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DESIGN OF FINANCIAL SYSTEMS: TOWARDS A SYNTHESIS OF FUNCTION AND STRUCTURE*

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This paper proposes a functional approach to designing and managing the financial systems of countries, regions, firms, households, and other entities. It is a synthesis of the neoclassical, neo-institutional, and behavioral perspectives. Neoclassical theory is an ideal driver to link science and global practice in finance because its prescriptions are robust across time and geopolitical borders. By itself, however, neoclassical theory provides little prescription or prediction of the institutional structure of financial systems — that is, the specific kinds of financial intermediaries, markets, and regulatory bodies that will or should evolve in response to underlying changes in technology, politics, demographics, and cultural norms. The neoclassical model therefore offers important, but incomplete, guidance to decision makers seeking to understand and manage the process of institutional change. In accomplishing this task, the neo-institutional and behavioral perspectives can be very useful. In this proposed synthesis of the three approaches, functional and structural finance (FSF), institutional structure is endogenous. When particular transaction costs or behavioral patterns produce large departures from the predictions of the ideal frictionless neoclassical equilibrium for a given institutional structure, new institutions tend to develop that partially offset the resulting inefficiencies. In the longer run, after institutional structures have had time to fully develop, the predictions of the neoclassical model will be approximately valid for asset prices and resource allocations. Through a series of examples, the paper sets out the reasoning behind the FSF synthesis and illustrates its application.

1 Introduction

This paper explores a functional approach to the design of a financial system in which financial functions are the "anchors" or "givens" of such systems and the institutional structure of each system

and its changes are determined within the theory.[1] The term "institutional structure," as used here, includes financial institutions, financial markets, products, services, organization of operations, and supporting infrastructure such as regulatory rules and the accounting system. The financial functions may be provided by private-sector, governmental, and family institutions. The proposed framework can be applied both as a *descriptive* theory to predict the design structure of existing financial systems and as a *prescriptive* one to explore how such systems should be designed.

For nearly three decades, the science of finance, largely based on neoclassical finance with its assumptions of frictionless markets and rational behavior, has had a significant impact on the global practice of finance, as highlighted in Section 2. Prospectively, we see that influence continuing and indeed expanding into a broader domain of applications. However, as outlined in Section 3, the neoclassical paradigm, as an effective abstraction from complex reality, is being challenged by two alternative paradigms, the new institutional (or neo-institutional) finance and behavioral finance.

Instead of examining each as competing alternatives, our central methodological thesis for implementing a functional theory of financial institutions is a synthesis of the neoclassical, the new institutional, and the behavioral perspectives on finance. We call this attempt to synthesize these three perspectives, *Functional and Structural Finance* (FSF). Section 4 frames that functional synthesis by offering a number of examples to illustrate the basic approach. Section 5 offers an overview of the key elements of FSF. The concluding section of the paper discusses the significant influence of a well-functioning financial system on long-term economic growth as further motivation for the systematic examination of financial system design.

Although the manifest purpose of the paper is to explore the design of the financial system and the synthesis of behavioral and transaction cost finance with traditional neoclassic finance, the analysis has direct implications for the process of investment management and for prospective evolution of the asset management industry. Indeed, several of the finance examples used to illustrate this approach to a functional synthesis are drawn from investment management.

The attempt at synthesis offered here is surely far from a complete and axiomatic development of FSF. Nonetheless, we harbor the hope that this first pass will stimulate further thought along these lines.

2   On the impact of finance science on finance practice

New financial product and market designs, improved computer and telecommunications technology, and advances in the theory of finance over the last generation have led to dramatic and rapid changes in the structure of global financial markets and institutions. The scientific breakthroughs in finance theory in this period both shaped and were shaped by the extraordinary innovations in finance practice that coincided with these revolutionary changes in the structure of world financial markets and institutions. The cumulative impact has significantly affected all of us—as users, producers, or overseers of the financial system.

Finance science has informed practice across a wide spectrum of finance applications, with powerful prescriptions for valuation, asset allocation, performance measurement, risk management, and corporate financial decision-making. Surely the prime exemplifying case is the development, refinement, and broad-based adoption of derivative securities such as futures, options, swaps, and other contractual agreements. Practitioner innovations

in financial-contracting technology have improved efficiency by expanding opportunities for risk sharing, lowering transaction costs, and reducing information and agency costs. Those innovations would not have been possible without the Black–Scholes option-pricing methodology, which was developed entirely within the academic research community.[2]

Indeed, in providing the means for pricing and risk measurement of derivative securities, finance science has contributed fundamentally to the remarkable rate of globalization of the financial system. Inspection of the diverse financial systems of individual nation-states would lead one to question how much effective integration across geopolitical borders could have taken place, since those systems are rarely compatible in institutional forms, regulations, laws, tax structures, and business practices. Still, significant integration did take place.

Derivative securities designed to function as adapters among otherwise incompatible domestic systems were important contributors to effective integration. In general, the flexibility created by the widespread use of derivatives as well as specialized institutional designs provided an effective offset to dysfunctional country-specific institutional rigidities. Furthermore, derivative-security technologies provide efficient means for creating cross-border interfaces without imposing invasive, widespread changes within each system.

An analogy may prove helpful here. Imagine two countries that want to integrate their pipelines for transporting oil, gas, water, or anything else. Country A has a pipeline that is square, while country B's pipeline is triangular. Country A's plan for integrating the pipelines is to suggest to B that it replace its triangular pipeline with a square one. This, of course, will require a very large and disruptive investment by B. Decision makers in country B, not surprisingly, have an alternative—country A

should tear up its square pipeline and replace it with a triangular one.

But rarely would either of those two plans make sense. Almost always, the better solution is to design an efficient *adapter* that connects the two existing pipelines with minimum impediments to the flow across borders.

This pipeline analogy captures much of what has been happening during the past twenty years in the international financial system. Financial engineers have been designing and implementing derivative contracts to function as efficient adapters that allow the flow of funds and the sharing of risks among diverse national systems with different institutional shapes and sizes.

More generally, financial innovation has been a central force driving the financial system toward greater economic efficiency. Both scholarly research and practitioner experience over that period have led to vast improvements in our understanding of how to use the new financial technologies to manage risk.

As we all know, there have been financial "incidents," and even crises, that cause some to raise questions about innovations and the scientific soundness of the financial theories used to engineer them. There have surely been individual cases of faulty engineering designs and faulty implementations of those designs in finance just as there have been in building bridges, airplanes, and silicon chips. Indeed, learning from (sometimes even tragic) mistakes is an integral part of the process of technical progress.[3]

However, on addressing the overall soundness of applying the tools of financial engineering, it is enough to note here the judgment of financial institutions around the world as measured by their practice. Today no major financial institution in the

world, including central banks, can function without the computer-based mathematical models of modern financial science. Furthermore, the specific models that these institutions depend on to conduct their global derivative pricing and risk-management activities are based typically on the Black–Scholes option pricing methodology.

