

Bank Regulation, Macroeconomic Management, and Monetary Incentives in OECD Economies

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Abstract

This paper argues that banks operating in systems where monetary and regulatory authority are unified in a central bank expect and receive preferential monetary policies, and so act less prudently than do banks in non-unified systems. These incentives arise when the natural tension between counter-cyclical monetary policy and pro-cyclical regulatory policy is resolved in ways that benefit the banking sector. I test the hypothesis using time series cross-sectional and multilevel models that exploit two types of policy interventions – accession to the European monetary union, and reassignment of domestic regulatory authority – within OECD countries from 1992-2007, the period during which the international Basel accords harmonized key aspects of national regulatory standards. The results strongly support the claim that there is a relationship between prudential behaviors of banks and the location of regulatory and monetary authority.¹

Policy makers must choose whether to give regulatory authority over the banking sector to central banks or to a separate agency. This decision is important: financial crises have grown in frequency and severity since the collapse of the Bretton Woods system (Bordo and Eichengreen 1999), and the recent crisis that originated in the subprime mortgage sector in the United States is “likely to be judged the most virulent global financial crisis ever” (Greenspan 2010). The median increase in public debt from financial crises is about 24% of GDP, and the median output loss from recent crises is about 25% of GDP (Laeven and Valencia 2010). Policy makers operating in this economic environment must maximize the stability of their banking sectors without choking off economic growth. Failure to achieve one goal or the other has an adverse effect on politicians’ ability to retain office.²

Recent research has highlighted this tension between macroeconomic and regulatory goals. For example, Copelovitch and Singer (2008, 664) claim that “the presence of regulatory responsibility in the central bank’s institutional mandate introduces an important bias into its monetary policymaking calculus”. Because their mandate includes both monetary regulatory aims, they argue, regulatory central banks face tradeoffs that nonregulatory central banks do not. Faced with this choice, they find that regulatory central banks will pursue policies that emphasize bank stability over price stability by tolerating higher inflation, which is indicative of expansionary monetary policies associated with greater bank profitability. One implication from their analysis is that while regulatory central banks trade off some macroeconomic performance by allowing higher inflation, the banking system will be more secure as a result. They conclude by asking, “Are central banks more stringent bank regulators than stand-alone regulatory agencies? This question is beyond the scope of the literature on the political economy of monetary policy, but nonetheless important for the expanding literature on comparative financial regulation” (Copelovitch and Singer 2008, 678).

This paper recasts that question, shifting focus to the ways in which institutional arrangements impact the behavior of private sector actors. I argue that the same policymaking bias

that leads regulatory central banks to pursue more bank-friendly policies than nonregulatory central banks also affects the incentives banks face. Specifically, I claim that the fact that regulatory central banks privilege the needs of the banking sector more than nonregulatory central banks alters the incentives facing banks operating in systems where monetary and regulatory authority are unified. If banks expect preferential policies from regulatory central banks, then they will take fewer steps to insure themselves against default risk. So long as banks' risk-taking activities stay above the minimum national and international requirements, regulators may find it difficult to prevent this behavior.

Following Copelovitch and Singer, I further argue that this dynamic is conditional upon the government's choice of exchange rate regime. Countries with open capital accounts only maintain monetary independence when exchange rates are allowed to float. Under a fixed exchange rate regime, central banks have less flexibility in pursuing monetary policies, and are therefore less able to privilege the needs of the banking sector. I extend Copelovitch and Singer's finding from the public to the private sector, and argue that banks operating in these sectors should not anticipate favorable monetary policies and should adjust their risk-taking activities accordingly.

By focusing on how institutional mandates affect outcomes, this paper contributes to several theoretical literatures. First, the previous political economy literature on banking regulation has focused on how domestic political institutions affect the creation of regulatory standards, or on principal-agent dynamics between regulatory institutions and governments, but has not examined how the location of regulatory authority impacts on private sector behaviors.³ Discussion of the effects of regulations and the location of regulatory authority on bank behaviors has been mostly implicit, if not absent entirely. By examining how the location of regulatory authority affects the incentive structure of banks, we may gain greater insight on the tradeoffs that policy makers face and the ways in which resolving these tradeoffs differently generates different outcomes.

Second, by focusing on conflicting mandates associated with the unification of macroe-

conomic and regulatory authority, this analysis also contributes to the literature on central banking. Specifically, it qualifies the claim that independent central banks can correct time-inconsistency problems by restricting the ability of policy makers to trade off long-term economic goals for short-term political ends.⁴ If granting regulatory authority to central banks alters private incentives in a way that leads to less prudent behavior in the financial sector, then those systems may be more susceptible in the long run to more frequent or more severe financial crises and the enormous resulting costs.⁵

Third, it answers several calls from political economists in response to the subprime crisis. Some suggest that a greater focus should be placed on the diversity in domestic political arrangements as they relate to the regulatory environment firms operate within, and in particular on “the incentives that national regulators and policymakers face” (Helleiner and Pagliari 2011, 194).⁶ Leblang and Pandya (2009) argue that scholars should pay more attention to the ways in which policy choices in one area – e.g. macroeconomic management – relate to policy choices in other areas – e.g. financial regulation – as well as on the behavior of micro-level units such as firms. Others argue that in general cross-national and intertemporal variations in domestic regulations are understudied by political economists, and in particular that the “relationship between regulators and regulated firms” and the conduct of “regulators themselves” are in need of more attention from scholars (Mosley and Singer 2009, 420-421). This paper seeks to advance these goals.

The article proceeds as follows: in the next section I discuss how the tension between macroeconomic and regulatory goals provides reasons for some states to unify authority in a single institution, and how this alters incentives in the banking sector. This discussion leads to specific hypotheses about the effects of the location of regulatory authority on bank behaviors. In the following section I test those hypotheses empirically using ordinary least squares and multilevel regression models of banking sector behaviors among OECD countries from 1992-2007, the period during which the international Basel accords significantly harmonized key regulatory standards across states. Specifically, I focus on the effect of two

types of interventions into the time series: accession to the European economic and monetary union (EMU), and a series of institutional shifts that followed episodes of financial instability during the 1990s. I then discuss the results of these tests, and conclude with a discussion of policy implications and possible extensions.

Policy Tension and Banks' Incentives

The role of central banks within an economy varies cross-nationally. Generally, central banks are tasked with managing macroeconomies by controlling the money supply through interest rate adjustments and financial transactions. This affects the cost of funds available to banks, which then affects the cost of funds available to businesses and consumers. Since monetary policy works on the macroeconomy indirectly, with banks as intermediaries between the central bank and the real economy, a healthy banking sector is a prerequisite for central banks to be effective in promoting stable economic growth (Schumpeter 1911; King and Levine 1993). Some central banks, but not all, are also required to regulate the activities of domestic banks in such a way as to promote stability in financial markets.

