NONLINEAR MODELING OF ECONOMIC AND FINANCIAL TIME-SERIES
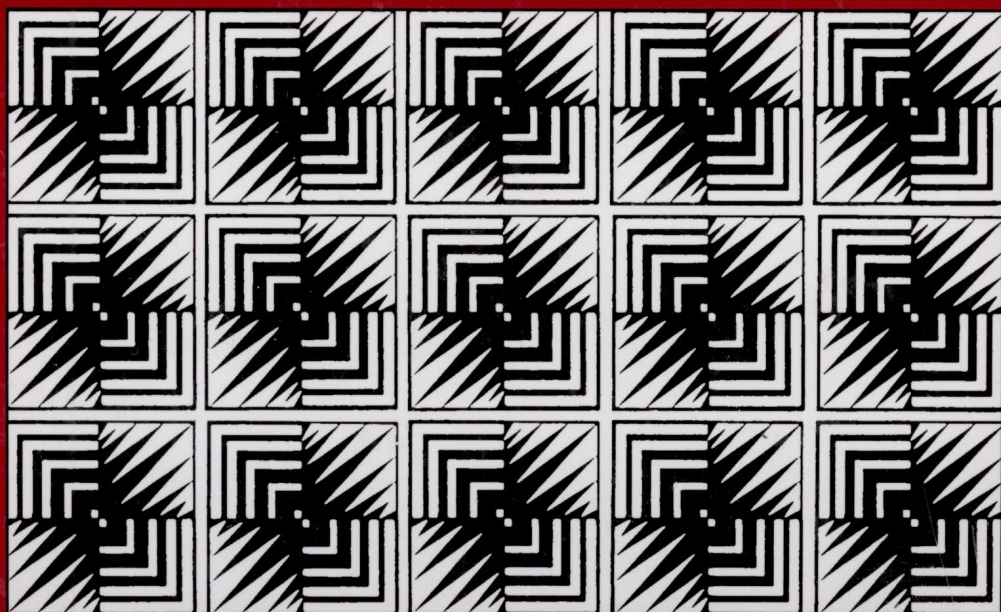

EDITED BY

FREDJ JAWADI AND WILLIAM A. BARNETT

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William A. Barnett
Series Editor

Introduction

During the global financial crisis of 2008–2009, most developed and emerging economies and financial markets have recorded important financial losses. Those economies have experienced momentous corrections, and their assets were significantly devaluated, implying many losses and bankruptcies for banks, investors, and firms. Overall, despite continuing efforts made by governments and central banks to support their financial systems, most financial markets (stock markets, derivative markets, monetary markets, and currency markets) have been strongly affected by this crisis. Furthermore, the rapid transmission of the US subprime crisis to several European and Asian developed and emerging countries and the transformation into a global financial and economic crisis have revealed a high level of financial integration and linkage with the US market. The financial shocks have also induced negative feedbacks to macroeconomic indicators, suggesting significant relationships between financial markets and macroeconomies.

In the literature, several recent studies have focused on financial markets to investigate the causes and effects of this crisis and have identified the financial market dynamics within the global financial crisis. Mainly, those authors have, on the one hand, highlighted negative and significant feedbacks between the financial crisis and financial markets, while characterizing significant decreases of stock returns and important increases of risk and risk premia associated with investment in stock markets. On the other hand, their findings have shown that sectors, even those not directly involved in this crisis (e.g., oil markets and information technology markets), were implicitly affected by this global financial crisis. Interestingly, the authors have unanimously pointed out the existence of asymmetric and nonlinear feedbacks. Indeed, their results suggest the presence of several structural changes, breaks, and regime changes characterizing the dynamics of financial markets. Usual econometric modeling may fail to reproduce these nonlinear dynamics, because the most common models limit a cycle to be linear, which is not appropriate to represent asymmetric dynamics. This evolving feature has particularly led to a commensurate increase in sophistication of nonlinear modeling techniques used for understanding financial market dynamics.

This volume aims at providing a comprehensive understanding of financial markets in various aspects using modern nonlinear financial econometric methods. It addresses the empirical techniques needed by economic agents to analyze the dynamics of these markets and illustrates

how they can be applied to the actual data. It also presents and discusses new research findings and their implications.

