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Program Report

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Asset Pricing

Monika Piazzesi*

The NBER's Asset Pricing Program was created in 1991. Today, it has more than 130 members who present and discuss their research findings at three annual meetings. These meetings take place in the Midwest in the spring, on the east coast in the summer, and on the west coast in the fall. It has been my honor to serve as Program Director for the past three years, which have been particularly interesting as the financial crisis has challenged some of the conventional wisdom about the workings of asset markets. During this time, the Program's members have produced an impressive collection of more than 300 NBER Working Papers.

This report focuses specifically on quantitative structural asset pricing models. In recent years, the AP members have been researching models that can provide unified explanations of a wide range of phenomena in financial markets. Even before the financial crisis, some of these models provided an important base for understanding financial institutions, frictions in financial markets (such as credit constraints), liquidity, investor heterogeneity, and the potential presence of investor irrationality in some markets. Of course, since the crisis, AP Program members have intensified their analysis of models with such features.

Understanding Returns on Average and over Time

A well-known stylized fact about financial markets is that average returns on stocks, long government bonds, and corporate bonds are higher than the return on short bonds. Why do investors demand high compensation for such investments? In a frictionless model with optimizing investors, there are two possible answers: either households are highly risk averse, or they perceive these investments to be very risky.

Another well-documented stylized fact is that the returns on certain long-short strategies are predictable: low current stock valuations relative

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Correction

In a previous NBER Reporter article on the first of three NBER conferences on “African Development Successes,” which took place in Cambridge on December 11–12, 2009, two of the early-stage projects were inadvertently omitted. They are: “Misallocation, Property Rights, and Access to Finance: Evidence from Within and Across Africa,” **Sebnem Kalemli-Ozcan**, University of Houston and NBER, and **Bent Sorensen**, University of Houston; and “Food Security and Infant Mortality,” **Nathan Nunn**, Harvard University and NBER, and **Nancy Qian**, Yale University and NBER. The final version of the first paper will be presented at a research conference in the summer of 2011, while the final version of the second paper will be presented at a research conference in July 2010.

to fundamentals (for example, dividends or earnings) tend to be followed by high subsequent returns. The returns on currency carry trades are predictable based on interest rate differentials. The carry trade involving only domestic bonds is predictable based on the slope of the term structure.

Why don't investors simply borrow and buy some more stocks when expected returns on stocks are high? An economic explanation of return predictability needs a mechanism that discourages investors from doing just that. If investors were to buy stocks in anticipation of high returns, then these purchases would drive up stock prices today, destroying return predictability.

There are two ways to discourage investors from buying in a frictionless setting with rational expectations. First, investors may be more risk *averse* in times when expected returns are high. In bad times, when stocks are trading at low prices, investors could be well aware that prices are likely to go up, but they may worry about taking on the extra risk associated with holding more stocks. Second, investors may be facing more *risk* in times when expected returns are high. During the financial crisis, for example, the Dow dropped below 7000, and still households did not want to buy more stocks. A plausible explanation is that they were worried about losing their jobs and preferred holding cash.

The early work on quantitative asset pricing asked whether models could explain one or maybe even a few of the above stylized facts in isolation. Over the last couple of years, the focus has been on whether the models can explain a wide variety of phenomena in financial markets simultaneously. This recent research has made important progress: we now have a much more consistent explanation of the size and time variation of risk premiums across different asset classes. By carefully documenting dimensions along which existing models don't perform as well, we also have made significant progress in understanding where the theory needs improvement.

Some of the analysis of financial market equilibrium is done in a frictionless setting, where standard optimization conditions (“Euler equations”) describe household behavior, but there are many reasons to believe that these Euler equations do not hold. For example, rich households may have financial advisors who manage their money for them, in which case the advisors' incentives may play important roles. Or, frictions

such as credit constraints may be preventing households from borrowing precisely when they need the extra cash. For example, during the financial crisis, it may have been harder to get a new car loan or mortgage. In that case, optimality conditions may lead to Euler inequalities. Finally, households may not have rational expectations. As a consequence, Euler equations may hold, but under beliefs that do not represent a rational assessment of past evidence. In particular, households may not be aware when expected returns on stocks are high, and so they have no reason to buy them. I describe recent work on models with such features later in this report.