By unifying regulatory authority and monetary authority in a central bank, policy makers may intend to address two policy goals – strong macroeconomic performance and financial stability – with one stroke. Given its position at the center of the financial system, a central bank has the necessary technical capacity to regulate the banking sector in ways that improve economic performance. But macroeconomic and regulatory policy goals are in tension (Goodhart and Shoenmaker 1993). Standard monetary policy is counter-cyclical: central banks expand the money supply when an economy is sluggish, and restrict money growth when an economy begins to over-heat and inflationary pressures mount. Prudential regulatory policies such as minimum capital adequacy ratios (*CAR*) – which require banks to maintain a minimum level of capital as protection against default risk in their asset portfolios – are pro-cyclical. A slowdown in economic activity leads to an increase in defaults, which

adversely affects bank earnings and erodes its capital base. In this environment banks must take action to boost their capital stock or risk insolvency and liquidation. Banks can improve their capital ratios by issuing new equity, selling assets, borrowing from the government, and scaling back issuance of new loans. In other words, banks protect against insolvency by decreasing normal banking activities. Such actions can lead to a self-perpetuating pro-cyclical pattern, whereby banks decrease lending, which further depresses an economy, leading to more defaults and a corresponding decline in bank capital. A study by Federal Reserve economists put it thus: “So long as bank rating systems are responsive to changes in borrower default risk, capital requirements... will tend to increase as an economy falls into recession and fall as an economy enters an expansion. To the extent that banks curtail (expand) lending in response, recessions (expansions) will be amplified” (Gordy and Howells 2006, 395). Thus, by restricting bank activity when it is most needed to spur economic activity, pro-cyclical regulatory requirements present an obstacle for policy makers in managing their national economies.

The natural tension between counter-cyclical macroeconomic and pro-cyclical regulatory goals is at the core of contemporary domestic and international regulatory reform discussions. In light of the subprime crisis that spread through the international financial system, the Bank for International Settlements (BIS) issued a report on “Central bank governance and financial stability” (Bank for International Settlements 2011). Perhaps unsurprisingly the BIS, which calls itself a “bank for central banks”, recommended a strong role for central banks in financial regulation.⁷ They also acknowledged the need to balance between macroeconomic and regulatory goals: “Most policy instruments relevant respectively to monetary policy and financial stability policy cannot be tightly focused so as to isolate their impact. For example, interest rates influence both expenditures and financial behavior. And prudential regulations also influence expenditures – through affecting the availability and pricing of credit – as well as financial behavior” (Bank for International Settlements 2011, 43). The BIS concluded that the best way to resolve these tradeoffs was to insulate regulators from political pressures and

allow them to conduct policy technocratically.

While perhaps desirable to some, this conclusion ignores the fact that regulators are political actors. Regulators are in a principal-agent relationship with governments; they must maintain financial stability or risk the removal of their authority (Singer 2007). This does not imply that all regulators are in the *same* principal-agent relationship with governments, however. When regulatory authority is located separately from monetary authority, a regulator can single-mindedly pursue its goal of financial stability. When regulatory and monetary authority are unified, the need to balance both goals incentivizes central banks to pursue more bank-friendly policies than they otherwise would. This may come in the form of emergency liquidity support or as a general predilection towards expansionary monetary policy, which allows banks to anticipate future profits and more easily absorb losses.

When central banks are also regulators, they may resist tightening monetary policy when that would place pressures on a struggling banking sector. Indeed, Goodhart and Schoemaker (1995) identify precisely this conflict of interest, and the BIS acknowledge the tendency. As banks observe this behavior, they should adjust their risk-taking preferences accordingly. There is a growing literature focused on how market actors respond to regulatory arrangements. Diamond and Rajan (2011) develop a model in which patterns of monetary intervention affects the behavior of banks. Several other researchers have empirically demonstrated that banks regularly “over-comply” with regulations, by maintaining higher capital ratios than required by statute, and that market discipline and government regulations are complements rather than substitutes (Bernauer and Koubi 2006; Brewer III, Kaufman, and Wall 2008).⁸ This leads to an equilibrium where banking systems have generally been much better capitalized than required by the Basel accords or other statutory requirements. However, not all banking systems over-comply to the same extent. The level of over-compliance may be tied to the expectation that banks have of the path of future monetary policy, and Stein (2012) argues that monetary policy can be used as a financial stability mechanism by altering the incentive structure facing banks.

If market participants expect favorable monetary policies from regulatory central banks, then banks may receive less discipline from markets and therefore over-comply less. At the same time, since statutory capital requirements have been harmonized across countries, the discretion of regulators to impose regulations stronger than the minimum standard is often limited, particularly when such demands would negatively impact competitiveness (Singer 2004). In expectation of favorable monetary policies banks have incentives to behave more riskily, markets have incentives to discipline less, and regulators have incentives to allow this behavior so long as it occurs above the minimum statutory requirements. The result can be a less stable financial system (Demirguc-Kunt, Detragiache, and Merrouche 2010; Berger and Bouwman 2011).

This logic can be made clear by considering how different institutional mandates condition the principal-agent relationship facing regulators. During economic slowdowns all central banks should stimulate the economy via expansionary monetary policy, thus making it more attractive for banks to lend to businesses and consumers. The desired result is an increase in economic activity sufficiently large to restore growth, close any output gap, and prevent deflation. Once the downturn has subsided, central banks with a single mandate to maintain price stability are likely to raise interest rates in order to limit inflationary pressures. Central banks with a dual mandate to manage the macroeconomy and regulate the banking sector will tend to pursue expansionary monetary policy for as long as it takes for the financial system to repair its balance sheets. In this way, regulatory central banks may alter their monetary policies to favor financial institutions. In fact, central bankers have explicitly made this argument when asking for regulatory authority. In a January 13, 2010 letter to Chairman Dodd and Ranking Member Shelby of the U.S. Senate Committee on Banking, Housing, and Urban Affairs, Federal Reserve Chairman Ben Bernanke wrote “Its supervisory activities provide the Federal Reserve information about the current state of the economy and the financial system that, particularly during periods of financial crisis, is valuable in aiding the Federal Reserve to determine the appropriate stance of monetary policy” (Bernanke 2010).