So much for the past: What about the impending future?

With its agnosticism regarding institutional structure, neoclassical finance theory is an ideal driver to link science and global practice because its prescriptions are robust across time and geopolitical borders. Future development of derivative-security technologies and markets within smaller and emerging-market countries could help form important gateways of access to world capital markets and global risk sharing. Financial engineering is likely to contribute significantly in the developed countries as well; as for instance in the major transitions required for restructuring financial institutions both in Europe and in Japan.[4]

But will the same intense interaction between the science and practice of finance continue with respect to the new directions of scientific inquiry?

3   The challenge to neoclassical finance

With its foundation based on frictionless and efficient markets populated with atomistic and rational agents, the practical applicability of the neoclassical modeling approach is now challenged by at least two alternative theoretical paradigms. One, *New Institutional Economics*, focuses explicitly on transaction costs, taxes, computational limitations, and other frictions.[5] The other, *Behavioral Economics*, introduces non-rational and systematically uninformed behavior by agents.[6] In contrast to the robustness

of the neoclassical model, the prescriptions and predictions of these alternatives are manifestly sensitive to the specific market frictions and posited behavioral deviations of agents.[7] Perhaps more latent is the strong sensitivity of these predictions to the institutional structure in which they are embedded.

There is a considerable ongoing debate, sometimes expressed in polar form, between the proponents of these competing paradigms. Those who attack the traditional neoclassical approach assert that the overwhelming accumulation of evidence of anomalies flatly rejects it.[8] They see a major paradigm shift to one of the new alternatives as essential for progress. Defenders of the neoclassical paradigm respond that the alleged empirical anomalies are either not there, or that they can be explained within the neoclassical framework, and that in either case, the proposed alternatives do not offer a better resolution.[9] That debate so framed is best left to proceed anomaly by anomaly and we say no more about it here.

Instead, we take a different approach. Rather than choose among the three competing theoretical perspectives, we believe that each, although not yet of the same historical significance, can make distinctive contributions to our understanding and each has its distinctive limitations.

In neoclassical theory, institutions "do not matter" in the sense that equilibrium prices and the allocation of resources are unaffected by specific institutional structures. As long as markets are efficient and frictionless, one can use almost any convenient financial system in a model for analyzing asset demands and the derived equilibrium asset prices and risk allocations will be the same as in models with more realistic and more complex financial systems.

In criticizing neoclassical theory, proponents of both neo-institutional and behavioral finance often

posit the same simple financial institutional structure in their models, and then proceed to show how the introduction of market frictions and deviations from rationality can cause significant changes in equilibrium allocations and asset price behavior. But this is not a valid argument. Unlike the frictionless and rational neoclassical case, there is no longer the invariance of optimal asset demands to institutional specifications. Hence, proper assessments, theoretical and empirical, of market allocational and informational efficiency and interpretations of apparent distortions on capital asset pricing from behavioral and transactional dysfunctions cannot be undertaken without explicit reference to a realistic modeling of the institutional environment. Thus, as major changes take place in the institutional structure for trading financial assets and allocating risks, one would expect that the impact of such frictions on asset prices would change. Indeed, from the FSF perspective, the particular institutions and organizational forms that arise within the financial system are an endogenous response to minimize the costs of transaction frictions and behavioral distortions in executing the financial functions common to every economy.[10] As a consequence, in well-functioning financial systems, high transaction costs and dysfunctional cognitive dissonance among individuals may not have a material influence on equilibrium asset prices and risk allocations. Therefore, from this perspective, market-friction and behavioral predictions may not provide reliable insights about observed asset prices and resource allocations, but they will be centrally important—along with technological progress—in explaining the actual institutional structure of the financial system and the dynamics of its change.

4   The functional synthesis

The central conclusion of FSF is that in well-developed financial systems, predictions of the neoclassical theory of finance will be approximately correct for asset prices and resource allocations, after the endogenous changes in institutional structure have taken place.[11] Furthermore, FSF can be used to predict likely changes in institutional structure and to identify targeted changes in that structure that might lead to more efficient allocations.

Many of the issues facing decision makers around the world today are about institutional change. In China, for example, decentralization and privatization of large parts of the economy during the past decade have produced remarkable improvements in standards of living. Public officials and business leaders now see an urgent need to create a financial infrastructure to support continued economic development. In Japan, officials are considering fundamental changes in the structure of their banking system to overcome economic stagnation. And in Europe and the United States, pension and Social Security reform has become a top priority. A critical issue everywhere is controlling the risk of default by financial institutions.

Neoclassical theory generally serves as a good starting point in addressing such policy issues. It can identify properties of an efficient equilibrium resulting from the assumptions of rational optimizing behavior and perfect competition. In the posited frictionless environment of neoclassical models, however, multiple alternative institutional structures are possible to support the same equilibrium asset prices and risk allocations.[12]

For example, the celebrated Coase theorem shows that in the absence of transaction costs, a variety of organizational structures can result in optimal resource allocation.[13] In such an environment there would be no reason for firms to exist, since the simpler neoclassical structure of atomistic agents interacting directly in competitive markets would work just as well. As Coase shows, however, when

transaction costs are brought into the analysis, then organizational structure matters. Some economic activities are best undertaken in large hierarchical firms, while other activities are best organized through atomistic markets.

Another well-known example of neoclassical assumptions leading to indeterminacy in structural form is the celebrated M&M Propositions regarding the capital structure of firms.[14] Modigliani and Miller prove that in the absence of transaction costs, agency costs, and taxes, firms would be indifferent with respect to their financing mix between debt and equity. When these frictions are taken into account, however, a firm's capital structure can matter a great deal.[15]

In both examples—the Coase Theorem and the M&M Propositions—the neoclassical model serves as a starting point for analysis of institutional structure. However, the neoclassical model alone cannot in general identify the most efficient structure. The new institutional and behavioral theories can be used to help identify features of the environment that may make one structure superior to another in a particular setting at a particular time.

Thus, the neoclassical model by itself offers some limited guidance to decision makers seeking to understand and manage the process of institutional change. In FSF, neoclassical, institutional, and behavioral theories are *complementary* rather than *competing* approaches to analyzing and managing the evolution of financial systems. By employing all three modes of analysis, FSF can perhaps help policy analysts to choose among competing structural solutions to real-world problems.

Instead of attempting a highly formal development of FSF, which is still quite tentative, we frame its synthesis of the different schools of thought using a series of illustrative examples.

The two fundamental tenets of FSF are:
- Neoclassical theory is approximately valid for determining asset prices and resource allocations (albeit as a reduced-form model), but offers little to explain which organizational structures for production and performing various financial functions and which particular market instruments and financial intermediaries will evolve.
- Neo-institutional and behavioral theories are centrally important in analyzing the evolution of institutions including market instruments and financial intermediaries, but are unlikely to provide significant and stable explanations of asset prices and resource allocations.[16]

4.1   Example 1. Transaction costs and option pricing

A quarter century ago, Hakansson (1979) wrote about the "Catch 22" of the option pricing model. His point was that *if* the conditions for Black–Scholes pricing are satisfied, then the option is a *redundant* security with no social purpose; and if the conditions are *not* satisfied, then the pricing model is *wrong*.[17] The seeming paradox can be resolved, however, by considering transaction costs.