Time-Varying Risk Aversion

John Y. Campbell and John H. Cochrane¹ develop a model in which investors have time-varying risk aversion. The key assumption in their model is that investors' utility functions depend on the past history of aggregate consumption, so they capture a "Catching up with the Joneses" motive. Investors are more risk averse in recessions, when their consumption is low relative to past aggregate consumption. They are less risk averse in booms, when their consumption is high, and so gambling feels less threatening. These countercyclical movements in risk aversion make investors want to be compensated more for holding risky assets (such as stocks) in recessions. Thus, the model generates expected returns that are high in recessions.

More recent papers have studied the performance of the Campbell-Cochrane model in other asset markets. Jessica Wachter² shows that a quantitative implementation of a model with time-varying risk aversion can simultaneously explain the predictability of stock returns (as in Campbell-Cochrane) and long-term government bonds. Her paper provides a unified explanation of pricing for stocks and bonds. Further, the real rate is countercyclical, so long-term real bonds are assets with low payoffs in recessions. As a consequence, investors demand positive average compensation for holding these bonds, generating an upward sloping real yield

curve (which helps the model generate an upward nominal yield curve as well.)

Long Chen, Pierre Collin-Dufresne, and Robert Goldstein³ apply the Campbell-Cochrane model to corporate bond markets. A challenge in these markets is that yields on Baa-rated corporate bonds are much higher than those on Aaa-rated bonds, despite the fact that the default probabilities of Baa bonds are only slightly higher than those of Aaa bonds. A model with time-varying risk aversion can account for high Baa-Aaa spreads, because investors are sensitive to the timing of defaults: defaults of Baa bonds are more likely to happen in recessions, when risk aversion is high. Therefore, investors want to be compensated with high yields for a small average amount of exposure to default.

Adrien Verdelhan⁴ explores a model with two countries that are populated by investors with risk aversion that depends on past aggregate domestic consumption. The model also has a pro-cyclical real interest rate. When domestic consumption is low, domestic investors are more risk averse and demand higher compensation for investing in risky strategies. At the same time, the domestic real interest rate is low. This mechanism explains why expected returns on the currency carry trade are high when domestic rates are low.

All of these papers have made important progress in our understanding of what models with time-varying risk aversion imply for asset pricing. Along the way, the researchers have uncovered a number of implications of these models that require more research. It has become clear, for example, that we need to settle the (empirical) question of whether real rates are pro-cyclical or countercyclical, and then modify the models to explain both bond and currency markets simultaneously.

Another implication of the Campbell-Cochrane model, pointed out by Martin Lettau and Wachter⁵, is that the strong time variation in risk premiums and thus discount rates make assets with "backloaded" dividends—assets that pay dividends far in the future rather than close to the present—appear riskier than assets with "frontloaded" dividends. Tano

Santos and Pietro Veronesi⁶ show that growth stocks have backloaded dividends, so habits tend to generate a "growth premium" rather than the "value premium" that we observe in the data.

Long-Run Risk

Ravi Bansal and Amir Yaron⁷ pursue the idea that investors worry about long-run risks, defined as small but persistent changes in expected consumption growth. They consider investors who demand compensation for assets that have low payoffs when bad news about future consumption growth arrives—such investors are said to have "Epstein-Zin" utility functions. Bansal and Yaron apply this model to stocks and provide a new story for the equity premium.

Recently, a large number of papers have applied this model to a variety of markets. Several of the studies investigate the model's implications for the cross-section of stock returns. Bansal, Robert Dittmar, and Christian Lundblad⁸ document that the cash flows of "value stocks," stocks of companies with high book values relative to their market values, vary more with news about future consumption growth than the cash flows of "growth stocks," stocks of companies with low book-to-market values. In the long-run-risk model, this larger covariance makes investors perceive value stocks as more risky. They therefore demand a higher compensation for holding them, explaining the value premium. Lars-Peter Hansen, John Heaton, and Nan Li⁹ document that the covariance between cash flows and news shocks will depend on how the estimation deals with time trends.

Long-run risk provides interesting new interpretations of average premiums, but by itself implies constant premiums. Therefore, long-run risk does not explain the predictability of asset returns, or the high volatility of returns. I will discuss later some recent attempts at combining long-run risk with time variation in risk.