As a result, we observe looser monetary policy in countries where central banks regulate (Copelovitch and Singer 2008).⁹

The expectation of monetary support for distressed firms is distinct from any belief that the fiscal authorities will bail out firms. In times of crisis bankers cannot be sure whether they will receive government support through fiscal policy or whether they will be allowed to fail.¹⁰ Fiscal bailouts are politically unpopular, and politicians are often punished for committing public funds to financial firms (Keefer 2007). During the recent subprime financial crisis some American financial institutions were given access to special funding sources from the government and were allowed to off-load damaged parts of their balance sheets to the Treasury Department and Federal Reserve (e.g. Bank of America, JPMorgan Chase, Goldman Sachs, Citigroup) while others were forced into liquidation or closure (e.g. Bear Stearns, Lehman Brothers, Merrill Lynch, Washington Mutual). In Europe, bank liabilities were guaranteed by some governments (e.g. Ireland), but quite often the price was steep: nationalization, or a large equity stake.¹¹ *Ex ante* none of the banks could know which would be saved and which would not be, or on what terms, so gambling on generous fiscal support would be exceptionally risky.¹² There is no definitive evidence that banks in the recent crisis systematically made that gamble, likely because the stakes were so high and the downside risk if they were wrong was enormous.

Regulatory central banks cannot make a credible commitment to withhold monetary policies favorable to banks, however. If they preside over a financial collapse they risk the removal of their authority (Singer 2007). Therefore, they have reason to favor bank stability over price stability, and so pursue policies that benefit banks (Copelovitch and Singer 2008). As regulatory central banks respond to the incentives given them by institutional mandate in observable ways, the banking sector may respond by acting more riskily, with the understanding that regulatory central banks must privilege their interests or jeopardize their authority. Thus private sector incentives are affected by the mandates associated with institutional arrangements in a straightforward fashion.

In the United States, for example, even before the subprime financial crisis many worried that the “Greenspan put option” – in which Federal Reserve Chairman Alan Greenspan established a pattern of intervening in crises to support financial markets – encouraged financial firms to behave more riskily.¹³ Indeed, many believed that this arrangement encouraged moral hazard (Miller, Weller, and Zhang 2002). During Alan Greenspan’s tenure at the Federal Reserve, the bank built a reputation for being willing to provide liquidity to troubled firms during periods of instability, and for keeping interest rates low until the financial sector was able to recover. Under Greenspan, the Federal Reserve intervened following the 1987 stock market crash, the Mexican peso crisis, the Asian financial crisis, the collapse of Long-Term Capital Management, and the collapse of the dot-com bubble. This repeated behavior led to an expectation that support from the Federal Reserve would be forthcoming in times of trouble, and investors began to price that support into their risk calculations (Roubini 2006; Goodhart 2008; Stiglitz 2010). As the dot-com bubble burst in 2000, chief investment officer of Deutsche Bank Ed Yardeni wrote in a company report, “Investors are worried about a hard landing. I am less concerned because I believe that the Fed is our friend” (quoted in Despeignes (2000)). During the subprime crisis, every major American investment bank not liquidated or sold converted their legal status to become bank holding companies, thus guaranteeing access to the Federal Reserve’s lending facilities in exchange for coming under the central bank’s regulatory orbit. The Federal Reserve responded by holding interest rates at or near zero from late 2008 until the time of this writing, and has paid interest on bank reserves during the same period. So while banks cannot rely on fiscal support from governments, they can expect regulatory central banks to offer monetary support.

Nonregulatory central banks do not face the same pressures. The European Central Bank (ECB), for example, does not regulate the European banking sector, and explicitly states that it will not serve as a lender of last resort for European banks (Walter and Bergheim 2008). In fact, under Article 123 of the Lisbon Treaty, it would be illegal for the ECB to

pursue some traditional lender of last resort functions. Support of the European banking system must come primarily from domestic governments, including domestic central banks.¹⁴

The same dynamic applies for non-monetary central banks, such as national central banks operating within the EMU. National central banks within the EMU do not control most of the tools of monetary policy, which are reserved for the ECB, but they do still maintain balance sheets. Many of them also serve as regulators of their domestic banking systems.¹⁵ According to European Union law, they – not the ECB – are the lenders of last resort for their domestic financial systems. When a central bank does not control monetary policy but does regulate, it can use its balance sheet to help distressed firms and is incentivized to do so. These tools are finite, however, so banks cannot expect unlimited liquidity support as they would from a central bank that controlled the printing press. Nor can they expect the overall stance of monetary policy to remain lax as the economy recovers, which would provide them with time to repair their balance sheets, because their domestic central does not have the tools to carry out this policy. Central banks that do not regulate may be hesitant to place the solvency of their institution at risk supporting firms for which they are not responsible. Therefore, their institutional mandate incentivizes them to provide some support to financial institutions, but that this support will be more limited than if they were responsible for the stability of the financial system.

This discussion leads to the central hypothesis of this paper: banks in systems where regulatory and monetary authority are unified in a central bank will protect themselves against risk less than banks in systems where authority is split. Because banks operating in unified systems expect and receive preferential policies from regulatory central banks, they act less prudently than they otherwise would. This arises from the relaxation of the tension between pro-cyclical regulatory policy and counter-cyclical monetary policy, and is thus distinct from the moral hazard that may arise from fiscal bailouts of systemically important, “too big to fail” financial institutions, but occurs for similar reasons. Fiscal bailouts of systemically-important financial institutions sometimes occur because policy makers have

strong incentives to avoid the immense economic devastation that follows financial crises. Monetary “bailouts” occur when regulatory central banks fear that a crisis will lead to the removal of their authority, which leads them to pursue more bank-friendly monetary policies than they otherwise would.

Data Analysis

To this point I have argued that banks will act less prudently in systems where monetary and regulatory authority are unified in a central bank because of the incentive structure inherent in those systems. In this section I describe a test of that hypothesis by examining the relationship between location of regulatory authority and bank behaviors in 28 OECD member countries from 1992-2007.¹⁶ Table 1 shows the location of regulatory and monetary authority for each country in the sample. To test the expected relationship, I exploit two types of policy interventions into the time series: the reassignment of regulatory authority in a number of countries, and relocation of monetary authority due to EMU accession, both around the turn of the millennium. In 1999-2000, five OECD countries transferred regulatory authority over their banking sectors.¹⁷ In all five cases regulatory authority was removed from central banks and given to a separate regulator. Twelve of the twenty-eight countries in the sample joined the EMU during the sample period. As part of EMU accession those states sacrificed monetary policy autonomy to the European Central Bank, which controls monetary policy in EMU countries but does not regulate banking sectors.¹⁸

The dependent variable is bank behavior, measured by the risk-weighted capital adequacy ratios (*CAR*) of banks. These data come from the Bureau van Dijk’s BankScope database, which contains firm-level data for over 29,000 financial firms. Of these, I limit my analysis to commercial banks and bank holding companies in the OECD.¹⁹ Because I am interested in how the location of regulatory authority affects banking systems at the national level, I collapsed the data on their means by country and year. Therefore, the unit of analysis

is yearly averages at the national level of firm-level *CAR*; this is a measure of the capital adequacy ratios of banking systems rather than any particular bank.