In reality most investors face substantial transactions costs and cannot trade even approximately continuously. But in a modern, well-developed financial system, the lowest-cost transactors may have marginal trading costs close to zero, and can trade almost continuously. Thus, the lowest-cost producers of options can approximate reasonably well the dynamic trading strategy, and their cost of replicating the payoffs to the option is approximately the Black–Scholes price.[18]

As in any competitive-equilibrium environment, price equals marginal cost. As is typical in analyses of other industries, the equilibrium prices of financial products and services are more closely linked to the costs of *efficient* actual producers than to *inefficient* potential ones. The result in this context is

that high-trading-cost individuals can become customers of low-trading-cost financial intermediaries and buy options at nearly the same price *as if* those individuals could trade continuously without cost.

The underlying force driving the development of efficient institutional structures is Adam Smith's "invisible hand"—firms seeking to maximize their profits in competitive product markets. Potential customers have a demand for the contingent payoffs associated with options, and profit-seeking financial firms compete to supply the options using the lowest-cost technology available to them. As marginal trading costs for the financial firms approach zero, equilibrium option prices approach the Black–Scholes dynamic-replication cost. Thus, we should find that with an efficient, well-developed financial system, over time, the neoclassical model gives the "correct" pricing as a reduced form, but options and other derivative financial instruments and the institutions that produce them are certainly not redundant.[19]

4.2   Example 2. Continuous-time portfolio theory

Our second example is closely related to the first one, but carries it a step further. Consider the Intertemporal CAPM and the assumptions of frictionless markets and continuous trading used in deriving it.[20] It is well known that by introducing transaction costs into a model with an institutional structure in which individuals all trade for themselves directly in the markets, one can get very different portfolio demand functions and thus very different equilibrium prices.[21] But in the presence of substantial information and transaction costs it is not realistic to posit that the *only* process for individuals to establish their optimal portfolios is to trade each separate security for themselves directly in the markets. Instead, individuals are likely to turn to financial organizations such as mutual and pension funds that can provide pooled portfolio

management services at a much lower cost than individuals can provide for themselves. Equilibrium asset prices will, therefore, reflect the lower marginal transaction costs of those financial-service firms and not the higher transaction costs of the individuals.

Neoclassical portfolio theory also offers some guidance in identifying the likely nature of the services to be provided by financial intermediaries. The theory of portfolio selection tells us that in the absence of transaction costs and with homogeneous expectations, individuals would be *indifferent* between choosing individually among all assets and choosing among a small number of optimized portfolios. This is the classic "separation" theorem of portfolio theory.[22] But in the presence of significant information and transaction costs, the separation theorem turns into an elementary theory of financial intermediation through mutual funds.

Mutual funds are the investment intermediaries that specialize in producing optimized portfolios by gathering the information needed (expected returns, standard deviations, and correlations among the full set of risky assets) and combining them in the right proportions (the efficient portfolio frontier). Because of economies of scale in gathering information, processing it, and trading securities, the transaction costs for mutual funds will be significantly lower than for individuals, so individuals will tend to hold mutual funds rather than trade in the individual securities themselves.

This view also addresses the issue of heterogeneous expectations in the Capital Asset Pricing Model by offering a justifying interpretation for its standard assumption of homogeneous beliefs: namely, investors in mutual funds in effect "agree to agree" with the return-distribution estimates of the professionals who manage those funds. Furthermore, since professional investors tend to use similar data sets and methods of statistical analysis, their estimates may be more homogeneous than would

otherwise be the case if individuals were gathering data and making forecasts directly for themselves.[23]

In more realistically complete models of lifetime portfolio selection, individuals may have complex optimal dynamic strategies. Here too, neoclassical theory offers a useful starting point for a theory of financial structure. As shown in Merton (1989), *for every dynamic trading strategy there exists an equivalent contingent contract or derivative security.* Black, Merton, and Scholes derived the option pricing model by showing that there is a dynamic trading strategy that replicates the payoffs from a call option. That same approach applies to any derivative security.[24] The contingent-claim-equivalence to dynamic portfolio strategies can be derived by running the option-pricing derivation "in reverse."[25]

From contingent-claim-equivalence it follows that a low-transaction-cost financial intermediary can sell to high-transaction-cost customers fully hedged ("immunized") contracts that have the contingent payoffs associated with an optimized portfolio strategy. The intermediary pursues the dynamic trading strategy at its lower transaction costs and provides the specified contractual payoffs to its customers.[26]

Note that under this view of the process of financial intermediation, the products traditionally provided by investment management firms tend to merge with the long-term contracts traditionally produced by the life insurance industry. This convergence transformation has been going on for many years in the market for variable annuities in the United States, although it has largely been motivated by the tax-deferral advantages of annuities.

If this view is correct, then as transaction costs continue to decline, financial intermediaries will produce more complicated-to-produce products that combine features of investments and insurance. They will be customized to provide easy-to-understand, seamless solutions to complex life-cycle risk management needs of households.

Households today are called upon to make a wide range of important and detailed financial decisions that they did not have to in the past. For example, in the United States, there is a strong trend away from defined-benefit corporate pension plans that require no management decisions by the employee toward defined-contribution plans that do. There are more than 9000 mutual funds and a vast array of other investment products. Along with insurance products and liquidity assets, the household faces a daunting task to assemble these various components into a coherent effective lifetime financial plan.

Some see this trend continuing with existing products such as mutual funds being transported into technologically less-developed financial systems. Perhaps this is so, especially in the more immediate future, with the widespread growth of relatively inexpensive Internet access to financial "advice engines." However, the creation of all these alternatives combined with the deregulation that made them possible has consequences: deep and wide-ranging disaggregation has left households with the responsibility for making important and technically complex micro-financial decisions involving risk—such as detailed asset allocation and estimates of the optimal level of life-cycle saving for retirement—decisions that they had *not* had to make *in the past*, are *not* trained to make *in the present*, and are *unlikely* to execute efficiently *in the future*, even with attempts at education.

The availability of financial advice over the Internet at low cost may help to address some of the information-asymmetry problems for households with respect to commodity-like products for which the quality of performance promised is easily verified. However, the Internet does not solve the "principal–agent" problem with respect to more fundamental financial advice dispensed by an agent.

That is why we believe that the future trend will shift toward more integrated financial products and services, which are easier to understand, more tailored toward individual profiles, and permit much more effective risk selection and control.[27]

Production of the new brand of integrated, customized financial instruments will be made economically feasible by applying already existing financial pricing and hedging technologies that permit the construction of custom products at "assembly-line" levels of cost. Paradoxically, making the products more user-friendly and simpler to understand for customers will create considerably more complexity for their producers. The good news for the producers is that this greater complexity will also make reverse engineering and "product knockoffs" by second-movers more difficult and thereby, protect margins and create franchise values for innovating firms. Hence, financial-engineering creativity and the technological and transactional bases to implement that creativity, reliably and cost-effectively, are likely to become a central competitive element in the industry.