It is possible to classify the chapters of this book into three groups regarding their applications and the implemented tools. This introduction first summarizes the chapters and then outlines some broad areas for future research.

The first chapter in this book is by Ricardo Sousa. This chapter studies the role of collateralizable wealth and systemic risk in explaining and forecasting future asset returns. The author points out that nonlinear deviation of housing wealth from its cointegrating relationship with labor income helps to forecast expected future returns. Using data for a set of industrialized countries, the chapter finds that when the housing wealth-to-income ratio falls, investors demand a higher risk premium for stocks. It also shows that the occurrence of crisis episodes amplifies the transmission of housing market shocks to financial markets.

In the second chapter, Mohamed El Hedi Arouri and Fredj Jawadi also focus on stock markets. This chapter investigates the stock market comovements between Mexico and the world capital market during the financial crisis. While applying recent nonlinear cointegration and nonlinear error correction models to investigate the comovements between stock prices over the recent period, this chapter specifies a nonlinear mechanism characterizing the comovement between the Mexican and world stock prices. It shows that a nonlinear relationship between stock prices is activated across economic regimes. These findings highlight strong evidence of significant comovements and integration that explain the global collapse of emerging stock markets in 2008–2009.

In the third chapter, the study of Wafa Kammoun Masmoudi looks at the effect of the financial crisis on hedge funds through the investigation of the relationships between global macro hedge funds and traditional financial assets. To explore this relationship, the author applies several causality and cointegration tests. Her findings show significant long- and short-term relationships between global macro hedge funds and traditional financial assets for Canada, France, and Germany. Her findings imply, as a consequence of the financial crisis, a reduction of opportunities for international portfolio diversification.

In the fourth chapter, Rania Hentati and Jean-Luc Prigent also focus on hedge funds. They have validated the non-normal distribution of univariate returns of hedge funds and show nonlinearity characterizing their distribution. Their results imply the inadequacy of using the linear correlation coefficients to describe the dependency between two variables in this context. The use of this coefficient is compromised outside the multivariate Gaussian case. After presenting methods for choosing dependency structures, three empirical studies have been conducted. The authors have shown that the

dependency structure between hedge funds, equities (represented by the MSCI Free Word index), and bonds (represented by the JPM Global Bond Index) can be modeled correctly by the Student copula. Their empirical validation for choosing the best structure of dependence also enables them to justify the use of copulas.

Chapters 5 and 6 look at the exchange rate market. Chapter 5 by Iuliana Matei aims to study the determinants of realignment expectations for 14 European countries over the period 2001:01–2009:12. The author shows that standard macroeconomic phenomena and financial crises over the selected period exerted a significant and positive impact on European's realignment expectations, indicating meaningful relationships between realignment expectations and financial crises (both systemic and nonsystemic crises) and macroeconomic variables.

Chapter 6 by Mohamed El Hedi Arouri and Fredj Jawadi looks at the specification of the linkages between oil prices and exchange markets over the last period. Applying recent linear and nonlinear econometric techniques over the period 1973–2009, the authors point out significant linkages between oil price and the US currency exchange rate. They highlight strong evidence of nonlinear mean-reversion between the oil and currency markets. In particular, their findings show that exchange rates are not a fundamental of oil prices, but exchange rate changes help to forecast oil prices in the short run.

Chapters 7 and 8 investigate modeling of economic time series with different econometric tools. In Chapter 7, Sébastien Pommier and Fabien Rondeau investigate empirical evidence of the main sources of economic interdependencies in Europe. While applying cointegration tools and carrying out panel estimations, the authors show strong evidence in favor of a positive relationship between openness, country size, knowledge accumulation, and the long-run sensitivity to European income. The authors conclude that the European income spillovers are not explained by specialization of trade and production and that those countries which benefit the most from economic integration are the largest and invest the most in R&D.