I focus on *CAR* because that is the most common prudential regulatory benchmark, and has been the focal point of the Basel accords since their 1992 implementation. Therefore, *CAR* presents a measure of the risk behaviors of banks that is broadly comparable across countries and time. *CAR* are simply the ratio of a bank's capital – comprised of tier 1 capital (including shareholder equity and disclosed reserves) and tier 2 capital (usually including undisclosed reserves and preferred stock) – to its assets, weighted according to the perceived risk in bank portfolios.²⁰ Therefore, $CAR = \frac{Capital}{RiskWeightedAssets}$. Less risky assets, such as cash or government bonds, require less capital to protect against potential default. More risky assets, such as unsecured loans, require larger capital cushions. Because of the risk-weighting mechanism there are two ways for banks to improve this ratio: by increasing the numerator (i.e. boosting the capital stock) or by reducing the denominator (i.e. holding fewer risky assets). An example of the former is issuing more stock; an example of the latter is increasing cash holdings. Table 2 shows common risk-weights for different types of assets, as defined by the Basel accord.²¹ Tier 1 capital, sometimes called “core” capital, is more broadly comparable across countries and time than tier 2 capital, which has different definitions in different jurisdictions. Therefore, I isolate tier 1 *CAR* in this analysis.²²

Because I wish to test how banks adjust their behaviors under different institutional arrangements, I focus on two primary explanatory variables: whether a national central bank regulates the domestic banking sector, and whether it controls monetary policy. The first of these is the location of bank regulatory authority, *Regulator*, which is a dichotomous variable equal to one if a central bank possesses some or all bank regulatory authority and zero if it does not.²³ A description of which states have regulatory central banks and which do not is in Table 1, and comes from the World Bank *Bank Regulation and Supervision* survey data set.²⁴ Where survey information was incomplete I supplemented the measure with data from national regulatory authorities and from Copelovitch and Singer (2008).

Because I expect banks operating in states with a regulatory central bank to behave more riskily, I expect *Regulator* to have a negative relationship with *CAR*.

I also include a dichotomous variable indicating whether a country is a member of the European economic and monetary union that has implemented all three stages of integration, including formal adoption of the euro as the national currency (*EMU*). This presents a measurement challenge: how should *EMU* countries with regulatory central banks be coded? Central banks that do not control monetary policy do not face the same policy tradeoff as those that do: regulatory central banks in *EMU* countries can make credible commitments to not use monetary policy to aid banks during downturns because they do not control the levers of monetary policy. However simply creating a new variable that combines location of regulatory authority and *EMU* membership risks conflating two very different effects. Regulatory central banks in *EMU* countries may not control monetary policy, but they still maintain balance sheets, have the ability to extend some liquidity support to their domestic banking systems, and function as the lender of last resort for domestic financial firms (Walter and Bergheim 2008). Banks in *EMU* countries may expect more assistance when regulated by central banks than otherwise, but less than if that central bank had control over monetary policy. Therefore, I include a binary variable equal to zero for all country-years in which a state was not a member of the *EMU* and one for all country-years in which a state was a member of the *EMU*.²⁵ Because central banks in *EMU* states do not control monetary policy, banks cannot rely on them for preferential monetary policy, but may still rely on other mechanisms provided by lenders of last resort. As such, I expect a positive association between *EMU* and *CAR*.

Bank behaviors may be influenced by the choices governments make regarding elements of macroeconomic stability such as the exchange rate regime, as this may affect the central bank's ability to conduct monetary policy. Countries with open capital accounts and a fixed exchange rate do not possess monetary independence (Fleming 1962; Mundell 1963). The difficulty in including such a measure is that it is difficult to capture the dynamics of the

eurozone, which has a fixed exchange rate within the currency area but a floating rate with the rest of the world. Additionally, studies have shown the *de jure* exchange rate regimes often diverge from *de facto* exchange rate practices (Calvo and Reinhart 2002; Calvo and Mishkin 2003; Guisinger and Singer 2010). Therefore, rather than including a hard coding scheme indicating the *de jure* exchange rate regime, I include the measure of exchange rate stability (*ERS*) from Aizenman, Chinn, and Ito (2008). *ERS* is a continuous measure – bounded between zero (least stable) and one (most stable) – for each country’s exchange rate movement relative to a “base currency”.²⁶ In countries with fixed exchange rates and open capital accounts banks may not expect preferential monetary policies even from regulatory central banks, because the monetary authorities do not possess monetary freedom.

Copelovitch and Singer argue, and find, that the response of central banks to their policy mandate is conditioned by the exchange rate regime and the size of the domestic banking sector. Specifically, they find that regulatory central banks allow higher inflation under floating exchange rate regimes with large banking sectors. Therefore I also include a measure of *Banking Sector Size*, calculated as the sum of total assets (in millions) controlled by a national banking sector in each year. These data came from the same BankScope database as the firms’ capital ratios, and are the sum of the total assets of the firms in the database for each country-year. Additionally, I estimate all models both with and without a series of interaction terms. First, I interact *Regulator* and *EMU* to test whether the effect of regulatory location is conditioned by *EMU* membership. Second is a three-way interaction term including *Regulator*, *ERS*, and *Banking Sector Size* as well as all possible two-way interactions between all three variables as recommended by Brambor, Clark, and Golder (2006). If these interactions show a significant conditional relationship, then we should expect banks operating in large financial systems with less stable exchange rates to behave more riskily than banks operating in smaller financial systems with more stable exchange rates.

I include a measure of financial *Openness* – the “KAOPEN” composite index created from

the IMF's *Annual Reports on Exchange Arrangements and Exchange Restrictions* – from Aizenman, Chinn, and Ito (2008). The index has four components – capital account restrictions, presence of multiple exchange rates, current account restrictions, and requirements to surrender export proceeds – and ranges from zero to one, with higher values indicating greater financial openness. I include *Openness* because states may seek to protect domestic firms by limiting the amount of competition they face from foreign firms. Previous literature assumes that this type of profit-padding regulation will induce domestic banks to act more prudently than they would if they faced stronger competition (Rosenbluth and Schaap 2003). If this is true, then we should see a significant negative relationship between *Openness* and *CAR*, meaning that banks lower their capital adequacy ratios and take on more risk when faced with foreign competition. While I agree that banks facing more competition may take on more risk to stay competitive, I also expect banks protected from foreign competition to face fewer constraints from market discipline. So I expect a weakly negative relationship between *Openness* and *CAR*.