These developments will significantly change the role of the mutual fund from a direct retail product to an intermediate or "building block" product embedded in the more integrated products used to implement the consumer's financial plan. The "fund of funds" is an early, crude example. The position and function of the fund in the future will be much like that of individual traded firms today, with portfolio managers, like today's CEOs, selling their stories of superior performance to professional fund analysts, who then make recommendations to "assemblers" of integrated retail financial products.

4.3   Example 3. Irrational pessimism/optimism

Having given two examples of how transaction costs can endogenously determine financial structure and

the production process while neoclassical models remain valid as reduced-form predictors of equilibrium asset prices and allocations, we now offer an example of how behavioral factors can have similar effects. As we know from the empirical studies done by Kahneman, Tversky, and other behavioral scientists, people's financial behavior can differ systematically from the neoclassical assumptions of rationality. In particular, it has been shown that when individual choices depend on probabilities, subjective estimates of these probabilities are often subject to large biases. It does not necessarily follow, however, that the market prices of products whose demand depends on probability estimates—products such as insurance—will reflect those biases. To see why, consider the market for life insurance.

Suppose that people systematically underestimate their life expectancies. Then, if they are risk-averse (or even risk-neutral) the price they will be willing to pay for life insurance will be "too high" relative to the actuarially fair price. For example, suppose that the actuarially fair annual price is $20 per $10,000 of insurance, but people would be willing to pay $40 as their "reservation" price. What would be the likely institutional dynamics of price formation in this market?

Life insurance firms that enter this market early might earn large profits because they can charge the reservation price of $40 while their underwriting cost will be the $20 expected loss. But others will examine the mortality data, calculate the spread between price charged and the objective costs of supplying life insurance, and soon discover the profit opportunity available. If there are no effective barriers to the entry of new firms, price competition will drive the price to the zero excess-profit point.[28]

Thus, in the long-run, competitive equilibrium, life insurance prices will reflect the rational unbiased probabilities of mortality, even though every buyer of life insurance has biased estimates of

these probabilities. The institutional structure of providers of this risk-intermediating function and its dynamics of evolution may be greatly affected by this behavioral aberration even though asymptotically it has no effect on equilibrium price and once again neoclassical pricing obtains, as a reduced form.[29]

4.4   Example 4. Home bias

Now consider the well-documented "home-bias" effect in portfolio selection.[30] Several rational explanations for this effect have been proposed in the economics and finance literature—for example, higher information costs for foreign vs. domestic shares.[31] But suppose that the reason is indeed an *irrational* bias against investing abroad. Thus, US residents prefer to invest in the shares of US corporations just because they are domiciled in the United States. They, therefore, invest far *less* abroad than is optimal according to the neoclassical model of optimal diversification.

Does the posited behavioral "aberration" result in an equilibrium allocation different from the neoclassical prediction?

Not necessarily. If US corporations were to invest only in US capital projects, then with investor home bias the equilibrium cost of capital and expected return on shares for US companies would be lower than in the neoclassical equilibrium, and higher for non-US projects and firms. However, with value-maximizing managers and absent legislative restrictions on investment, this equilibrium is not sustainable. With the lower cost of capital for the shares of US corporations, US firms will find that direct investments abroad will have higher net present value than domestic ones.[32] Asymptotically in the limiting case of no other imperfections except investor home bias, US corporations would end up issuing shares in the United States and investing overseas until they reach an asset allocation and cost of capital that is the same as predicted in a neoclassical no-home-bias equilibrium.

Thus, the final equilibrium asset prices and allocations will be as predicted by neoclassical finance theory. However, the *institutional structure* in which specific financial functions are executed may be materially determined by investor home bias. Of all possible institutional structures that are consistent with the neoclassical equilibrium, FSF looks for the one that most effectively mitigates the distortionary effects of home bias. Thus, instead of mutual funds and other investment intermediaries exclusively serving the function of international diversification on behalf of US residents, home bias may cause domestically based manufacturing and service companies to perform this diversification function through direct investment.

Much the same story would be true at a more micro-level for regional biases within a country's borders. For example, Huberman (1999) reports that people invest disproportionately in the shares of their *local* Bell Operating Systems. Again, we argue that this behavior does not necessarily lead to a distortion in equilibrium prices of shares relative to the neoclassical prediction. However, this behavior would lead one to predict that Bell operating companies located in more investor-rich regions might branch out and invest directly in operating companies in other less wealthy regions. Cross-regional diversification would thus be performed by the operating telephone companies themselves rather than by mutual funds and other "pure" financial intermediaries.

Note the operation here of the "invisible hand." Each individual investor retains his/her home-biased behavior, and firm actions are driven by the motive of maximizing net present value, without requiring any explicit awareness of that behavior.

Recognition that endogenous institutional changes may affect the influence of home bias on asset

prices, if that bias is behaviorally driven, suggests some interesting time series tests which compare the amounts of stock of companies held directly by "locals" who are not managers of the firms in the 1950s, 1970s, and 1990s. One might expect that the much larger institutional holdings of stocks in the latter periods would mitigate the home bias effect.[33] Much the same tests could be applied to investments in local mutual fund groups that over time have moved into investing in shares of foreign companies.

4.5   Example 5. Regret aversion[34]

Now consider another example from investing to illustrate how institutions might respond to an irrational behavior pattern by creating new financial instruments. Suppose that people do indeed have an aversion to feeling sorry after-the-fact for earlier investment decisions they made. If this behavioral trait is widespread, then we might expect to find a demand in the market for "look-back" options. A look-back call option gives its owner the right to buy an underlying security at the lowest price at which it traded during the term of the option. Similarly, a look-back put option gives its owner the right to sell the underlying security at the highest price at which it traded during the term of the option.[35] Thus, by paying a fixed insurance-like premium, the investor is assured of no regret from his investment decisions during the subsequent period covered by the option, because he will buy the stock at the lowest price (or sell it at the highest price) possible. There is of course a prospect for regret from paying for the option itself, if the *ex post* gain from the option does not exceed its cost. However, such regret, if any, may well be minimal because the premium is fixed in advance (bounding the amount of regret) and the "base" price for comparison (if the investor had sold or bought at some point instead of purchasing the option) is likely to be "fuzzy." Furthermore, if the marketing of the option frames it psychologically as

"regret insurance," then investors may be no more at risk of realizing regret from paying the premium than from the purchase of other standard forms of insurance, such as fire and theft protection on a house or car.

Those regret-averse investors who would otherwise hold sub-optimal portfolio strategies because of strong regret aversion may well be willing to pay a premium price for such an option. The theory laying out the production technology and production cost for an intermediary to create look-back options first appeared in the scientific literature more than two decades ago.[36] Today, look-back options are available widely over-the-counter from investment and commercial banks.

