong, simply because he ignores the interaction between selection and incentive effects.

[75] 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.

payment structures related payments to *observables*, inputs, processes, outputs.[76, 77, 78]. Because what went on in one market affect others, the credit, labor, and land markets were *interlinked;* one could not decentralize in the way hypothesized by the standard perfect information model. The theory thus served as the basis of the *rural organization*[79] in developing countries.

The basic principles were subsequently applied in a variety of other market contexts. The most obvious was the design of labor contracts. (Stiglitz 1975a).

Payments can depend too on *relative* performance; relative performance may convey more relevant information than absolute performance. If a particular company's stock goes up when all other companies' stock goes up, it may say very little about the performance of the manager. In Nalebuff and Stiglitz [1983a, 1983b] we analyzed the design of these relative performance compensation schemes (contests). One of the strong arguments for competitive, decentralized structures is that they provide information on the basis of which one can design better incentive pay structures than those which rely on the performance of a single individual only.

Credit markets too are characterized by complicated contracts. Lenders would specify not only an interest rate, but also impose other conditions (collateral requirements, equity requirements) which would have both incentive and selection effects.[80] Indeed, the simultaneous presence of both selection and incentive effects was important: in the absence of the former, it might be possible to increase the collateral requirement *and* raise interest rates, still ensuring that the borrower undertook the safe project.[81, 82]

[76] 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.

[77] In Stiglitz [1974b] the contracts were highly linear. In principle, generalizing payment structures to non-linear functions was simple. 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]). 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] and Gale [1991].

[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] See, in particular, Braverman, Hoff, and Stiglitz [1993].

[80] See, for instance, Stiglitz and Weiss [1983b, 1986, 1987]. Even with these additional instruments there could still be non-market clearing equilibria.

[81] Venture capital firms represent an interlinkage of capital and "management" markets. See Hellmann [1998].

[82] As another application, "contracting" – including provisions for risk sharing – came to play an important role in explaining macro-economic 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].

Incentives and reputation in market equilibrium

Incentives are based on rewards and punishments. In modern economies, the most severe punishment that one can impose is to fire an individual.[83] But if the individual could get a job just like his current one, then there would be no cost. Good behavior is driven by earning a surplus over what one could get elsewhere. Thus, in labor markets, the wage must be higher than what the worker could get elsewhere (which may be zero, if there is unemployment); in the goods market, firms must feel a loss when they lose a customer because of a shoddy product, so the price must exceed the marginal cost of production. Thus, the long standing presumption that in competitive equilibrium price equals marginal cost *cannot* be true in markets with imperfect information. (See Shapiro and Stiglitz [1984], Shapiro [1983] and Klein and Leffler [1981].)

Equilibrium wage and price distributions

One of the most obvious differences between the predictions of the model with perfect information and what we see in every day life is the conclusion that the same good sell for the same price everywhere. We all spend a considerable amount of time shopping for good buys. The differences in prices represent more than just differences in quality (service). There are *real* price differences. Since Stigler's classic paper [1961], there has been a large literature exploring optimal search behavior. Stigler, and most of the search literature, took, however, the price or wage distribution as given. They did not ask how did it arise. Given the search costs, could it be sustained? For instance, if search costs are relatively low, one might have thought (if one bought the older theories) that markets would look very much like they would with zero search costs, in which case there would be no price or wage distribution. It is not surprising that given that information is costly, if there are shocks to the economy – the demand for a good goes up in some locale, so price there rises – that prices are not fully arbitraged instantaneously. But much of the wage and price dispersion cannot be related to such "shocks."

Our analysis of efficiency wage theory provided an alternative explanation. We showed that it paid firms to pay more than they had to, e.g. to reduce labor turnover costs. But it might pay some firms to pay higher wages than others.