The devastating consequences of banking crises should also affect banks' *CAR*. These are infrequent events, occurring in only about 2% of country-year observations, but have profound effects on *CAR* by weakening the capital base of the banking sector. To account for the effects of banking crises, I include a dichotomous variable, *Bank Crisis*, indicating whether a country has suffered from a systemic banking crisis within the past three years, including the current period.²⁷ This variable comes from the IMF's *Financial Crisis Episodes* database, described by Laeven and Valencia (2008, 2010). There is a risk of conflating cause with effect, however; lower *CAR* leave banks more susceptible to crisis, but the occurrence of crisis will also deteriorate *CAR* by eroding a bank's capital base. Because I am trying to control for the effects of crises rather than explain them, I remain agnostic about the causal direction between *CAR* and *Bank Crisis*, but expect a significantly negative association between them.

The remaining economic controls are taken from the World Bank *World Development*

Indicators database. The most theoretically important of these is the logged *Inflation* rate (measured by GDP deflator), as this is the mechanism by which Copelovitch and Singer (2008) determine policies preferential to the banking sector. If *Inflation* is significantly correlated with *CAR* at a significantly high level, then we can conclude that bank behaviors are simply a response to central bank actions. If *Inflation* is not significantly correlated with *CAR* and *Regulator* and *EMU* are, this would provide evidence that there is an relationship between banks' behaviors and the institutional organization of monetary and regulatory authority that is distinct from the actual monetary policies pursued by central banks. Other macroeconomic controls include the logged GDP *Growth* rate, and *Current Account* balance as a percentage of GDP. I expect *Growth* to be positively correlated with *CAR*, meaning that I expect banks' capital adequacy ratios to deteriorate during economic downturns. Countries that run large, persistent current account deficits increase the risk of financial crises (Reinhart and Rogoff 2008), which should be negatively correlated with *CAR*, so I expect *Current Account* to be positively associated with *CAR*.

Model and Results

I estimate a variety of regression models to test the association between the independent variables on tier 1 *CAR*.²⁸ The primary models are ordinary least squares (OLS), which include fixed effects to control for the presence of large unit effects in the data,²⁹ and a temporal multilevel (MLM) specification where country-year observations are “seeded” within countries which are in turn seeded within years.³⁰

Table 3 shows the results from the regressions. Models 1 and 2 are OLS specifications, while models 3 and 4 take into account the multilevel structure of the data. Models 2 and 4 include interaction terms. The first thing to note is that, while the size, direction, and significance of the variables are largely stable across specifications, the inclusion of interaction terms does little to improve model fit. In the OLS specifications there is a slight increase in

R^2 , but not as much as we might expect from the inclusion of five additional parameters.³¹ In the MLM models the inclusion of interactions actually *decreases* model fit according to the Bayesian Information Criterion (BIC), which includes a penalty for the use of increased parameters to discourage “kitchen-sink” modeling.

None of the macroeconomic variables have a consistently significant effect on *CAR*, except for current account balance and experience with a recent banking crisis. Holding the other variables at their means, a one standard deviation increase in the current account balance (5.546 percentage points of GDP) is associated with a roughly 7.2% increase in *CAR*, while a recent banking crisis correlates with a 15-20% reduction in capital ratios. Capital account openness does not have a large or significant relationship with *CAR*, which may indicate that governments cannot easily induce prudence through “profit-padding” regulations as Rosenbluth and Schaap (2003) claim. Also notable is that inflation is not a significant nor substantively large predictor of capital ratios, indicating that banks’ risk-taking activities are not merely a direct response to monetary policy outcomes. Nor are banks sensitive to GDP growth rates or exchange rate stability in the non-interactive models.

In contrast, the models provide strong support for the hypothesis that banks alter their prudential behaviors in response to the monetary and regulatory institutional arrangements within states. In all models banking systems that are regulated by their central banks have significantly lower tier 1 *CAR* than those regulated by a separate agency. In models 1 and 3, the semi-elasticity of *Regulator* is 0.176-0.18, meaning that on average banking systems regulated by central banks have roughly 18% lower *CAR* than banking systems with a separate regulator, holding the other variables at their means. These effects are statistically significant at the 5% level, and are consistent with the central hypothesis of this paper. *EMU* membership also has a substantively and statistically impact on banks’ *CAR*. On average, and holding the other variables at their means, EMU membership increases *CAR* by roughly 12.5-13.3% in models 1 and 3. These estimates reach statistical significance at traditional levels, and provide support for the argument that banks behave more prudently

when national central banks do not control monetary policy.

The size of the domestic banking sector does have a statistically significant independent impact in model 1 and 3. Although the estimated parameter is small (coefficient of $4.61\text{e-}13$ in model 1, $4.40\text{e-}13$ in model 3), that is due to the scale of the variable. A one standard deviation increase ($1.2\text{e+}11$) in the total assets held by the domestic banking sector is correlated with a roughly 5.5% increase in tier 1 capital ratios relative to the mean ($1.58\text{e+}10$).

Interpretation of the models including interaction terms is more complicated, but supports the expectations from theory and is consistent with some of the prior findings by Copelovitch and Singer (2008). Figure 1 shows the marginal effect of *Regulator* on *CAR* in model 2 at different levels of exchange rate stability and different sizes of the domestic banking sector. The graph plots seven lines: the size of the assets held by the domestic banking sector at its minimum, at the 25th, 50th, 75th, 90th and 95th percentile, and at the maximum. The first five and last two lines are stacked nearly on top of each other, indicating that the effect of *Regulator* on *CAR* is not conditional on banking sector size except at very high levels, and these estimates do not reach statistical significance. But as expected, the relationship between *Regulator* and *CAR* is strongest in terms of substance and significance when the exchange rate is less stable, which is when the central bank has the most discretion over monetary policy. This relationship holds at all levels of banking sector size excepting the very largest. Figure 2 shows the marginal effect of *Regulator* for different values of *ERS*, and reinforces the pattern from the three-way plot: *Regulator* has significantly negative effect on tier 1 *CAR* when exchange rates are less stable.

In summary, the effects from the institutional variables of interest behave as expected. The fact that *Regulator* and *EMU* gain significance while *Inflation* does not suggests that in aggregate banks do not only respond to policy or the broader macroeconomic environment when making choices over their risk tolerance. In addition, they respond to the institutional set-up in the countries within which they operate. The effect is strongest when central banks have greater discretion over monetary policy, as indicated by both the interaction between

exchange rate stability and *Regulator* and the importance of *EMU* membership.