The point of this example is to suggest that if regret aversion is indeed a significant behavioral phenomenon, then FSF theory predicts an institutional response in the form of creating products like look-back options. If regret is so widespread that it affects equilibrium prices, then at a given point in time, one investor's regret concern about selling a security is likely to mirror another investor's regret concern about buying that security. If so, a properly designed institution or market may be able to "pair off" these offsetting demands and neutralize the regret effect on asset demands. Thus, the theoretically predicted incremental effect that this behavioral phenomenon might have had on equilibrium asset prices and allocations in an institutional environment without look-back options or another functionally equivalent institution can be mitigated or eliminated entirely with their inclusion by institutionally rational intermediaries.[37]

4.6   Example 6. Organizational design

In this example, we move from financial products to consider how organizational design itself might offset dysfunctional individual behavior and produce

an end result that is in line with neoclassical predictions. For example, suppose that when making investment decisions individually, analysts tend to be optimistic and overconfident in their forecasts for the securities they study.[38] Let us suppose further that when individual analysts, each of whom has studied a different security, are brought together in a group and asked to form a group consensus regarding all of the securities, the bias is mitigated or altogether eliminated.[39]

FSF theory would predict a strong tendency for asset-management and other financial-service firms to organize investment selections as a group process including creating investment committees to evaluate the recommendations of individual security analysts and portfolio managers. The committees would have the effect of mitigating the bias of the individual analysts. Consequently, there would be little or no impact of this individual bias on actual investment choices and equilibrium asset market prices.

4.7   Example 7. Don't change behavior; solve with institutions

Now suppose it were possible to change the behavior of individuals to make them less optimistic and overconfident when analyzing individual securities. Although such a change in behavior would eliminate the bias, it might be better not to tinker with the behavior of individuals. The reason is that although optimism and overconfidence are dysfunctional in the domain of security analysis, they may be functional in other domains vital to individual success. That is, there can be unintended and unanticipated consequences of this action. By eliminating a person's optimism and overconfidence in general, we may therefore do more harm than good. Thus, it may be considerably better to rely on investment committees as a means of offsetting the individual bias caused by overconfidence than

to attempt to alter the behavior of the individual analyst.

4.8   Example 8. Sociological elements of behavioral finance[40]

The preceding examples of behavioral distortions of efficient risk allocation and asset pricing all involve cognitive dissonance of individual agents. However, there is another dimension of potential behavioral effects that is sociological in nature in that it derives from the social structure of the financial system. Sociological behavior is neither under the control of individuals within that social structure nor a direct consequence of simple aggregation of individual cognitive dysfunctions. A classic instance within finance is the Self-Fulfilling Prophecy (SFP),[41] applied for instance to bank runs: a bank would remain solvent provided that a majority of its depositors do not try to take their money out at the same time. However, as a consequence of a *public* prophesy that the bank is going to fail, each depositor attempts to withdraw his funds and in the process of the resulting liquidity crisis, the bank does indeed fail. Each individual can be fully rational and understand that if a "run on the bank" does not occur, it will indeed be solvent. Nevertheless, as a consequence of the public prophesy, each depositor decides rationally to attempt to withdraw his savings and the prophecy of bank failure is fulfilled. As we know, one institutional design used to offset this dysfunctional collective behavior is deposit insurance. There are of course others.

"Performativity" or Performing Theory has been employed as a mode of analysis with respect to the accuracy of the Black–Scholes option pricing model in predicting market prices of options, exploring whether the model's widespread public dissemination and use by option traders may have actually caused market pricing to change so as to make the model's predictions become more accurate.[42] Other recent work applying sociological analysis to finance

issues includes studies of the sociology of arbitrage and understanding the development of derivative and other financial markets.[43]

5   Elements of functional and structural finance

In this section we review the main analytical elements of FSF as exemplified by the cases of the preceding section.

5.1   Functions are the "anchors"

When studying the dynamics of financial systems, it is best to adopt an analytical framework that treats *functions* rather than *institutions* as the conceptual anchors.[44] In this analytical framework the functions are exogenous, and the institutional forms are endogenously determined.

5.2   The point of departure is the neoclassical paradigm

When analyzing changes in parts of the financial system, a useful point of departure is the neoclassical paradigm of rational agents operating opportunistically in an environment of frictionless markets. If existing prices and allocations fail to conform to the neoclassical paradigm, it is helpful to focus on why this is so. The possible causes of such a failure might be:

- Existing institutional rigidities, in which case we might consider applying institutional design techniques to circumvent their unintended and dysfunctional aspects or abolish them directly, if the institutional sources are no longer needed.
- Technological inadequacies, which may disappear over time as a result of innovation.
- Dysfunctional behavioral patterns that cannot be offset by institutional changes.

5.3   Theory as a predictor of practice

As technology progresses and transaction costs continue to fall, finance theory is likely to provide increasingly more accurate predictions and prescriptions for future *product* innovations. Combining behavioral theory with neoclassical theory, together with existing theory within New Institutional Economics, should produce better predictions and prescriptions for the kinds of *institutional* changes to expect.[45]

5.4   Institutional rationality versus individual irrationality

Even when individuals behave in ways that are irrational, institutions may evolve to offset this behavior and produce a net result that is "as if" the individuals were behaving rationally. This is a version of Adam Smith's "invisible hand." Structural models that include transactions costs, irrational behavior, or other "imperfections" may give distorted predictions when framed in a neoclassical "minimalist" institutional setting of atomistic agents interacting directly in markets. It is, therefore, essential to include the endogenous institutional response. Studies of the impact of transactions costs or irrational behavior patterns would be greatly enhanced if as a matter of format, they included a section on institutional designs that have the potential to mitigate the effects of these patterns on prices and allocations. The resulting institutional design, if not already in place, can be seen as providing either a prediction about the dynamics of future institutional change or as a normative prescription for innovation.

5.5   Synthesis of public and private finance

The FSF approach has no ideological bias in selecting the best mix of institutions to use in performing financial functions. It treats all institutions, whether

governmental, private-enterprise or family based, as potential solutions. The same techniques of financial engineering apply whether the financial system is dominated by governmental institutions or by private-sector ones or by a balanced mix of the two. FSF seeks to find the best way to perform the financial functions for a given place at a given time.

For example, consider alternative systems for financing retirement. In recent years, there has been great interest around the world on this subject, and big changes are occurring in the institutional means for providing this essential financial function. In some countries where the economy is primarily based on traditional agriculture, retirement income is provided almost entirely by the retiree's family. In other countries it is provided by government, or by a mix of government and private-sector pension plans.

This is not by accident. The best institutional structure for providing income to the retiree population varies from country to country, and within a single country it changes over time. That best structure depends on a country's demographics, its social and family structure, its history and traditions, and its stage of economic development. And it changes with changes in technology.