As I began to analyze these models, an important insight occurred: there could be a wage distribution even if all firms were identical, e.g. faced the same search costs. It was clear that even small search costs could make a large difference to the behavior of product and labor markets. This was a point that Diamond [1971] had independently made in a highly influential paper, which serves to illustrate powerfully the lack of robustness of the competitive equilibrium theory. Assume, as in the standard theory, all firms were charging the

[83] 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.

competitive price, but there were an epsilon cost of searching, of going to another store. Then any firm which charged epsilon/2 greater would lose no customers. It would thus pay him to increase his price. And it would similarly pay all other firms to increase their prices. But at the higher price, it would again pay each to increase his price. And price increases until the price charged is the monopoly price. Even small search costs thus lead even a market with many firms to charge monopoly prices. Work with Salop (Salop and Stiglitz [1977, 1982, 1987], Stiglitz [1979b, 1989c]), showed that in situations where there were even small search costs, markets would be characterized by a price distribution. If everyone were charging the same price, it would pay some firm either to raise his price, to exploit the high search costs customers who he would not lose, or to lower his price, to steal customers away from his rivals. The standard wisdom that said that not everyone had to be informed to ensure that the market acted perfectly competitive was simply not in general true.[84]

EFFICIENCY OF THE MARKET EQUILIBRIUM AND THE ROLE OF THE STATE

Perhaps the most important single idea in economics is that competitive economies lead, as if by an invisible hand, to a (Pareto) efficient allocation of resources, and that every Pareto efficient resource allocation can be achieved through a competitive mechanism, provided only that the appropriate lump sum redistributions are undertaken. It is these (fundamental theorems) of welfare economics which provide both the rationale for the reliance on free markets, and the belief that issues of distribution can be separated from issues of efficiency, allowing the economist the freedom to push for reforms which increase efficiency, regardless of their seeming impact on distribution; if society does not like the distributional consequences, it should simply redistribute income.

The economics of information showed that neither of these results was, in general, true. To be sure, economists over the preceding three decades had identified important market failures – such as the externalities associated with pollution – which required government intervention.[85] But the scope for market failures was limited, and thus the arenas in which government intervention was required were limited.

Early work, already referred to, had laid the foundations for the idea that economies with information imperfections would not be Pareto efficient, *even taking into account the costs of obtaining information*. There were interventions in the market that could make all parties better off. We had shown, for instance, that incentives for the disclosure and acquisition of information were far from perfect; imperfect appropriability meant that there might be insufficient incentives, but the fact that much of the gains were "rents," gains by

[84] For a survey, see Stiglitz [1989c].

[85] 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.

some at the expense of others, suggested that there might be excessive expenditures on information. One of the arguments for unfettered capital markets was that there were strong incentives to gather information; if one discovered that some stock was more valuable than others thought, if you bought it before they discovered the information, then you would make a capital gain. This price discovery function of capital markets was often advertised as one of its strengths. But the issue was, while the individual who discovered the information a nano-second before any one else might be better off, was society as a whole better off: if having the information a nano-second earlier did not lead to a change in real decisions (e.g. concerning investment), then it was largely redistributive, with the gains of those obtaining the information occurring at the expense of others. Another example illustrates what is at issue. Assume hundred dollar bills were to fall, one each at the left foot of each student in my class. They could wait to the end of the lecture, then pick up the money; but that is not a Nash equilibrium. If all students were to do that, it would pay any one to bend down and quickly scoop up what he could. Each realizing that immediately picks up the dollar bill at his foot. The equilibrium leaves each no better off than if he had waited – and there was a great social cost, the interruption of the lecture.[86]

There are potentially other inefficiencies associated with information acquisition. Information can have adverse effects on volatility[87]. And information can lead to the destruction of markets, in ways which lead to adverse effects on welfare. We described earlier how the existence of asymmetries of information can destroy markets. Individuals sometimes have incentives to obtain information (creating an asymmetry of information), which then leads to the destruction of insurance markets, and an overall lowering of welfare. Welfare might be increased if the acquisition of this kind of information could be proscribed. Recently, such issues have become sources of real policy concern, in the arena of genetic testing. Even when information is available, there are issues concerning its use, with the use of certain kinds of information having either a discriminatory intent or effect, in circumstances in which such direct discrimination itself would be prohibited.[88]

