

# Research Statement

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## Overview

I am a macroeconomist focused on the problems related to financial intermediation and time-inconsistent behavior. The typical research questions I am interested in concern the nature of frictions in the allocation of credit. Why do governments struggle at times to borrow from international financial markets despite having the power to tax their citizens? Why has the banking sector been in retreat over the past decade, and why do corporations increasingly borrow from unregulated creditors? How can the student loans system be designed efficiently to ensure that talented individuals can afford and are willing to attend college?

The research I have conducted so far is broad both on the *extensive* and on the *intensive* margin. On the extensive margin, my papers span a wide variety of topics, such as sovereign debt and default, bank regulation and firm financing, optimal tax system design, as well as the pricing of financial products. On the intensive margin, my research uses a rich methodological toolbox, including calibrated quantitative macroeconomic models (with representative and heterogeneous agents), the mechanism design approach with incentive compatibility constraints, and causal econometric inference with microdata. In what follows, I describe these projects, grouped by general research agendas, in more detail.

## Sovereign debt and default

The largest body of my research has been devoted to studying the mechanics of sovereign default crises. My interest in this topic started with the European Debt Crisis of 2010-2012 which presented economists with a form of paradigm shift, proving that advanced countries are not immune to such disruptive events.

“**Learning about Debt Crises**” (AEJ: Macro, [5]) seeks to answer a long-standing question of why many sovereign debt crises seem to be weakly correlated with economic fundamentals (and hence difficult to forecast or protect against). A motivating observation is that the timing of the European Debt Crisis was different from many of the previous debt crises in emerging market countries. Specifically, the level of stress in the European government bond markets was low during the initial shocks of the Great Recession in 2008-2009, and increased significantly only starting from 2010. This paper argues that information frictions may have played a role, and supports this argument with evidence from real-time GDP forecast errors. Early on, all leading forecasting institutions remained fairly optimistic about the prospects of the European economic recovery from the recession. As the recovery did not materialize, the long-term forecasts became more pessimistic and that is also when the peripheral countries experienced a surge in borrowing costs. A new model of sovereign debt is then proposed that incorporates uncertainty and learning about an underlying disaster risk. Agents observe the adverse shocks but are initially skeptical about a possibility of a new Great Depression that could bring about a wave of sovereign defaults among advanced countries. As a result, as the

main model experiment shows, interest rate spreads can remain essentially at zero and explode with a lag that matches the sharp change in the belief about an underlying growth regime.

The above paper also highlighted an important puzzle in the literature – modern quantitative models of sovereign default (with long-term debt) struggle to replicate the high *volatility* of interest rate spreads that we observe in the data. Protracted crises are difficult to generate because the government in such models reduces its debt sharply at the first sign of bad news. The above paper presented a resolution to this issue that is specific to the European episode, but a question remains: can we think of a more general approach of bringing the standard model closer to the data?

**“Borrowing into Debt Crises”** (Quantitative Economics, [6]) proposes such an approach based on the observation that in reality governments face considerable obstacles in adjusting their expenditure and debt. The paper introduces a model of government good production which uses public employment and other variable expenses as inputs. The inputs have varying degrees of downward rigidity which means that it is costly to reduce them. Facing an adverse income shock, the government borrows to smooth out the reduction in public employment, which results in increasing debt and higher spread. The rigidity is quantified using the OECD government accounts data and results in two important findings. Qualitatively, the typical government in the model tends to increase its debt ratio at the height of the debt crisis. Quantitatively, the rigidity explains about 70% of the missing bond spread volatility relative to a standard model using the data for Mexico, a frequent sovereign defaulter among emerging market countries.

Another long-standing topic in sovereign default research concerns the risky borrowers’ choice of government debt maturity. **“The Ultralong Sovereign Default Risk”** (Working paper, [4]) is motivated by the observation that many governments, including frequent defaulters, have recently issued debt at the long end of the yield curve, most notably 100-year bonds. Two natural questions can be asked: why have such bonds emerged only so recently, and why are investors willing to buy them despite a long history of defaults in countries such as Mexico? The paper constructs a model that can answer these questions. First, by assuming that the risk-free interest rate follows a stochastic process (rather than being a fixed parameter as is standard in the literature), it shows that impatient borrowers choose to extend the maturity of their debt to hedge against future interest rate hikes. Because shocks to the risk-free rate tend to be highly persistent, the government needs an “ultralong” debt instrument such as century bonds to achieve the desired level of insurance. Moreover, in the presence of default risk, this insurance is disproportionately valuable precisely in the low current interest rate states (which can be associated with the recent decade when the ultralong debt emerged). Second, the model can be used to analyze the observed spreads on 100-year bonds. It turns out the model calibrated to Mexico’s frequent default history comes quite close at matching the spreads in the data. This implies that investors who buy such securities have priced the historical risks fully and do not bet on Mexico becoming a more reliable borrower in the next century.