These changes in retirement systems are sometimes treated as exogenous events or framed as the result of policy mistakes of the past. Instead, we propose that they be viewed systematically as part of a dynamic process of institutional change that can be analyzed and improved using the latest financial technology.[46]

5.6   The financial innovation spiral [47]

The evolution of retirement systems, and indeed the financial system as a whole, can be viewed as an innovation spiral, in which organized markets and

intermediaries compete with each other in a static sense and complement each other in a dynamic sense. That intermediaries and markets compete to be the providers of financial products is widely recognized. Improving technology and a decline in transactions costs has added to the intensity of that competition. Inspection of Finnerty's (1988, 1992) extensive histories of innovative financial products suggests a pattern in which products offered initially by intermediaries ultimately move to markets. For example:

- The development of liquid markets for money instruments such as commercial paper allowed money-market mutual funds to compete with banks and thrifts for household savings.
- The creation of "high-yield" and medium-term note markets, which made it possible for mutual funds, pension funds, and individual investors to service those corporate issuers who had historically depended on banks as their source of debt financing.
- The creation of a national mortgage market allowed mutual funds and pension funds to become major funding alternatives to thrift institutions for residential mortgages.
- Creation of these funding markets also made it possible for investment banks and mortgage brokers to compete with the thrift institutions for the origination and servicing fees on loans and mortgages.
- Securitization of auto loans, credit-card receivables, and leases on consumer and producer durables, has intensified the competition between banks and finance companies as sources of funds for these purposes.

This pattern may seem to imply that successful new products will inevitably migrate from intermediaries to markets. That is, once a successful product becomes familiar, and perhaps after some incentive problems are resolved, it will become a commodity

traded in a market. Some see this process as destroying the value of intermediaries. However, this "systematic" loss of successful products is a consequence of the functional role of intermediaries and is not dysfunctional. Just as venture-capital firms that provide financing for start-up businesses expect to lose their successful creations to capital market sources of funding, so do the intermediaries that create new financial products expect to lose their successful and scalable ones to markets. Intermediaries continue to prosper by finding new successful products and the institutional means to perform financial functions more effectively than the existing ones, all made possible by the commodization of existing products and services.

Thus, exclusive focus on the time path of individual products can be misleading, not only with respect to the seemingly secular decline in the importance of intermediation, but with respect to understanding the functional relations between financial markets and intermediaries. Financial markets tend to be efficient institutional alternatives to intermediaries when the products have standardized terms, can serve a large number of customers, and are well-enough understood for transactors to be comfortable in assessing their prices. Intermediaries are better suited for low-volume customized products. As products such as futures, options, swaps, and securitized loans become standardized and move from intermediaries to markets, the proliferation of new trading markets in those instruments makes feasible the creation of new custom-designed financial products that improve "market completeness," to hedge their exposures on those products, the producers (typically, financial intermediaries) trade in these new markets and volume expands; increased volume reduces marginal transaction costs and thereby makes possible further implementation of more new products and trading strategies by intermediaries, which in turn leads to still more volume. Success of these trading markets and custom

products encourages investment in creating additional markets and products, and so on it goes, spiraling toward the theoretically limiting case of zero marginal transactions costs and dynamically complete markets.

Consider, for example, the Eurodollar futures market that provides organized trading in standardized LIBOR (London Interbank Offered Rate) deposits at various dates in the future. The opportunity to trade in this futures market provides financial intermediaries with a way to hedge more efficiently custom-contracted interest-rate swaps based on a floating rate linked to LIBOR. A LIBOR rather than a US Treasury rate-based swap is better suited to the needs of many intermediaries' customers because their cash-market borrowing rate is typically linked to LIBOR and not to Treasury rates.

At the same time, the huge volume generated by intermediaries hedging their swaps has helped make the Eurodollar futures market a great financial success for its organizers. Furthermore, swaps with relatively standardized terms have recently begun to move from being custom contracts to ones traded in markets. The trading of these so-called "pure vanilla" swaps in a market further expands the opportunity structure for intermediaries to hedge and thereby enables them to create more-customized swaps and related financial products more efficiently.

As an example, consider the following issue faced by smaller countries with funded pension plans sponsored by either the government or by private institutions. Currently, these pension funds invest almost entirely in domestic securities—debt and equity issued by local firms, municipalities, and other entities. Although there would appear to be significant potential benefits from international risk-sharing by pension funds, this has not yet happened to any significant extent.

One way for such international risk-sharing to occur is for the small-country pension funds to invest abroad and for foreign financial institutions to offset this flow of funds by investing in the small country. However, there are significant barriers to such international flows of investment funds. Small country governments fear that the outflows will not be matched by inflows of funds, and therefore impose restrictions on the amount that pension funds can invest abroad. At the same time, investors in large countries are reluctant to invest in smaller countries for fear of manipulation and expropriation of their investments.

To circumvent many of these obstacles and obtain better international diversification, pension funds may rely increasingly on international swap contracts.[48] A swap contract consists of two parties exchanging (or "swapping") a series of payments at specified intervals (say, every 6 months) over a specified period of time (say, 10 years). The payments are based upon an agreed principal amount (called the "notional" amount), and there is no immediate payment of money between the parties. Thus, as in forward and futures contracts, the swap contract itself provides no new funds to either party. The size of each swap payment is the difference between the actual value of the item specified in the contract (e.g., an exchange rate or an interest rate) and the value specified in advance in the contract. International pension swaps would enable a small country to diversify internationally without violating restrictions on investing capital abroad.[49]

Swap contracts provide an excellent example to illustrate the importance of institutional details that are routinely ignored in neoclassical analysis. As mentioned earlier in this paper, the neoclassical theory of derivatives focuses on the equivalences among various combinations of derivatives and the underlying assets. Thus, in a frictionless perfect-market environment, leveraged cash market positions, swaps, forward contracts, and futures

contracts all perform fundamentally the same economic function of risk-transfer, and their prices are all linked to each other by a pricing relation that rules out arbitrage profits. In this limited sense, given cash or forward or futures contracts, swaps are "redundant."

But in the actual world of contemporary international finance, small differences in the institutional details can have material implications for the speed of implementation. Futures contracts are *multilateral-party* exchange-traded instruments, whereas swap contracts are *bilateral* and are almost never traded on an exchange. To introduce a new type of futures contract requires a formal process of approval by the governing body of the exchange, representing a consensus of the exchange members, which can number in the hundreds. In sharp contrast, to introduce a new type of swap contract requires only consensus between the two counterparts to the contract. This difference makes it possible to innovate and execute new types of swap contracts in a fraction of the time required to introduce a new futures contract.

Today's swap contracts also differ from a series of back-to-back loans or forward contracts. Like swaps, forward contracts are flexible bilateral instruments, but they lack a uniform standard. Modern swap contracts follow a standard format developed during the early 1980s by the International Swap Dealers Association (ISDA). The ISDA's standard contract has been tested in a variety of jurisdictions around the world. Over the years the document has been amended and has evolved to meet legal and regulatory requirements virtually everywhere.