Conclusion

In this paper, I argue that the unification of monetary and regulatory authority has a profound effect on bank behaviors. Because of the counter-cyclical nature of monetary policy and the pro-cyclical nature of regulatory policy, central banks that also regulate the banking sector will often have to balance opposing policy goals. Previous research argues that regulatory central banks often resolve this tradeoff by pursuing more expansionary monetary policies – which favor the banking sector – than nonregulatory central banks (Copelovitch and Singer 2008). I extend the implication of this logic to the private sector, arguing that banks will respond to institutional organizations by acting less prudently when they expect preferential policies from their central bank. The results of statistical models analyzing capital adequacy ratios in OECD countries support this hypothesis. Specifically, I find that risk-weighted tier 1 capital adequacy ratios are higher when central banks do not possess regulatory authority over the banking sector. I also find that banking systems where monetary authority has been given to an outside agency, as in the member states of the European economic and monetary union, have higher capital-to-risk ratios. Both findings support the expectation that unifying monetary and regulatory authority in a single agency presents banks with a different set of incentives than if authority was split.

These results call into question the contention that central banks may be able to induce prudence from banks by enacting policies favorable to them. Rosenbluth and Schaap (2003) argue that this sort of “profit-padding” policy reduces the necessity of excessive risk-taking for profitability, and thus encourages banks to act less riskily. This analysis qualifies that claim. In fact, it establishes the possibility of the opposite case under some conditions: if banks expect preferential policies they may choose to act less prudently than they otherwise would. However, the statistical insignificance of the capital account openness variable sug-

gests that at least some regulations that protect profits by restricting competition has an indeterminate effect. Further research is needed to disentangle this relationship.

These findings have several important implications for policy. First, states often re-examine their regulatory structures following financial crises. Some have argued that locating regulatory authority in a central bank can eliminate institutional rivalries and lead to better-coordinated policy (Bernanke 2010; Bank for International Settlements 2011). I do not question that assessment, but argue that the relaxation of policy tension has a side effect by altering banks' risk-taking activities. This can make locating regulatory authority in a central bank that also controls monetary counter-productive from the perspective of financial stability, to the extent that less-capitalized banking systems are more prone to crisis.

On the other hand, there may be a benefit to unifying policy authority: increased macroeconomic flexibility. While I do not directly test that hypothesis here, the analysis relies on the findings from previous literature that policy tension is relaxed in an environment where an independent central bank also regulates the banking sector. If this is true, regulatory central banks should have greater capacity to make macroeconomic adjustments when needed. So long as the relaxed policy tension does not lead to an increased risk of financial crisis, states may be better off when regulatory and monetary authority are unified. If national leaders feel that they can protect against financial crises in other ways, for example through strict non-discretionary prudential standards, then giving regulatory authority to central banks may have positive results. The revision of the Basel accords following the subprime crisis may be evidence of this. Rather than rely on the discretion of regulators, the revised Basel accords sharply increase capital standards. How banking systems respond to these statutory changes remains to be seen.

There are limitations to the analysis presented here. The greatest challenge comes from the fact that it is difficult to directly test the behavioral relationship I expect here. It is possible that there is some other mechanism that is also consistent with the statistical results. For example, perhaps the patterns we observe in the data are a result of efficiency-seeking.

If separate regulators systematically over-regulate, they may sacrifice economic performance in the process. Regulatory central banks may pursue more bank-friendly policies, but if these do not increase the risk of financial crisis then they may be better able to manage their domestic economies without incurring too much downside risk. It may seem obvious that better-capitalized banking sectors are less prone to crisis, and the research cited above finds such a relationship, but there may be tipping points or other conflating factors that are not analyzed here.

This analysis does not directly examine whether the location of monetary and regulatory institutions affects the probability of a financial crisis. While a full study of the question is well beyond the scope of this study, some broad correlations are consistent with the results presented here. According to IMF researchers, eight of the twelve OECD countries (66%) with regulatory central banks experienced a banking crisis in 2007-8; nine of eighteen (50%) of countries with non-regulatory central banks did (Laeven and Valencia 2010). And the focus of the revision of the international banking standards in the Basel III accord has been to tighten statutory requirements on capital, liquidity, and leverage. This, perhaps, indicates a desire to lessen regulator discretion.

Finally, the analysis presented here offers avenues for continued research. If a tradeoff exists between financial stability and macroeconomic flexibility, what political factors determine how this tradeoff is resolved? Why would leaders in some states, but not all, choose stability over flexibility? Prior research suggests that leaders will be held accountable for the outcomes of policy choices in both areas, so how do they choose which goal to privilege? Do they understand the effects of the choices they make? Do banks or other interest groups lobby for particular institutional arrangements? One interesting fact that emerges from the analysis here is that all institutional reforms during 1992-2007 moved away from unified authority: twelve states ceded monetary independence by joining the EMU during the sample period, seven of which had regulatory central banks. Five states switched the location of regulatory authority during the sample period, and all of them set up a regulator

separate from the central bank. Given that financial crises have become more frequent and more severe in the post-Bretton Woods period, perhaps leaders are choosing stability over flexibility in their domestic economies. Further research is needed to shed light on these questions.

Notes

¹An online appendix with supplemental material, as well as replication materials, will be made available at the my website upon publication.

²For a cross-national analysis of the relationship between growth and elections, see Alesina et al. (1996). Haggard (2000) discusses how voters in East Asian democracies punished incumbent governments following the 1997 financial crisis, while Keefer (2007) demonstrates that citizens can, and do, hold politicians accountable in the wake of financial crises.

³For a discussion of how electoral rules influence regulatory choice see Rosenbluth and Schaap (2003). Singer (2007) explores the principal-agent relationship between legislatures and financial regulators.

⁴There is a broad literature focused on this question. See Simmons (1994) for a discussion of how independent central banks privileged domestic price stability over other policy goals during the interwar years. Maxfield (1997) shows that when isolated from political pressures, central banks in developing countries privilege long run over short run outcomes. Cukierman (1992) demonstrates that while central banks are never fully independent, those with broader discretion are more successful in moderating inflation, which in turn improves long run macroeconomic health.

⁵The relationship between financial stability and the capital adequacy of banks is discussed in Demirguc-Kunt, Detragiache, and Merrouche (2010); Berger and Bouwman (2011).

⁶Their focus is on the cooperation between national regulators in the international arena, but the point is easily extended.

⁷Quote taken from <http://www.bis.org/about/index.htm>, accessed May 3, 2012.

⁸Some regulators feel the same way. Market discipline is one of three “pillars” of the second international Basel accord. Formal capital adequacy requirements – discussed in detail below – is another.

⁹Note that Copelovitch and Singer find a conditional effect: regulatory central banks pursue more bank-friendly policies when the size of the domestic banking sector is large and

when they operate under floating exchange rates. I discuss these refinements in greater detail below.

¹⁰The political choice of whether to bail out insolvent firms or enforce closures is carefully analyzed in Rosas (2006).

¹¹For example, as a condition of the Northern Rock nationalization shareholders and hedge funds received no compensation. In exchange for fiscal support, the British government also took large equity stakes in firms such as the Royal Bank of Scotland.