A particularly contentious aspect of the academic debate surrounding most of the prominent debt crises is whether the observed spikes in the interest rates on government bonds are self-

fulfilling. In such a scenario, investors who expect that the government may be reluctant to service its debt obligations may demand a higher compensation for risk; yet this increase in borrowing costs is precisely what pushes the government into default, hence confirming the investors' initial belief. This idea has long appealed to researchers who over time have developed theoretical mechanisms to operationalize it. However, the quantitative relevance of such models has been elusive because of the restrictive assumptions they impose, for example about the nature of the stochastic process driving the country's output. **“Multiplicity in Sovereign Default Models: Calvo Meets Cole-Kehoe”** (Working Paper, [1]) constructs a simple model to show that belief-driven debt crises are possible and quantitatively relevant even in the *absence of income shocks*. The key to this result is an interaction between interest rate multiplicity and rollover risk. We show that if investors believe a rollover crisis is possible (i.e. government's inability to roll over any debt due to the markets' fear of a looming default) then there may exist multiple interest rates supporting the same level of debt obligation. Yet, the existence of such a multiplicity, combined with a risk of exogenous switching between the overlapping interest rates, is precisely what justifies the occurrence of rollover crises.

## **Bank regulation and firm financing**

My most recent research agenda has focused on studying the implications of Basel III, the most significant set of changes to bank regulation to date, adopted globally in the aftermath of the Financial Crisis of 2008. The following papers are based on a micro dataset of matched firm-lender credit accounts in South Korea which we have acquired jointly with my co-authors from a corporate credit bureau in that country. This dataset has allowed us to investigate with a high degree of precision the impact of changes to bank regulation on the landscape of financial intermediation.

The first paper, **“Capital Regulation and Shadow Finance: A Quantitative Analysis”** (Revised and Resubmitted to the Review of Economic Studies, [3]), is motivated by an observation from our dataset that the introduction of Basel III in Korea coincided with a 25% decline in corporate lending by regulated banks, and an increase of similar magnitude in lending by non-bank financial institutions (which are referred to as shadow lenders). The natural question that arises is: to what extent did the reform cause these changes, and how? The paper answers these questions using both empirical and theoretical tools. First, it exploits the rich structure of the data, and a quasi-experimental nature of the reform implementation in Korea, to estimate the *elasticity of regulated bank lending with respect to the capital requirement*, as well as the spillover effect of the reform on shadow lending. It finds robust and significant (economically and statistically) estimates for both measures which (on the aggregate level) indicate that Basel III can account for most of the observed decrease in regulated bank lending, and about three quarters of the increase in shadow lending. But through what channel does capital regulation affect lending? This question is especially relevant for understanding the behavior of shadow creditors who are not directly affected by the change in regulation. To answer this question the paper constructs a quantitative model with heterogeneous banks and firms. It shows that regulated banks respond to higher capital requirements directly by cutting credit supply and building up equity to avoid the penalties related to non-compliance. On the other hand, shadow lenders are not directly impacted by the reform, but still respond

to it through the general equilibrium adjustment of interest rates. By combining the empirical microeconomic analysis with the quantitative macroeconomic modeling, the paper bridges two separate methodological approaches from the literature and arrives at essentially the same estimates of the reform’s effects. These results are important for understanding the unintended consequences of the latest global change in bank regulation, and will hopefully inform any future changes to the Basel system.

While the first paper ([3]) has focused on the supply of credit, the second one, “**Intangible Capital and Shadow Financing**” (Working paper, [2]), investigates the recent trends in corporate financial intermediation on the demand side. The natural question to ask is: what types of firms are increasingly borrowing from non-bank lenders as opposed to regulated banks, and why? By combining the aforementioned dataset of matched firm-lender credit accounts with information on firm balance sheets, this paper shows that borrowers who rely on shadow financing tend to be firms who disproportionately rely on *intangible capital* in their production. Examples of intangible assets include knowledge accumulated from research and development, software, patents and human capital of employees. Furthermore, the disparity in shadow financing widens in years 2013-2018, a period of credit tightening related to the Basel III implementation in Korea. To establish a formal link between these trends, the paper builds a model of heterogeneous firms with two sources of financing: shadow and traditional bank, and assumes collateral constraints for the latter. Higher collateral requirement drives intangible-intensive firms away from bank borrowing and results in the rise of shadow credit, just as we observe in the data. The framework is then used to conduct experiments related to various policy proposals. In particular, it quantifies the potential efficiency costs of suppressing the rise of shadow financing (with the goal of enhancing financial stability), as well as the potential benefits of enabling regulated banks to collateralize some intangible assets (mimicking the latest policy proposals in Korea).