Now that the legal infrastructure has been thoroughly tested and practitioners and regulators have developed confidence in it, the pace of swap innovation is likely to proceed at a much faster rate and with much lower transaction costs.[50] With the infrastructure in place, the cost of implementing

new types of swaps involving other underlying securities, commodities, economic indexes, and the like, will be relatively low.

A well-established legal and transactional infrastructure for swaps together with the enormous scale of such contracts outstanding[51] set conditions for the prospective use of swaps and other contractual agreements to manage the economic risks of whole countries in a non-invasive and reversible fashion.[52] Thus, countries can modify their risk exposures separately from physical investment decisions and trade and capital flow policies. This application of financial technology offers the potential for a country to mitigate or even eliminate the traditional economic tradeoff between pursuing its comparative advantages, which by necessity requires it to focus on a relatively few related activities and achieving efficient risk diversification, which requires it to pursue many relatively unrelated activities.

6   Conclusion: finance and economic growth

We have framed and illustrated by examples the FSF approach to the design of financial systems. We conclude here with some observations connecting the design and implementation of a well-functioning financial system with the broader economic issues of promoting long-term economic growth.

Nearly a half century ago, Robert Solow's fundamental work on the long-run determinants of economic growth concluded that it was technological progress, not high rates of saving or population growth, that account for the vast bulk of growth. Subsequent studies have tried to reduce the unexplained residual by adding other measurable inputs. A large body of recent research work suggests that well-functioning financial institutions promote economic growth. These conclusions emerge from cross-country comparisons,[53] firm-level studies,[54]

time-series research,[55] and econometric investigations that use panel techniques.[56] And in their historical research, North (1990), Levine (2002), Neal (1990), and Rousseau and Sylla (2003) have all concluded that those regions—be they cities, countries, or states—that developed the relatively more sophisticated and well-functioning financial systems were the ones that were the subsequent leaders in economic development of their times.

An integrated picture of these findings suggests that in the absence of a financial system that can provide the means for transforming technical innovation into broad enough implementation, technological progress will not have a significant/substantial impact on the economic development and growth of the economy. Therefore, countries like China or even Japan, that need to undertake restructuring of their financial systems, should consider not only their short-run monetary and fiscal policies, and not only the impact of these policies on national saving and capital formation, but also how changes in their financial institutions will affect their prospects for long-term economic development.

But substantial changes and adaptations in the institutional implementation will be necessary in different countries. There are at least two reasons: (1) national differences in history, culture, politics, and legal infrastructure, and (2) opportunities for a country that is in the midst of restructuring its financial system to "leap frog" the current best practices of existing systems by incorporating the latest financial technology in ways that can only be done with "a clean sheet."

There is not likely to be "one best way" of providing financial and other economic functions. And even if there were, how does one figure out which one is best without assuming an all-knowing benevolent ruler or international agency? One must take care to avoid placing the implementation of

all economic development into one institutionally defined financial channel.

Fortunately, innovations in telecommunications, information technology, and financial engineering offer the practical prospect for multiple channels for the financing of economic growth. Multiple channels for capital raising are a good idea in terms of greater assurance of supply at competitive prices. They also offer the prospective benefits of competition to be the best one in a given environment at a given point in time.

Much of the traditional discussion of economic policy focuses on its monetary, fiscal, currency management aspects and on monitoring capital and trade flows. These are important in the short run, and thus also in the long run, in the sense that one does not get to the long run without surviving the short run. However, if financial innovation is stifled for fear that it will reduce the effectiveness of short-run monetary and fiscal policies (or will drain foreign currency reserves), the consequences could be a much slower pace of technological progress. Furthermore, long-run policies that focus on domestic saving and capital formation as key determinants of economic growth do not appear to be effective. Policies designed to stimulate innovation in the financial system would thus appear to be more important for long-term economic development.

Notes

[1] That is, in this theory, financial functions are *exogenous* factors and the institutional structure is *endogenous*.

[2] For an overview of the impact of option pricing on finance theory and practice, see Merton (1998) and Scholes (1998).

[3] For a detailed exposition of this view see Petrosky (1992). See also Draghi *et al.* (2003, pp. 27–35) for application of financial science and technology to anticipating and managing macro-financial crises.

[4] For early applications of the FSF approach to bank reform and pension reform, see Merton and Bodie (1993) and Bodie and Merton (1993), respectively.

[5] See International Society for New Institutional Economics, www.isnie.org. Transaction Cost Economics is a central part of the paradigm; see Williamson (1998).

[6] Behavioral Economics has its intellectual roots in the work of Kahneman *et al.* (1982). Barbaris and Thaler (2003) provide a recent and comprehensive survey on behavioral finance. A very different approach to behavioral finance is to study the relations between emotions and rational financial decision-making by measuring physiological characteristics. See, for example, Lo and Repin (2002).

[7] Intersecting Transactions Cost Finance and Behavioral Finance is Experimental Finance, which takes explicit account of learning by market participants and its effects on financial market price paths and derives and tests behavior in laboratory experiments; cf. Bossaerts (2002) and Bossaerts and Plott (forthcoming) and the Caltech Laboratory for Experimental Finance, www.hss.caltech.edu/~pbs/LabFinance.html.

[8] See the papers by Hall (2001), Hirshleifer (2001), Lamont and Thaler (2003), Shiller (1999), Shleifer (2000), and Thaler (1993, 2000).

[9] See Fama (1998), Ross (2002, 2004), Rubinstein (2001), Schwert (2003), and Weitzman (2004).

[10] Fama (1980), Fama and Jensen (1983a,b), Jensen and Meckling (1976) and Ross (1973) also provide a theory of endogenous determination of organization design and institutions, driven by minimizing agency costs.

[11] That approximation becomes precise asymptotically as the underlying system approaches a complete market functionally.

[12] Thus, since the actual institutional environment does not matter with respect to its predictions about asset prices and resource allocations, the frictionless neoclassical model should be treated as a reduced-form model, not a structural one. As noted earlier in the text, that same institutional robustness does not apply to predictions of asset price behavior in transaction-cost and behavioral models.

[13] See Coase (1937, 1960).

[14] See Modigliani and Miller (1958).

[15] In offering their proposition, Modigliani and Miller did not assert that capital structure "doesn't matter" in the real world. Instead, by identifying sufficient conditions, they isolate where to look to explain why it does matter.

[16] Gilson and Kraakman (2003) reach a similar conclusion on relative importance with respect to behavioral finance from a different analytical framework.

[17] The formal derivation of the Black–Scholes model assumes that all agents can trade continuously without cost. Under some further restrictions on asset price dynamics, there exists a dynamic trading strategy in the underlying stock and the risk-free asset that would exactly replicate the payoffs to the option. Hence, by ruling out arbitrage, the option price is determined.