Chapter 8 by Dominique Guégan and Patrick Rakotomarolahy develops "Alternative methods for forecasting GDP." In particular, this chapter aims to forecast GDP using the nonparametric technique known as the multivariate nearest neighbors method and to provide asymptotic properties for this method. Using the multivariate nearest neighbors method, the authors provide better forecasts of the Euro area monthly economic indicator and quarterly GDP than with a competitive linear VAR model. The authors also provide the asymptotic normality of this k-nearest neighbor regression estimator for dependent time series, and thereby produce confidence intervals for the point forecast in their time series.

In the final chapter, Hachemi Ben Ameur examines the constant proportion portfolio insurance (CPPI) method, when the multiple is allowed

to vary. In this framework, the author provides explicit values of the multiple as a function of the past asset returns and other state variables. He shows how the multiple can be chosen to satisfy the guarantee condition at a given level of probability and for particular market conditions. According to this chapter, a new multiple can be determined according to the distributions of the risky asset log return and volatility.

Overall, the findings of these chapters yield several important implications regarding the dynamics of economic and financial series along with the financial crisis and its main consequences. Indeed, the empirical results point out strong evidence of nonlinearity and asymmetry in most time series under consideration. The presupposed hypotheses of independency and efficiency seem to be strongly rejected and further evidence of strong integration and comovements between financial markets (stock prices, exchange rates, hedge funds) is shown. Furthermore, emerging markets appear not to be spared from the global financial crisis, since they are economically and financially integrated with economies of developed countries. The financial crisis is explored in different types of financial assets, such as stocks, hedge funds, and bond yields.

From a methodological point of view, it appears that nonlinear models fit the dynamics of economic and financial series better than linear models. This may result from the fact that nonlinearity better enables capture of structural breaks and discontinuities induced by market frictions and financial crises and the dynamics of economic and financial series along with the properties of business cycles through different regimes.

The research topics discussed in these chapters can be seen as a rapid look into mainstream, cutting-edge areas of economic and financial time-series modeling. The findings should provide further areas of innovative research. For example, Chapter 1 opens new and challenging avenues for understanding the dynamics of the relationship between the housing sector, stock market and government bond developments, and the banking system. Chapter 2 analyzes the evolution of emerging and developed stock price comovements. Chapters 3 and 4 yield some evidence of hedge fund properties over the financial crisis. Chapters 5 and 6 offer an overview of exchange rate markets and their dynamics over the last decades. The last chapters develop new methods to describe and forecast the main economic cycle properties and the dynamics of macroeconomic time series.

Acknowledgement

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Contents

Chapter 1

Collateralizable Wealth, Asset Returns, and Systemic Risk: International Evidence

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Abstract

Purpose – The purpose of this chapter is to assess the role of collateralizable wealth and systemic risk in explaining future asset returns.

Methodology/approach – To test this hypothesis, the chapter uses the residuals of the trend relationship among housing wealth and labor income to predict both stock returns and government bond yields. Specifically, it shows that nonlinear deviations of housing wealth from its cointegrating relationship with labor income, *hwy*, forecast expected future returns.

Findings – Using data for a set of industrialized countries, the chapter finds that when the housing wealth-to-income ratio falls, investors demand a higher risk premium for stocks. As for government bond returns: (i) when they are seen as a component of asset wealth, investors react in the same manner and (ii) if, however, investors perceive the increase in government bond returns as signaling a future rise in taxes or a deterioration of public finances, then they interpret the fall in the housing wealth-to-income ratio as a fall in future bond premia. Finally, this work shows that the occurrence of crisis episodes amplifies the transmission of housing market shocks to financial markets.

Originality/value of chapter – These findings are novel. They also open new and challenging avenues for understanding the dynamics of the relationship between the housing sector, stock market and government bond developments, and the banking system.

1. Introduction

The theoretical and empirical literature has shown that credit markets are not perfect and are characterized by the lack of arbitrage and rationing (Stiglitz and Weiss, 1981). Besanko and Thakor (1987) argue that these problems could be avoided if borrowers had enough collateralizable wealth. In fact, banks would be able to offer two different contracts to prospective customers: (i) one requiring a high collateral (and a low interest rate), therefore, attracting low-risk individuals; and (ii) another one requiring less collateral (and a high interest rate), thus favoring high-risk entrepreneurs.