¹²Only the largest firms received fiscal support at all. Smaller firms were generally allowed to fail. According to the United States Federal Deposit Insurance Corporation, 412 banks controlling \$668,373,777 in assets were allowed to fail from 2008-2011. Data taken from <http://www2.fdic.gov/hsob/SelectRpt.asp?EntryTyp=30>, accessed December 18, 2011.

¹³In finance, a “put option” is a financial instrument allowing one party to sell an asset at a specified price at a determined future date, thus hedging against the risk that the asset will decline in value. The “Greenspan put”, while an informal arrangement, referred to the Federal Reserve’s pattern of lowering interest rates in response to financial distress, thus increasing liquidity in the financial system, encouraging risk-taking, and supporting the value of financial assets.

¹⁴The ECB has not fully lived up to this mandate, and since 2007 has intervened in financial markets sporadically. Nevertheless there is no equivalent of the “Greenspan put” in the European monetary system. And the inactions of the ECB following the spread of the subprime crisis to Europe are illustrative: bailouts were done by national governments using fiscal tools. While the ECB provided some liquidity support, it was not on a sufficiently large scale to halt the crisis. Indeed, European banks often had to seek emergency financing from the U.S. Federal Reserve, which they received because of counterparty risk that would have adversely affected American institutions. At the time of this writing, the central debate in the ongoing EU debt crisis is whether the ECB should be more proactive in crisis management, or retain its narrow mandate for price stability.

¹⁵In the OECD, there are seven EMU members where the national central bank regulates the domestic banking sector, as noted in Table 1: France, Greece, Ireland, Italy, Netherlands, Portugal, and Spain.

¹⁶Several countries entered the OECD during the sample period – Mexico in 1994; Czech Republic in 1995; Hungary, Poland, and South Korea in 1996; Slovakia in 2000. The results of the statistical analysis are robust to the exclusion of these countries. I include these countries in the sample beginning with the year of entrance. Two other countries – Luxembourg and Mexico – are also excluded due to non-random missingness in key independent variables. Japan is an extreme outlier on the dependent variable, with very high ratios. In the statistical appendix I report results excluding Japan, does not have a regulatory central bank; the substantive results do not change.

¹⁷Australia, Iceland, South Korea, and the United Kingdom transferred regulatory authority from their central banks to a separate agency in 1999. Turkey did so in 2000.

¹⁸Every state that joined the EMU did so in 1999, except for Greece, which became a member in 2001.

¹⁹The full data set also includes investment banks, central banks, clearinghouses, government credit institutions, trust corporations, savings banks, cooperatives, microfinance institutions, securities firms, mortgage brokers, private asset management companies, non-banking credit institutions, and multi-government banks. I exclude these firms to focus on the types of financial institutions subject to common prudential regulations like those in the Basel accords. I also examined the models including investment banks in the sample. These results, which are substantively similar to those reported, are available in the statistical appendix.

²⁰In the statistical analyses I report results for the tier 1 ratio because of concerns about the variability in the definitions of tier 2 capital across countries. Under the Basel accords the definition of tier 1 capital is common across all countries; however, what assets constitute tier 2 capital varies significantly across countries. The results reported below are robust in

direction and significance to the use of total (tier 1 + tier 2) ratio as the dependent variable, and the size of the effect of the variables of interest generally increases. These results are reported in the statistical appendix. The results reported here, in other words, are the more conservative estimates of the effect of the independent variables of interest on banks' risk-taking activities.

²¹The original Basel agreement – “International Convergence of Capital Measurement and Capital Standards” a.k.a. “Basel I” – may be accessed at <http://bis.org/publ/bcbasc111.pdf>. It was agreed in 1988 by the representatives of the G-10 governments, mostly central banks, to be implemented by 1992. While the agreement was limited to the G-10, it was quickly adopted by many other governments, especially those of industrialized economies. It has since been updated by a “Revised Framework” a.k.a. “Basel II” in 2004, although implementation has been uneven. In response to the subprime crisis the Basel Committee drafted another revision in 2010, “A Global Regulatory Framework for More Resilient Banks and Banking Systems”. “Basel III” is to be put in place over the next decade.

²²The results do not change if tier 2 capital is included in the ratio, as reported in the appendix.

²³Following previous literature, I classify a central bank as regulatory if it has complete or partial regulatory authority (Copelovitch and Singer 2008).

²⁴Available at <http://go.worldbank.org/SNUSW978P0>, last accessed March 4, 2011.

²⁵Because I am primarily interested in institutional arrangements I am confident that using a simple binary variable specification is appropriate. Moreover, Belke and von Schnurbein (2012) demonstrate that the Executive Committee of the ECB has broad agenda-setting authority and takes the median position of the member countries, which suggests that a more nuanced coding scheme would needlessly complicate the empirical models and interpretation of their results.

²⁶In this index the base currency is treated as missing for all country-years for the United States. This reflects the fact that in a world of ‘n’ countries there are ‘n-1’ independent

exchange rates, so one country in the system can maintain exchange rate stability without sacrificing monetary independence or financial openness. The authors ascribe this position to the United States, and thus code their *ERS* as “missing” since there is no base currency against which to measure the United States’ exchange rate stability. To keep the U.S. in the analysis, I assign these country-years the highest level of stability.

²⁷The results do not substantively change if the variable is expanded to include any banking crisis within the previous five years, or if it is restricted to the current year.

²⁸Because of skewness in the data due to the presence of outliers I transformed these country-year *CAR* averages onto the logarithmic scale. While this was done for statistical reasons, such a transformation also has attractive interpretive qualities: coefficients of non-logarithmic input variables, such as the primary explanatory variables, can be interpreted as percentage-changes in *CAR* corresponding to unit changes in the input variable (i.e. semi-elasticities); coefficients of log-transformed input variables, such as some economic controls, can be interpreted as percentage-changes in *CAR* corresponding to one-percent changes in the input variable (i.e. elasticities). It is often more intuitive to conceptualize percentage-changes in *CAR* rather than level-changes, so a log-transformation of the outcome variable gives the analysis greater interpretive, as well as statistical, leverage.

²⁹The inclusion of fixed effects isolates the temporal effect of within-panel changes in the independent variables on the dependent variable.

³⁰In the statistical appendix I also report time series cross-sectional regression models with standard errors clustered on fixed effects parameters to correct remaining autocorrelation. Additionally, in the appendix I report models that include a lagged dependent variable (LDV). Including a LDV can potentially produce biased and inconsistent parameter estimates due to heteroskedasticity (Achen 2000). However, this bias is in the “right” direction from the perspective of inference, as it leads to more conservative estimates of the effects of regressors on the regressand (Keele and Kelly 2006). The substantive results do not change in direction or significance, although the size of coefficient estimates generally shrink with

the inclusion of the LDV as we would expect.