Moreover, asymmetries of information were shown to be related to absent or imperfect markets. They help explain why the market for lemons, or the credit or labor or equity markets worked imperfectly. The fact that markets with imperfect information worked differently – and less well – that markets with perfect information was not, by itself, a damning criticism of markets. After all, information is costly, and taking into account the costs of information, markets might be fully efficient. Stigler had essentially argued for this perspective, but without proof. Our research showed that this assertion – or hope – was simply not correct. Earlier work had established that when mar-

[86] See Stiglitz [1989k].
[87] For a discussion in the context of the East Asia crisis, see Furman and Stiglitz [1998].
[88] 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].

kets are absent or imperfect, market equilibrium might be *constrained* Pareto inefficient, that is, taking into account the absence of the market, everyone could be made better off.[89] Moreover, since asymmetries of information give rise to market power, and *perfect* competition is required if markets are to be efficient, it is perhaps not surprising that markets with information asymmetries and other information imperfections are far from efficient.

But while it was thus not surprising that markets might not provide appropriate incentives for the acquisition and dissemination of information, the market failures associated with imperfect information are far more profound. The intuition can be seen most simply in the case of models with moral hazard. There, the premium charged is associated with the *average* risk, and therefore, the average care, taken by seemingly similar individuals. The moral hazard problem arises because the level of care cannot be observed. Each individual ignores the effect of his actions on the premium; but when they all take less care, the premium increases. The lack of care by each exerts a negative externality on others.

The essential insight of Greenwald and Stiglitz [1986][90] was to recognize that such externality-like effects are pervasive whenever information is imperfect or markets incomplete – that is always – and as a result, markets are essentially never constrained Pareto efficient.[91] In short, market failures are pervasive.

There were two other implications. The first was the non-decentralizability of efficient market solutions. The notion that one could decentralize decision making to obtain (Pareto) efficient resource allocation is one of the fundamental ideas in economics. Greenwald and Stiglitz showed that that was not in general possible. Again, a simple example illustrates what is at issue. An insurance company cannot monitor the extent of smoking, which has an adverse effect on health. The government cannot monitor smoking any better than the insurance company, but it can impose taxes, not only on cigarettes, but also on other commodities which are complements to smoking (and subsidies on substitutes which have less adverse effects.)[92] Earlier work with Braverman [1982] had shown the consequences of this decentralizability, the

[89] 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].

[90] 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 quilibria in an economy with an agency or principal agent problem was not (constrained) Pareto efficient. Later work, with Arnott [1990] explored in more detail the market failures that arise with moral hazard.

[91] Arnott, Greenwald, and Stiglitz [1994] provide a simple exposition using the standard self-selection and incentive compatibility constraints.

[92] These ideas are extended and generalized in Arnott and Stiglitz [1991b]. In Stiglitz [1998c]. I explore the role of corrective taxation (correcting for externalities) in the presence of imperfect information.

interlinkage of land, labor, and credit markets in agrarian markets of developing countries.

Markets are also interlinked over time. *Intertemporal linkages* impair the efficacy of competitive processes, as we have already noted. Standard theory has it that if an employer does not treat an employee well, he simply moves to another firm. But informational asymmetries impair labor mobility, partially locking the employee into his employer, or the borrower into his creditor[93]. While with perfect information and perfect markets, some of the consequences of this reduction in ex post competition could be corrected by the intensity of ex ante competition, there is little reason to believe that is in fact the case.[94]

One of the sources of the market failures is *agency problems*, such as those which arise when the owner of land is different from the person working the land. The extent of agency problems – and therefore of market failures – thus depends on the distribution of wealth, as we noted earlier in our discussion of sharecropping. It is simply not the case that one can separate out issues of equity and efficiency.[95]

Moreover, the notion that one could separate out issues of equity and efficiency also rested on the ability to engage in lump sum redistributions. But as Mirrlees [1971] had earlier pointed out, with imperfect information, this was not possible; all redistributive taxation was distortionary. But this had important implications for a wider range of policies beyond simply the design of tax structures. It meant that interventions in the market which changed the before tax distribution of income could be desirable, because they lessened the burden on redistributive taxation.[96] Again, the conclusion: the second welfare theorem, effectively asserting the ability to separate issues of distribution and efficiency, was not true.[97]

In effect, the Arrow-Debreu model had identified the single set of assumptions under which markets were (Pareto) efficient. There had to be perfect information, or, more accurately, information (beliefs) could not be *endogenous*, they could not change either as a result of the actions of any individual or firm, including investments in information. But in an information economy, a model which assumes that information is *fixed* seems increasingly irrelevant.