In addition, the efficiency of the housing finance system is of key interest to financial institutions, homeowners, and policy makers. Liquidity and collateralizable wealth play, therefore, a major role for asset pricing. First, liquidity shocks are positively correlated with shocks to returns (Jones, 2002). Second, assets have higher expected returns when they are positively correlated with aggregate market liquidity (Pastor and Stambaugh, 2003; Acharya and Pedersen, 2005). Third, assets with high transaction costs or illiquid assets normally trade at a discount (Brennan and Subrahmanyam, 1996).

While differences in expected returns are typically explained by differences in risk, the covariance of portfolio returns and contemporaneous consumption growth does not fully explain the cross-sectional variation (Mankiw and Shapiro, 1986; Breeden et al., 1989). As a result, the identification of the economic sources of risk remains an important issue. Moreover, given the strong linkages between housing market developments and stock market dynamics, many authors started to consider features of those markets in asset pricing models (Lustig and van Nieuwerburgh, 2005; Yogo, 2006; Fernandez-Corugedo et al., 2007; Piazzesi et al., 2007; Sousa, 2007).

This chapter addresses the role of collateralizable wealth in analyzing predictability of both stock and government bond returns for a set of industrialized countries. Specifically, I assess the forecasting power of the nonlinear deviations of housing wealth from its cointegrating relationship with labor income, *hwy*, for expected future returns.

The rationale behind this linkage lies on the fact that a decrease in housing prices reduces the value of housing in providing collateral services and, therefore, increases household's exposure to idiosyncratic risk.

Consequently, a decrease in the ratio of asset wealth to human wealth predicts higher stock returns. As for government bond returns, one needs to understand the way government debt is perceived by the agents. If government bonds are seen as a component of asset wealth, then investors demand a higher bond risk premium when they face a fall in the ratio of housing wealth-to-income. If, however, the issuance of government debt is understood as leading to an increase in future taxation or as a symptom of public finance deterioration, then investors will interpret the fall in the housing wealth-to-income ratio as predicting a decrease in future government bond returns.

I show that the housing wealth-to-income ratio, *hwy*, predicts both stock and government bond returns, which highlights the characteristic of housing as providing collateral to the banking system. It also emphasizes the important channel by which shocks originated in the housing sector are transmitted to risk premium in asset markets.

The empirical findings suggest that the predictive power of *hwy* for real stock returns is substantial, ranging between 6% (the US), 8% (Finland and the UK), and 10% (Australia) over the next 4 quarters.

With regard to government bond returns, the analysis shows that one can cluster the set of countries into two groups. In the first group (which includes Australia, Denmark, Finland, the Netherlands, and Spain), *hwy* has an associated coefficient with negative sign in the forecasting regressions. The predictive power is, particularly, large for the Netherlands (11%), Finland (13%), and Spain (49%). This, therefore, corroborates the idea that government debt is seen as part of the investor's asset wealth, which implies that agents exhibit a *non-Ricardian* behavior. In the second group (which includes Belgium, Canada, France, Germany, Ireland, Italy, Japan, Sweden, the UK, and the US), the forecasting regressions show that *hwy* has a positive coefficient. Specifically, the predictive ability of *hwy* is large for Germany (11%), Ireland (12%), Belgium (28%), and the US (29%). Consequently, agents in these countries perceive the rise in government bond returns rather as a deterioration of public finances and as signaling an increase in future taxation, that is, they behave in a *Ricardian* way.

Finally, I ask about the importance of episodes of crisis in amplifying the transmission of shocks in the housing market to the financial system. In particular, I assess whether the occurrence of systemic versus nonsystemic crises can help improving our understanding about the linkages between housing and financial markets. I show that the predictive power of future asset returns is indeed improved when one takes into account the presence of such phenomena, especially, the systemic ones.

The robustness of the results is analyzed in several directions. In fact, I show that: (i) the inclusion of additional control variables does not change the predictive power of *hwy* and (ii) models that include *hwy* perform better

than the autoregressive and the constant expected returns benchmark models.