Most papers on long-run risk treat expected consumption growth as unobservable—that is, a latent variable. As a consequence, it can be difficult to esti-

mate the amount of long-run risk in the data. To get a sense of the amount of long-run risk in the Bansal and Yaron (2004) model, Jason Beeler and Campbell¹⁰ simulate data from the model and run forecasting regressions of future consumption growth based on current price-dividend ratios. They can explain more than 30 percent of the variation in the simulated data at the 5-year horizon, and so they conclude that the amount of long-run risk in this particular quantitative implementation is too large.

Martin Schneider and I¹¹ investigate the implications of a model with Epstein-Zin utility for nominal government bond prices. We estimate the joint dynamics of consumption growth and inflation and document that higher inflation today is bad news for future consumption growth. Since long-term bonds are assets with low payoffs in states when inflation is surprisingly high, investors demand compensation for holding long bonds. The model thus predicts that long bonds pay higher returns on average than short bonds—hence it can explain positive slope in the nominal term structure of interest rates.

Disaster Risk

In 1984, Thomas Rietz advanced the idea that rare disasters in consumption make investors worry more about holding stocks and thus may explain a large equity premium. Disasters are rare, so their frequency, size, and duration are difficult to measure. One approach is to calibrate these disasters to well-known crisis events, like the Great Depression, as I did in a 2004 paper written with Francis Longstaff. Another possibility is to treat them as peso problems, which investors fear, but which are not observed in the data sample.

Like long-run risk, disasters provide new interpretations of average premiums, but they do not provide any mechanism for volatility in stock valuations. To generate volatility, or predictability of returns, the probability of a disaster has to vary over time, so that consumption growth is heteroskedastic. I will discuss recent

research later in this article that combines disasters with such time-varying risk.

Disasters often affect the returns on both stocks and bonds (for example, in most countries, stock and bond values crashed during the two World Wars). This means that they may affect the average level of returns on these assets, but not their difference—the equity premium. There are few examples in history where disasters affect only stocks (for example, the Great Depression, or Argentina in 1998-2001.) Robert Barro¹² documents these historical disasters and develops a model that allows disasters to affect stocks and bonds.

Consumption data from other countries is difficult to obtain. Many studies therefore use the more easily available GDP data to measure disasters. This is problematic, because GDP consists of consumption and investment, and what comes down most during an economic disaster is investment, not consumption (which enters the Euler equation and thus matters for pricing.) During the Great Depression, for example, real GDP fell by 30 percent but consumption only dropped by 10 percent. During the recent financial crisis, consumption fell by roughly 3 percent. Barro and Jose Ursua¹³ have now put together an impressive dataset on international consumption and documented historical disasters—including their duration—observed in various countries.

Barro's 2006 paper has inspired a substantial body of follow-up work on disaster risk. Several papers have measured the importance of disaster risk from data on options. Craig Burnside, Martin Eichenbaum, and Sergio Rebelo¹⁴; Jakub Jurek¹⁵; and Emmanuel Farhi, Samuel Fraiberger, Xavier Gabaix, Romain Ranciere, and Verhelhan¹⁶ each use a different approach to study the evidence in currency options. David Backus, Mikhail Chernov, and Ian Martin¹⁷ measure the frequency and size of disasters in consumption from options on U.S. equity indexes.

Along the way, the literature has come up with new techniques that are helpful in solving models with disasters. Ian Martin¹⁸ uses higher order cumulants to

derive asset prices and returns in a model of disasters. Gabaix¹⁹ develops a class of linearity-generating processes that lead to closed-form solutions for bond and stock prices²⁰.

Time-Varying Risk

Another reason why returns may be predictable is that the amount of risk in the economy varies over time. Shmuel Kandel and Robert Stambaugh²¹ document such time variation in the variance (“heteroskedasticity”) of aggregate consumption growth data and evaluate its asset-pricing implications with Epstein-Zin utility.