Dysfunction institutions

As the theoretical case that markets in which information was imperfect were not efficient became increasingly clear, several arguments were put forward against government intervention. One we have already dealt with: the gov-

[93] See Stiglitz and Weiss [1983b].
[94] See, for instance, Stiglitz [1987h]
[95] A point that had also been made earlier in Shapiro and Stiglitz [1984].
[96] See Stiglitz [1998c].
[97] 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 decentralizibility were raised in Arnott and Stiglitz [1991b].

ernment too faces informational imperfections. For our analysis had shown that the incentives and constraints facing government differed from those facing the private sector, so that even when government faced exactly the same *informational* constraints, welfare could be improved upon.[98]

There was another argument, which held up no better. The existence of market failures – absent or imperfect markets – does give rise to non-market institutions. The absence of death insurance gave rise to burial societies. Families provide insurance to their members against a host of risks for which they either cannot buy insurance, or for which the insurance premium is viewed to be too high. But in what I call the *functionalist fallacy*, it is easy to go from the observation that an institution arises to fulfill a function to the conclusion that actually, *in equilibrium*, it serves that function. Those who succumbed to this fallacy seemed to argue that there was no need for government intervention because these nonmarket institutions would "solve" the market failure, or at least do as well as any government. Richard Arnott and I [1991] showed that, to the contrary, non-market institutions could actually make matters worse. Insurance provided by the family could crowd out market insurance; insurance companies would recognize that the insured would take less risk because they had obtained insurance from others, and accordingly cut back on the amount of insurance that they offered. But since the non-market (family) institutions did a poor job of divesting risk, welfare was decreased.[99]

The Arnott-Stiglitz analysis reemphasized the basic point made at the end of the last subsection: it was only under very special circumstances that markets could be shown to be efficient. Why then should we expect an equilibrium involving non-market institutions and markets to be efficient?

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

[98] For a more extensive discussion of the economic role of the state, see Stiglitz [1989a].

[99] 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.

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.[100] This was the central insight of the Modigliani-Miller theorem.[101] We have noted how the willingness to hold (or to sell) shares conveys information, so that how firms raise capital does make a difference.[102] 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,[103] firms act in a risk averse manner[104] – with risk being more than just correlation with the business cycle.[105]

[100] For early explorations of the implications of taxes for corporate finance, see Stiglitz [1973b, 1976a].

[101] See Modigliani and Miller [1958]. They won the Nobel Prize in 1985 and 1990, respectively. In Stiglitz [1969a], I showed that there 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.

[102] 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 Maljuf [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]).

[103] 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.

[104] See, in particular, Greenwald and Stiglitz [1991].

[105] For an elaboration of this point, see Stiglitz [1987c, 1989g].

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.[106] 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 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.[107]

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).[108] 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)[109] 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 moment. 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 do[110] – 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

[106] 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 liquid would be able to obtain finance, and thus would not face a liquidity problem.

[107] 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].

[108] 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.

[109] It was also assumed that firm value maximization would lead to efficient outcomes. When there are 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].

[110] For an early analysis of these issues, see Stiglitz [1972b]. For a general theorem, see Grossman and Stiglitz [1977].

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, 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][111], 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 takeovers) 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.[112] 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.

[111] 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 copartnery 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.

[112] 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 takeover, see Hirshleifer [1995]. For a survey of the broader literature on corporate governance, see Shleifer and Vishny [1997].

(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[113] – actions which firms could take which 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.)

Organization 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 organization design. Even if individuals are well intentioned, with limited information, mistakes get made. To err is human. Raj 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.[114]

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

[113] See, e.g. Stiglitz [1973b, 1982d].

[114] 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].

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 shown stressed the importance of costs of adjustment of prices[115], 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 market[116] 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 where 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 of key observed macro-economic phenomena. In debt contracts, tipically 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 [117]. 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 capi-

[115] Mankiw [1985], Akerlof and Yellen [1985].