The research presented in this chapter is indebted to the work of Lettau and Ludvigson (2001). However, the authors use the consumer's intertemporal budget constraint to explore the predictive ability of the deviations of consumption from its long-run relationship with aggregate wealth and labor income, *cay*, for stock returns. In contrast, I use the structure of the preferences of the representative agent to assess the forecasting power of the deviations of housing wealth from its equilibrium relationship with labor income, *hwy*, for both stock returns and government bond yields.

This work is organized as follows. Section 2 reviews the literature on the predictability of asset returns. Section 3 describes the theoretical approach. Section 4 discusses the empirical results from the forecasting regressions for stock returns and government bond yields. Section 5 provides the robustness analysis. Section 6 analyzes the role of systemic. Finally, in Section 7, I conclude and discuss the implications of the findings.

2. Literature Review

In this section, I review the literature on the predictability of stock returns and government bond returns, in particular, by highlighting the works that focus on the transmission of housing market developments to the financial system.

2.1. Predictability of Stock Returns

Risk premium is generally considered as reflecting the ability of an asset to ensure against consumption fluctuations. The empirical evidence has, however, shown that the covariance of returns across portfolios and contemporaneous consumption growth is not sufficient to justify the differences in expected returns. In fact, the literature on asset pricing has emphasized the role of market inefficiencies (Fama, 1998; Fama and French, 1996), the rational response of agents to time-varying investment opportunities that is driven by variation in risk aversion (Constantinides, 1990) and by changes in the joint distribution of consumption and asset returns (Duffee, 2005), and different models of economic behavior. These explanations also justify why expected excess returns on assets appear to vary with the business cycle.

Therefore, different economically motivated variables have been developed to capture time variation in expected returns and document long-term predictability. Lettau and Ludvigson (2001) show that the transitory deviation from the common trend in consumption, aggregate wealth, and

labor income is a strong predictor of stock returns, as long as the expected returns to human capital and consumption growth are not too volatile. Bansal and Yaron (2004) find that the long-run risk, that is, the exposure of assets' cash flows to consumption is an important determinant of risk premium. Julliard (2004) emphasizes the role of labor income risk, while Parker and Julliard (2005) measure the risk of a portfolio by its ultimate risk to consumption, that is, the covariance of its return and consumption growth over the quarter of the return and many following quarters. Lustig and van Nieuwerburgh (2005) show that the housing collateral ratio can shift the conditional distribution of asset prices and consumption growth. Yogo (2006) and Piazzesi et al. (2007) emphasize the role of nonseparability of preferences in explaining the countercyclical variation in equity premium, while Fernandez-Corugedo et al. (2007) focus on the relative price of durable goods. Sousa (2007) shows that housing can be used as a hedge against wealth shocks. Chien and Lustig (2010) find that accounting for the importance of collateralizable wealth, namely, by allowing agents to file for bankruptcy, allows one to improve asset pricing predictions.

2.2. Predictability of Bond Returns

In contrast with the literature on the predictability of stock returns, there are just a few studies that try to explain the factors undermining bond risk premia. Fama and Bliss (1987) show that the spread between the *n*-year forward rate and the one-year yield can forecast the *n*-year excess bond returns. Campbell and Shiller (1991) find that excess bond returns can be predicted by the Treasury yield spreads. More recently, Cochrane and Piazzesi (2005) highlight that a linear combination of forward rates explains up to 44% of the variation in next year's excess returns on bonds with maturities ranging from one to five years.

While these findings imply that bond risk premium is time varying, they are, in general, silent regarding its relationship with macroeconomic magnitudes. Campbell and Cochrane (1999) suggest that risk premia on equity reflects a slow-moving habit that is driven by shocks to aggregate consumption.

Despite the linkages between equity risk premia and the macroeconomic fundamentals addressed in the above-mentioned works, their importance for bond risk premia has been typically neglected. Moreover, the existing empirical evidence tends to show that excess bond returns can be forecasted not by macroeconomic variables such as aggregate consumption or inflation, but rather by pure financial indicators, such as forward spreads and yield spreads. For instance, Ludvigson and Ng (2009) find marked countercyclical variation in bond risk premia.