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Dissertation Title:
Essays on the Econometrics of Financial Crisis Dynamics

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Expected Completion Date: May 2012

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Ph.D., Economics, Yale University (2012, expected)
M.Phil., Economics, Yale University (2009)

M.A., Economics, Yale University (2007)
B.S. (*with high honors*), Mathematics add. major Economics, Michigan State University (2006)

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Carl Arvid Anderson Fellowship, Cowles Foundation (2011-2012)
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Doctoral Fellowship, Yale University (2006-2011)
Summer Fellowship, Yale University (2007, 2008)
Edward A. and Eleanor B. Carlin Award, Outstanding Senior in Economics, Department of Economics, Michigan State University (2006)
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Financial Markets, Spring 2011, Spring 2009
Introduction to Microeconomics, Fall 2010
Intermediate Microeconomics, Fall 2009
Econometrics and Data Analysis, Fall 2008

Working Papers:

"Estimation of Hazard Models with Dependence Across Observations" (Job Market Paper)

"Regime Changing Lévy Processes: Approximation of Financial Crisis Dynamics"

"Semi-Nonparametric Estimation of Multidimensional Lévy Processes"

Conference Presentations:

SMU-ESSEC Symposium on Empirical Finance & Financial Econometrics, June (2011)

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Econometric Theory
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Dissertation Abstract

The effect of financial crises on asset prices and wider economic activity is of considerable interest, impacting almost all economic decision making. Recent history shows that failing to account adequately for the possibility of significant financial stress can threaten the solvency of major institutions, including governments. Given that large financial crises are relatively rare events, an important consideration for empirical work is the limited available data. Another aspect of the data is dependence. Covariates often have correlated movements in response to economic downturns. Negative macroeconomic outcomes can be precipitated by problems in the financial sector. With these issues in mind, this dissertation develops tools for estimating economic and financial models that involve crisis events.

The first chapter addresses hazard estimation of random economic events assuming various types of dependence across observations. The methods are designed to examine the impact that different macroeconomic and financial conditions have on hazard rates. The models allow for common macroeconomic covariates, both observed and unobserved, to impact hazard rates of all observations. These covariates drive correlation in default around crisis periods. Asymptotic results are derived allowing for the resulting dependencies. The unobserved macro variable in the model is a global latent risk factor. This component improves model fit and forecasting accuracy.

The second and third chapters in this dissertation are related. Their goal is to characterize periods of financial crisis where complicated dynamics appear in time series. The second chapter considers estimation of a best approximation for financial time series using regime changes. These regimes involve Lévy processes and estimation determines the number and

position of the regime shifts. The third chapter derives flexible estimates of multidimensional Lévy processes. The approach can be used to characterize observed time series between regime shifts and allows for changing dependence between related variables across regimes. This replicates important features in crisis data.

I. Estimation of Hazard Models with Dependence Across Observations: Correlation, Frailty and Contagion (Job Market Paper)

Chapter 1 develops tools for examining correlated random economic events. Examples include unemployment spells, mortgage default and corporate default. Events are modeled as random times by specifying a hazard determined by stochastic covariates. Dependence across observations manifests in three ways. First, covariate processes that determine the hazard rate may be correlated across observations. This type of dependence is present if hazard rates depend on macroeconomic variables such as the 3-month treasury rate or unemployment rate. Second, contagion may be present. One default may directly increase the probability of another. Finally, a global unobserved risk factor can influence default in all observations. This latent factor is referred to as frailty.

I derive nonparametric and semi-nonparametric estimates of the underlying hazards in the presence of the above mentioned types of dependence. When there is dependence in the underlying covariates, a kernel estimation approach is developed to estimate the underlying hazard function. Asymptotic results hold in the presence of macroeconomic covariates. In a second model, I allow for contagion and frailty in addition to dependence between covariates across observations. For this model, a semi-nonparametric likelihood estimate is developed. Contagion is defined through a covariate whose value depends on other defaults. The effect of covariates on the hazard rate is consistently estimated, including the covariates that constitute contagion. The global latent risk factor comprising frailty follows a diffusion and its path is consistently estimated. This path characterizes the process and can be used in forecasting. In an empirical application, the methods are used to estimate hazard rates of corporate default.

II. Regime Changing Lévy Processes: Approximation of Financial Crisis Dynamics

Conventional time series models have struggled to characterize observed prices during financial crises. Financial prices, such as the S&P 500, experience movements that are difficult to capture with even the most complex models in use. One approach has been to add additional components to existing models in order to achieve the uncommon dynamics. But this approach suffers from data limitations - there are simply not enough financial crises to reasonably estimate the proposed extensions.

The issue with standard models is that they are inherently dynamic. Their specification is such that an estimate of the model describes how prices will propagate under all situations. Because of this, data must be observed over many crises in order to characterize how prices move in a crisis situation. Instead of a dynamic model, I focus on historical description and estimate a regime changing model. The regimes are not assumed to be randomly determined. The issue of limited data is significantly alleviated by this assumption.

The proposed model is assumed to follow simple stochastic processes over relatively short periods of time. When the period is over, the regime changes to another simple model. Within regimes, the time series follows a Lévy process, thereby encompassing a large class of

semimartingales. Most of the no arbitrage arguments used in finance require underlying prices to be semimartingales. Accordingly, Lévy processes are a natural choice for approximations. Lévy processes can produce a wide range of skewness, kurtosis and other distributional aspects. This flexibility allows complicated dynamics to be well approximated by Lévy processes and regime changing.

When the underlying process is a semimartingale, the estimation methods converge to the regime changing Lévy process that best approximates the underlying dynamics. The approach leads to a rigorous way of choosing the number of regimes and the position of their breaks. Once the proper number of breaks and break dates are estimated from the data, the entire dynamics of the regimes between these dates can be estimated with other methods (see chapter 3). Although we do not believe the underlying process strictly follows a Lévy process between breaks, a good approximation is achieved. Once the regimes are estimated, their characteristics and sequencing can be compared with theoretical explanations of the financial crisis, including comparison with discrete time general equilibrium models.

III. Semi-nonparametric Estimation of Multidimensional Lévy Processes

The third chapter in this dissertation is a technical note on semi-nonparametric estimation of Lévy processes. Sieve estimation is used as a building block to semi-nonparametric estimation of multidimensional Lévy processes. Lévy copulas are used to model dependence between one-dimensional Lévy processes. The approach uses empirical characteristic functions.

The ability to characterize multidimensional Lévy processes is useful for the notion of approximation developed in the second chapter of this dissertation. In most situations, we are concerned about several financial series and their interdependence. Using the methods of chapter 2, it is possible to incorporate these time series into the break date estimation. Then, multidimensional Lévy processes characterizing several related time series are used to approximate the dynamics between regime changes.