³¹The inclusion of the interaction terms weakly passes a joint F-test with a P-value of 0.08.

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Tables

Table 1: Location of Bank Regulatory Authority in the OECD

Regulatory Central Bank	EMU	Nonregulatory Central Bank	EMU
Australia ¹	No	Austria	Yes
Czech Republic	No	Belgium	Yes
France ²	Yes	Canada	No
Greece	Yes	Denmark	No
Hungary	No	Finland	Yes
Iceland ³	No	Germany ⁴	Yes
Ireland	Yes	Japan	No
Italy	Yes	Luxembourg	Yes
Netherlands	Yes	Mexico	No
New Zealand	No	Norway	No
Portugal	Yes	Poland	No
Slovakia	No	Sweden	No
South Korea ⁵	No	Switzerland	No
Spain	Yes		
Turkey ⁶	No		
United Kingdom ⁷	No		
United States ⁸	No		

¹ The Reserve Bank of Australia regulated the banking sector until 1999.

² Regulatory authority in France is located in the Commission Bancaire, which includes the Governor of the French central bank as well as members of the Treasury. Following Goodhart and Schoenmaker (1995) and Copelovitch and Singer (2008), I classify the Banque de France as a regulatory central bank.

³ The Bank of Iceland was regulator until the establishment of the Financial Supervisory Authority in 1999.

⁴ The German Bundesbank is responsible for some tasks involved in regulation, like data gathering and dissemination, but regulatory authority ultimately resides with the separate Federal Financial Services Supervisory Authority.

⁵ The Bank of Korea was responsible for supervision of the banking sector until 1999, when authority was given to the Financial Supervisory Service.

⁶ The Turkish Central Bank was primary regulator until 2000, when authority was handed over to the Banking Regulation and Supervision Agency.

⁷ The Bank of England regulated the banking sector until 1999, after which regulatory authority was transferred to the Financial Services Authority.

⁸ The Federal Reserve is one of several bank regulators in the United States, but does share regulatory authority, and so fulfills the criteria necessary to be considered a regulatory central bank.

Table 2: Common Risk Weights by Asset Type

Type of Asset	Risk Weight
Cash	0%
OECD sovereign debt	
Claims on OECD banks	
Securities issued by government agencies	20%
Municipal debt	
Residential mortgages	50%
Unsecured loans	
Claims on non-OECD banks	100%
Other non-securitized debt	

Table 3: Determinants of Tier 1 Capital Adequacy Ratios

Variable	Model 1	Model 2	Model 3	Model 4
Regulator	-0.180 (0.001)	-0.337 (0.000)	-0.176 (0.019)	-0.359 (0.002)
EMU	0.133 (0.007)	0.247 (0.000)	0.125 (0.041)	0.236 (0.004)
ERS	-0.019 (0.873)	-0.193 (0.255)	-0.028 (0.816)	-0.241 (0.182)
Banking Sector Size	0.000 (0.020)	0.000 (0.518)	0.000 (0.039)	0.000 (0.601)
Openness	-0.227 (0.077)	-0.194 (0.122)	-0.186 (0.193)	-0.157 (0.273)
Banking Crisis	-0.202 (0.031)	-0.162 (0.070)	-0.187 (0.023)	-0.153 (0.067)
GDP Growth	0.010 (0.411)	0.013 (0.271)	0.009 (0.320)	0.011 (0.222)
Inflation	0.014 (0.552)	0.019 (0.430)	0.005 (0.819)	0.010 (0.676)
Current Account Balance	0.013 (0.037)	0.013 (0.040)	0.012 (0.019)	0.013 (0.020)
Regulator*EMU		-0.237 (0.011)		-0.237 (0.058)
Regulator*ERS		0.394 (0.076)		0.457 (0.058)
Regulator*Banking Sector Size		0.000 (0.149)		0.000 (0.183)
Banking Sector Size*ERS		0.000 (0.422)		0.000 (0.247)
Regulator*Banking Sector Size*ERS		-0.000 (0.158)		-0.000 (0.191)
Constant	5.751 (0.000)	5.750 (0.000)	2.794 (0.000)	2.830 (0.000)
N	384	384	384	384
R ²	0.702	0.713		
Log-Likelihood			-131.652	-124.437
BIC			322.81	332.134

Models 1 & 2: OLS regression with fixed effects and robust standard errors.
Models 3 & 4: Hierarchical linear model.
P-values in parentheses.

Figures

Figure 1: Marginal Effect of Regulator, Three-way Interaction

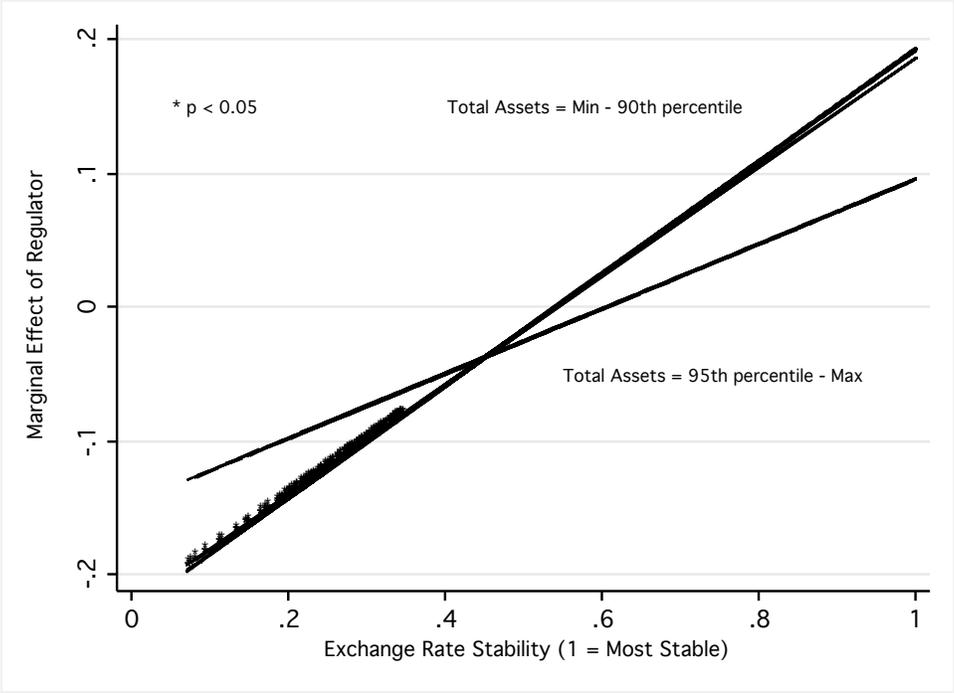


Figure 2: Marginal Effect of Regulator, Conditioned by ERS