A number of papers have looked jointly at long-run risk and heteroskedasticity. For example, Ravi Bansal and Amir Yaron²² show that such a model can account for a number of facts in stock returns, including the observed predictability of returns. Hui Chen²³ shows that time-varying risk makes firm defaults more likely in recessions and more painful for claimholders, which explains both high credit spreads in corporate bond markets and low leverage ratios by firms.

Another set of papers has investigated time-varying disaster probabilities, which also capture heteroskedasticity in consumption. Francois Gourio²⁴ and Wächter²⁵ specify the disaster probability to be an autoregressive process and calibrate the parameters to match return data on stocks and bonds.

Intermediation

Motivated by recent events, members of the AP group have further explored models with financial institutions. In these models, the Euler equations of households do not necessarily hold because households delegate their portfolio management to institutions, such as mutual funds and hedge funds. The assumption in these models is that households cannot participate directly in these markets, but must participate through financial intermediaries.

Zhiguo He and Arvind Krishnamurthy²⁶ analyze a model with both

stocks and bonds in which households can invest in bonds directly but not in stock. Instead, households invest with intermediaries who manage a portfolio of stocks and bonds. They further assume that the total amount of funds that households can invest with intermediaries is constrained to be less than a multiple of the intermediaries' internal funds. This "intermediation constraint" is assumed to always bind. In response to a negative shock to the cash flows of stocks, the wealth of intermediaries falls. Because of the intermediation constraint, households have to reduce their investments with intermediaries and thus have a smaller portfolio weight on stocks. The only way for markets to clear is for intermediaries to increase their portfolio weight on stocks, which in turn increases the intermediaries' consumption exposure to the stock market. As a consequence, risk premiums in the stock market rise in bad times.

Dimitri Vayanos and Paul Woolley²⁷ consider a model with a bond and many different stocks. Households can buy a passive index of these stocks or they can invest with an active portfolio manager. There are also "buy and hold" investors who hold stocks in proportions different from the passive index. The portfolio manager can generate higher returns than the passive index by buying stocks that are in low demand by these "buy and hold" investors and are thus undervalued. A key assumption is that portfolio managers can be good or bad (that is, manage money at low or high costs), and that households learn about their ability. If households receive high returns on their actively managed portfolios, then they will update their information about the manager's ability and invest more. The model can thus explain why high past returns on an active fund will generate higher future inflows into the fund.

In papers that will be presented at the 2010 NBER Summer Institute, In Gu Kang, He, and Krishnamurthy²⁸ document changes in balance sheets of financial institutions over the recent financial crisis. Tobias Adrian, Emanuel Moench, and Hyun Shin²⁹ document that these balance sheets are informative about risk pre-

miums in financial markets. In particular, they show that an expansion of balance sheets – higher growth rates of leverage or assets by financial institutions – predicts higher future economic activity (for example, GDP growth) and lower future excess returns (on a variety of stock portfolios, corporate bonds, and government bonds.) Of course, because the regressions involve endogenous variables, we are not sure whether these are causal relationships.

Heterogeneous Expectations

Schneider and I³⁰ use evidence from the Michigan survey to document that young households were forecasting higher inflation rates than older households during the late 1970s and early 1980s. Since mortgages are nominal contracts, younger households perceive real mortgage rates to be lower than older households, creating gains from trade across generations. As a consequence, young households borrow and buy houses, which are the only asset that can be used as collateral, and thereby drive up house prices. This effect is further reinforced by mortgage subsidies that increase in times of high expected inflation and also make housing more attractive than stocks as an investment. Taken together, these mechanisms help explain the house price boom and stock price decline of the late 1970s and early 1980s.

In a later paper³¹ we again use Michigan survey data to document expectations about future house prices. Before the boom, a small fraction (10 percent) of households thought that now was a good time to buy a house because house prices would go up in the future. This fraction doubled towards the end of the housing boom, during the years 2004–5, when 20 percent of households believed that buying a house was attractive because house prices would go up further. We then ask whether in a model with search frictions — like the housing market — a small fraction of optimists is enough to drive up house prices. The answer is yes, because prices are measured in a small number of housing transactions. In these transactions, the most optimistic buyers are matched with sellers.

Ulrike Malmendier and Stefan Nagel³² document that investor expectations depend on their lifetime experiences. Based on data from the Survey of Consumer Finances, they show that investors who experienced low stock returns are more pessimistic about future returns, participate less in the stock market, and invest a smaller share of their portfolio in stocks.