[18] The case is further strengthened by taking into account the fact that such intermediaries only need to dynamically hedge their *net* exposures after offsetting them within the firm. See Merton (1989) and footnote #26 here.

[19] For further discussion, see Merton (1989, pp. 251–254, 1992, pp. 466–467) on "quasi-dichotomy."

[20] Merton (1973, 1992).

[21] Constantinides (1986).

[22] Cass and Stiglitz (1970), Markowitz (1952), Tobin (1958), and Merton (1971, 1973, 1992).

[23] As evidence for this convergence in data sources, consider the ubiquitous CRSP data or COMPUSTAT. Sharpe (2004) provides a simulation-based model which computes equilibrium optimal portfolio allocations for investors with heterogeneous beliefs and compares those optimal portfolios to the CAPM-predicted ones.

[24] See Merton (1992, Chapter 13).

[25] This type of procedure is developed in Haugh and Lo (2001) and in Merton (1989, pp. 250–254, 1992, pp. 450–464). See also Merton (1995, pp. 477–479, 2002, pp. 62–63) for its application to central bank open-market operations.

[26] A more accurate assessment of the real-world impact should also take into account other risk-management tools that intermediaries have to reduce transaction costs. For instance, as developed in analytical detail in Merton (1992, pp. 450–457), intermediaries need only use dynamic trading to hedge their *net* derivative-security exposures to various underlying assets. For a real-world intermediary with a large book of various derivative products, netting can vastly reduce the size and even the frequency of the hedging transactions necessary. Beyond this, as part of their optimal risk management, intermediaries can "shade" their bid and offer prices among their various products to encourage more or less customer activity in different products to help manage their exposures. The limiting case when the net positions of customer exposures leaves the intermediary with no market exposure is called a "matched book."

[27] For more detailed discussions, see Aaron (1999), Bodie (2003), Bodie *et al.* (2001) and Merton (2002, 2003).

[28] In the realm of investing, see Coval and Thaker (forthcoming) for a prime demonstration with a formal model of the role of institutionally rational intermediaries in bridging the dysfunctional behavior between irrationally optimistic individual entrepreneurs and irrationally pessimistic individual investors. Cohen, Gompers, and Vuolteenaho (2002) provide empirical evidence that institutional investors tend not to make cognitive errors of under-reaction to corporate cash-flow news that individual investors appear to do.

[29] Benink and Bossaerts (2001) and Benink *et al.* (2004) present an alternative, "Neo-Austrian" view of the dynamic adjustment process in which asset prices tend to move *toward* an efficient and stable equilibrium but never *reach* that equilibrium and thus, are always inefficient and inconsistent with neoclassical pricing.

[30] See for examples, Coval and Moskowitz (1999), Cronqvist and Thaler (2004), Hong, Kubik, and Stein (2004), Huberman (1999), Lewis (1998) and Portes and Rey (forthcoming).

[31] More generally, see Merton (1987) for a portfolio and asset pricing model in which passive indexing investment strategies are permitted but active investors trade only in firms they know about, and the cost of information limits the number of firms an active investor knows about.

[32] For some preliminary evidence that can be used to support this view, see Baker, Foley and Wurgler (2004).

[33] Although a time series test has not yet been undertaken, the findings of Hong *et al.* (2004) appear to support this view in a cross-sectional analysis of firms.

[34] Regret aversion is the tendency to avoid taking any action due to a fear that in retrospect it will turn out to be less than optimal.

[35] Look-back options are a particular version of exotic options, a major financial industry line of products.

[36] Goldman *et al.* (1979); see more recently, Shepp and Shiryaev (1993).

[37] A similar approach could be taken for mitigating other types of psychological factors that may also influence investment decisions dysfunctionally. For a convenient listing of those factors affecting investing, see http://www.altruistfa.com/behavioralinvestingpitfalls.htm. Thaler and Benartzi (2004) provide a real-world example of correcting the economic impact of cognitive errors with a product designed to use pre-commitment to offset the dysfunctional behavior affecting individual retirement saving. Another example is found in Miller (2002) who shows how collective non-cooperative behavior in markets can learn to avoid bubbles.

[38] Thaler (2000) writes: "We all tend to be optimistic about the future. On the first day of my MBA class on

decision-making at the University of Chicago, every single student expects to get an above-the-median grade, yet half are inevitably disappointed."

39 Scherbina (2004) finds evidence that the presence of institutional investors in equity markets tends to exert corrective pressure on share prices against the distorting information-processing errors of individual investors. Cohen (2003) finds that individuals reduce their equity exposures more than institutions after a market decline and increase their exposures more than institutions after a market rise, which could be the result of greater risk aversion for individuals or price-change-sensitive optimism or pessimism. It would be interesting to explore whether this difference between institutional and individual investing behavior is related to greater use of group decision-making by institutions.

40 See Smelser and Swedberg (1994) and Swedberg (2003) for an overview of economic sociology.

41 See R.K. Merton (1948, 1957).

42 See MacKenzie (2004a, b, forthcoming) and Mackenzie and Millo (2003). The distinction between Performativity and a SFP is subtle but significant. Performativity implies that the widespread belief in the model causes pricing in the market to change toward greater conformity with the model than before. The concept of a SFP applies only if the prophesized event—in this case the model-predicted option pricing—would not have occurred in the absence of its public proclamation, usually suggesting that the proclamation (the model) was dysfunctionally "unjustified." Hence, even if widespread public knowledge of the model's adoption leads others to use it, it is not a SFP if the model is economically valid or would be justified, even in the absence of its public proclamation. See Merton (1992, p. 471).

43 See MacKenzie (2000, 2003, 2004a, b, forthcoming).

44 See Merton (1993) on the functional perspective. The functional analytical framework presented here is developed in Crane et al. (1995). Financial functions for financial institutions are also used in a different analytic framework that originates from the important work of Diamond and Dybvig (1986).

45 As discussed in Footnote 42 for pricing models, Performativity can apply as well to the evolution of institutional change. If a better theory of institutional dynamics starts to become more widely adopted, its predictions about those dynamics will become more accurate as its adoption spreads and more players use it to make decisions about institutional changes.

46 Bodie (2000).

47 See Merton (1993, pp. 27–33). The description here draws heavily on Merton and Bodie (1995).

48 Bodie and Merton (2002).

49 This swap innovation, including with capital controls, is set forth in Merton (1990).

50 The cost of doing a standard interest-rate swap is today about 1/2 of a basis point—that is only $5000 on a notional amount of $100 million!

51 It has been estimated that the *notional* amount of derivative contracts outstanding globally is $216 trillion. Some large banking institutions have several trillion dollars each on their balance sheets.

52 See Draghi et al. (2003, pp. 37–44) and Merton (1999, 2002, pp. 64–67, 2004) for development of this idea.

53 See King and Levine (1993a,b) and Demirguc-Kunt and Levine (2001).

54 See Demirguc-Kunt and Maksimovic (1998, 1999).

55 See Rousseau and Wachtel (1998, 2000).

56 See Levine et al. (2000).

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