## Optimal contracting with time-inconsistent behavior

Another area of my research concerns optimal contracting with time-inconsistent behavior. “**Efficient Consolidation of Incentives for Education and Retirement Savings**” (AEJ: Macro, [8]) revisits a classic question in public finance: how to insure agents against risk in lifetime income? The latest literature on this topic has focused on the large observed income differences between college and non-college graduates, and proposed a design of tax instruments to help individuals mitigate the risk involved in education investments. At the same time, however, policymakers have been concerned that workers do not save enough for retirement, even college-educated individuals with high incomes. This puts the social security system under stress and may lead to higher distortionary taxation in the future. A central insight of this paper is that, with present-biased agents, optimal policy may be designed to provide incentives for risky educational investments and for retirement savings *at the same time*. Specifically, it shows that optimal tax distortions vary with education status by disproportionately subsidizing the retirement savings of college graduates. Such a tax system can be implemented using income-contingent student loans and existing retirement policies, augmented by a new tax instrument that subsidizes retirement savings for college graduates. The instrument mimics the latest policy proposals under debate in US Congress that would allow

employers to offer 401(k) matching contributions proportional to student loans repayment. By building a realistically calibrated quantitative model, the paper offers a framework to measure the potential welfare benefits of introducing such an instrument.

**“Commitment versus Flexibility and Sticky Prices: Evidence from Life Insurance”** (Review of Economic Dynamics, [7]) turns to an optimal pricing problem of a time-inconsistent firm. The motivating observation is that prices of certain long-term contracts tend to be rigid over time. This is particularly stark in the case of life insurance premiums which on average remain fixed for over three years even though the marginal cost of underwriting insurance fluctuates daily (as it primarily depends on interest rates). The key insight of the paper is that such a price rigidity may arise endogenously as an optimal solution to the firm’s time inconsistency problem. Because switching between long-term contracts entails significant transaction costs for consumers (such as search costs as well as, in the case of life insurance, the risk of health reclassification), the service provider may be tempted to take advantage of its held-up consumers by raising prices. To attract them ex-ante, the insurer must then design a pricing scheme that will discourage its future self from giving in to the temptation. The paper solves for an optimal contract which takes the form of a simple cutoff rule: premiums are rigid for cost realizations smaller than the threshold, while adjustments must be large and are only possible when cost realizations exceed it. While this result largely fits in a growing “commitment vs flexibility” literature, it is the first one to be quantified in a calibrated model. The paper shows that the predicted premium rigidity is quantitatively significant and matches several patterns of the data in the cross-section and over time.

## Current Research In Progress

My latest work-in-progress includes research projects that broadly fit each of the three research agendas described above. In what follows, I briefly introduce these new projects.

**International macroeconomics** My latest work goes beyond sovereign debt flows and studies the joint dynamics of international capital and trade flows in a frictional world. Under a tentative title of “Trade Costs and Financial Frictions: A Horse Race” (joint with Hyunju Lee), this paper seeks to understand what drives globalization and de-globalization: trade costs or financial frictions? In order to answer this question, we build a model that explicitly accounts for both international gross trade flows and gross capital flows. Using the information comprised in the overall *volume* of flows (rather than their net balance), the model can be used to estimate the underlying time series of trade costs and financial frictions, and to quantify the joint dynamics between the two. It is important to understand the mechanics of international goods markets and capital markets jointly, as frictions in one of the markets may spill over to the other market. The paper studies several periods of recent economic history: a globalization trend preceding the Great Recession, the simultaneous collapse in both trade and capital flows during the Great Recession, as well as the nascent period of de-globalization that followed it.

**Bank regulation** It is important to point out that the two aforementioned papers ([2] and [3]) are purely positive in nature and do not contrast the quantified costs of bank regulation against any benefits that it provides. Going forward, I am working on a new paper, tentatively

titled “Optimal Capital Regulation: Micro Evidence and Macro Implications” (joint with Hyunju Lee), that uses the findings from this pipeline to revisit the question of optimal bank capital requirements. Doing so requires trading off the extent of the reallocation in credit markets induced by the reform (measured by the estimated elasticity of credit supply with respect to the capital requirement) with the benefits of potentially improved financial stability that more capitalized banks bring about (net of the potential instability brought about by shadow lenders). We are currently developing a model that embeds such a trade-off in a reduced form and is informed by the empirical findings from our previous two papers.

**Optimal contracting** An open question that arises from [8] and other related studies is how to optimally design incentives for *intergenerational* educational investment. Such incentives are present in the tax code of various countries (for example, 529 savings plans in the United States) but it is unclear how their implementation compares to a constrained efficient allocation that can be achieved with a mechanism design approach. In a new paper under development, tentatively titled “Optimal Incentives for Dynastic Educational Investments” (joint with Pei Cheng Yu), we construct a quantitative overlapping generations model in which parents save to invest in their children’s education. A planner is tasked with incentivizing older generations to provide efficient work effort and invest in the education of their children despite the risks involved in such investments (concerning both the uncertainty around the children’s innate ability type and the eventual outcomes of their college education).

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