Other Heterogeneity

Heterogeneous agent models may do a good job in matching the heterogeneity in the data on household portfolios, but this heterogeneity may not matter for aggregates such as asset prices. For example, Dirk Krueger and Hanno Lustig³³ provide various examples of economies in which uninsurable income shocks do not matter for the equity premium. Nobuhiro Kiyotaki, Alexander Michaelides, and Kalin Nikolov³⁴ show that in their heterogeneous agent model, more lax collateral constraints do not lead to higher house prices.

However, there has been some research by AP Program members that has found encouraging evidence about incorporating heterogeneity. For example, Jonathan Parker and Annette Vissing-Jorgensen³⁵ document that the consumption of rich households is over five times more volatile than aggregate consumption, which may help to explain average premiums in financial markets. Yi-Li Chien, Harold L. Cole, and Lustig³⁶ build a model in which a large fraction of households do not rebalance their portfolios in response to aggregate shocks. As a consequence, households who do rebalance need to sell more stocks in good times and buy more stocks in bad times. This mechanism generates time variation in risk premiums.

Concluding Remarks

The financial crisis has had many negative effects on the economy, but it has had positive effects in stimulating a range of new research in asset pricing. Asset Pricing Program members have begun to evaluate whether conventional models can make sense of the experience in financial mar-

kets during the crisis. Many of the assumptions and mechanisms in these models are being questioned. To borrow from the title of Malmendier and Nagel's paper, we will see a lot more interesting research by "Crisis Babies" over the coming years.

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Research Summaries

International Trade and Organizations

Pol Antràs*

The three central primitives of international trade theory are consumer preferences, factor endowments, and the production technologies that allow firms to transform factors of production into consumer goods. A limitation of traditional trade theory, however, is that the specification of technology treats the mapping between factors of production and final goods as a black box. In practice, the decisions of agents in organizations determine this mapping. Recently, international trade economists have incorporated insights from the field of Organizational Economics into their theories, thereby shedding new light on the mapping between factors of production and consumer goods. This research agenda is important for at least three reasons. First, it provides an explanation for phenomena that standard trade theory is unable to explain (such as the boundaries and hierarchical structure of multinational firms, or the determinants of intrafirm trade). Second, this literature illustrates how considering the endogenous response of organizations to changes in the economic environment

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(such as falling trade costs, declining communication costs, or improvements in contract enforcement) can dramatically affect or even overturn some predictions of standard models. Third, this line of models leads to a revision of key aspects of the design of efficient international trade agreements.

What follows is a brief account of some of my own contributions to the literature on international trade and organizations. In my joint survey article with Esteban Rossi-Hansberg,¹ we have attempted to provide a more balanced overview of this literature.

Property Rights and the International Organization of Production

In my Ph.D. dissertation, I studied different aspects of the recent increase in the globalization of production. I stressed the fact that in developing their global sourcing (or offshoring) strategies, firms not only decide on where to locate the different stages of the value chain, but also on the extent of control they want to exert over these processes. Firms may decide to keep the production of intermediate inputs within firm boundaries, thus engaging in foreign direct investment (FDI) and intrafirm trade, or they may choose to contract with arm's

length suppliers for the procurement of these components, thus engaging in foreign outsourcing and arm's-length trade. In order to understand systematic patterns in these firm decisions, models of the international organization of production that combine elements from international trade models and from theory-of-the-firm models are needed. In early work, I built on the influential incomplete-contracting, property-rights theory of the firm of Grossman, Hart, and Moore.²

In a first paper,³ I unveil two systematic patterns in the intrafirm component of U.S. trade and show that an incomplete-contracting version of the Helpman and Krugman (1985) framework can successfully explain them. More specifically, I start out by demonstrating the existence of 1) a positive cross-industry correlation between capital intensity and the share of intrafirm imports in total U.S. imports, and 2) a positive cross-country correlation between an exporting country's relative capital abundance and the share of intrafirm trade. The theoretical model establishes that these correlations can easily be rationalized in a world in which property rights are allocated in an efficient manner across producers worldwide. The key partial equilibrium result in the paper is that vertical integra-