[116] 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].

[117] The importance of these phenomena had been emphasized earlier by Irving Fisher [1933]. Stiglitz [1999d] emphasizes the consequences of *differences* in the speeds of adjustments of different prices.

tal.[118] 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 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 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.[119] 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 pro-cyclically, 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[120]

A particularly important aspect of our reformulation of macro-economics focused 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 the with 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 GDP. 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

[118] 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].

[119] For discussions of credit rationing and macro-economic activity, see Stiglitz and Weiss [1992].

[120] The ideas set forth in this section are developed at greater length in Greenwald and Stiglitz [1990b, 1991, 1999].

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.[121] 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.[122]

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,[123] 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.[124]

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[125] and development[126]

While most of the macro-economic analysis focused on exploring the implications of imperfections of credit markets arising out of information prob-

[121] 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.

[122] See also Hellman, Murdoch, and Stiglitz [2000].

[123] There is now a large literature arguing that these are the crucial variables of concern. For an early discussion, see Blinder and Stiglitz [1983].

[124] See Stiglitz [2001d].

[125] This section is based in part on Greenwald, Kohn, and Stiglitz [1990] and Stiglitz [1992e, 1994a, 1994b].

[126] 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).

lems 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 their growth. In particular, "equity rationing" – especially important in developing 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.[127]

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.[128] While it is not possible to summarize briefly the results, one conclusion does 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.

[127] See, in particular, the discussion in the World Bank [1999].

[128] 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].

The fact that when there are asymmetries of information, markets are not, in general, constrained Pareto efficient implies 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 and overcome asymmetries of information. 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[120]

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 information 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

[120] The discussion of this section draws upon Atkinson and Stiglitz [1976], Stiglitz [1982e, 1987f], and Mirrlees [1975a], and Brito *et al.* [1990, 1991, 1995].

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.)[130] 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 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,[131] allowing far better and more effective systems of regulation than had existed in the past.[132]

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 there were frequently 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

[130] 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* Pareto 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.

[131] See, e.g. Laffont and Tirole [1993] and Sappington and Stiglitz [1987a].

[132] 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, Murdock and Stiglitz [2000].

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.

Washington consensus

Perhaps 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[133], as well as in managing the transition from Communism to a market economy[134] and in managing crises. Ideas matters, 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[135], 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

[133] See, for instance, Stiglitz [1998a].
[134] See, for instance, Stiglitz [2001e, 2000a], Hussein, Stern, and Stiglitz[2000].
[135] See, in particular, Furman and Stiglitz [1998] and Stiglitz [1999e].

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 confirms[136] 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[137].

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

[136] See Stiglitz [2001e].
[137] For fuller discussions of these issues, see Hussein, Stern, and Stiglitz [2000] and Stiglitz [2000a].

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 imperfect information paradigm itself was highly robust; there were some quite general principles, while the workings 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.[138] I have criticized the Washington consensus development strategies partly on the grounds that they perceived of 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.[139]

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[140].

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 in interacted with governments, basing loans on conditionality – were counterproductive. A fundamental change in development strategy occurred at the World Bank in the

[138] 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.
[139] See, e.g. Stiglitz [1995b, 1998a].
[140] See Collier and Gunning [1999], Collier [1998] and Collier [2000].

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 perspectives, I was returning to a theme I had raised thirty years ago, during my work on the efficiency wage theory in Kenya[141], 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 [1986]. 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.[142] 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."[143]

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. So too here (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 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:

[141] Stiglitz [1973a, 1974d].

[142] For a discussion with references to the literature, see Stiglitz [2000d].

[143] 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.

> 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 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 to in public life. And just as we recognize that disclosure requirements – greater transparency – and specific rules of the game (e.g. related to corporate governance) can affect the effectiveness of the take-over mechanism and the overall quality of corporate governance, so too the same factors can affect political contestabilty and the quality of public governance.

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[144], 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 offi-

[144] 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.

cial who has given the reporter privileged access to information, particularly 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 talk I have traced the replacement of one paradigm with another. The deficiencies in the neoclassical 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 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 en-

hance 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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