The EU Sovereign CDS Ban: Asset Pricing and Welfare Implications under Optimal Beliefs

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Trading in the CDS market in this paper occurs because irrational investors have optimal beliefs about the default state of the economy, those investors tend to be overly optimistic that default is less likely. Since the imposition of the CDS ban on member states of the European Union in 2012, not only are investors forced to share risk through an incomplete capital market, optimal beliefs about default can also change. I show two sets of asset pricing implications can occur, one in which stock market values increase and countries' borrowing rates decrease after the ban is imposed, and one in the opposite direction. I find empirical support for the former, and also show the CDS ban is welfare improving in this case. While rational investors would benefit from lifting the ban, the gain is not sufficient to compensate irrational investors for their utility loss.

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Abstract

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Keywords: Sovereign Debt, Credit Default Swaps, EU Regulation 236, Heterogeneous Beliefs, Incomplete Markets.

JEL Classification: G12, G15, G18, H63.

1 Introduction

On Tuesday October 18, 2011, the European Union reached an agreement to limit trading of credit default swaps on EU member states. Written into law as EU Regulation 236, the ban came into effect on November 1, 2012, and is still active at the time this paper is written. It aims to ensure a higher level of consumer and investor protection, since entering into a sovereign credit default swap without underlying exposure to the risk of a decline in the value of the sovereign debt could have an adverse impact on the stability of sovereign debt markets, as argued in the legislative act signed by Schulz and Wammen (2012).

In general equilibrium, it requires some form of investor heterogeneity to assess the costs and benefits of credit default swaps, even without imposing a ban. Disagreement in beliefs about the state of the economy triggering default does seem like a natural candidate to explore. However, instead of assuming exogenous heterogeneous priors as usually done in this literature, I explore the objective of optimal expectations introduced by Brunnermeier and Parker (2005). One group of investors endogenously derives its belief about the default state by taking into account the effect on anticipatory utility. And given the negative skewness an economic crises tends to induce, it appears optimal for such investors to be overconfident and to underestimate the true likelihood of default.

I explore three research questions in this setting: First, do optimal expectations produce an open interest in the sovereign CDS market comparable in size to what we saw prior to the ban? Second, the CDS market in this paper is not redundant – investors rebalance their positions in the stock and bond market and prices adjust after the ban. Are countries' borrowing rates different *because* of the restricted trading in the CDS market? Third, do we have some evidence of the CDS ban being welfare improving?

The following table shows the size of the sovereign CDS market for member states of the EU. According to the Depository Trust & Clearing Corporation, these countries have the largest net notional amount outstanding in the second Quarter of 2011, shortly before the ban was announced. All countries have in common that the size of the CDS market is at least 1% of the amount of public debt outstanding.

	Pre ann	Post ann	Post imp	Post / Pre	DO Q2/11	Pre / DO
Portuguese Republic	6,584	-1,676	-1,033	-41.2%	194,700	3.38%
Republic of Austria	6,327	-760	-1,158	-30.3%	265,690	2.38%
Republic of Finland	2,314	148	-254	-4.6%	103,506	2.24%
Kingdom of Spain	18,113	-3,702	-3,352	-38.9%	829,312	2.18%
Ireland	4,146	-574	-1,100	-40.4%	205,814	2.01%
Kingdom of Denmark	2,619	283	-928	-24.6%	147,770	1.77%
Kingdom of Belgium	6,994	-1,764	-1,733	-50.0%	452,998	1.54%
Kingdom of Norway	1,014	153	-269	-11.4%	81,234	1.25%
French Republic	20,990	1,233	-8,125	-32.8%	1,906,167	1.10%
Republic of Italy	25,050	-4,176	-1,539	-22.8%	2,313,849	1.08%
Federal Republic of Germany	17,033	2,803	-5,870	-18.0%	1,621,605	1.05%

Table 1: **CDS Outstanding.** Pre ann is the net outstanding amount of CDS pre announcement, between Jan 1 and Oct 14, 2011. Post ann is the change in the net outstanding amount of CDS post announcement but pre implementation, between Oct 21, 2011 and Oct 26, 2012. Post imp is the change in net outstanding amount of CDS post implementation, between Nov 2, 2012 and Dec 27, 2013. The data source is DTCC. DO is the national debt outstanding as reported in Quarter 2 of 2011, as reported by Bloomberg. All values are in million USD.

The market size has collapsed since 2011 – for some countries since the announcement, for others since the enforcement of the ban. The ban is targeting uncovered CDS positions; we should not expect the market size to approach zero, some interest will remain due to other hedging purposes. The model in this paper produces zero bond holdings prior to the ban, hence all CDS positions can be interpreted as uncovered, and are subject to the ban.[1] Optimal expectations produce a reasonable size of the CDS market assuming that a -10 percent shock in economic output is associated with default in the debt contract. I show that irrational agents are even more overconfident in the incomplete market and beliefs depend on the level of recovery. This opens up two sets of asset pricing implications: one in which stock market values increase and countries' borrowing rates decrease; and one in the opposite direction.

The first set occurs due to incomplete markets, all agents are forced to share risk indirectly through the stock and bond market. Suboptimal risk sharing is associated with lower consumption volatility and lower risk premia. Stock and bond market values are higher in the incomplete market, and expected returns and borrowing rates are lower. The second set occurs due to a larger degree of dispersion in beliefs in the incomplete market, associated with larger consumption volatility. This effect can overcompensate the former, supporting an increase in expected returns and in borrowing rates.

I find empirical support for the first set of implications. The 11 EU countries shown above experience an increase in stock market values and a decrease in bond yields after the ban, on average, compared to countries that were not affected. While the model can explain this qualitatively, I can not match the size of the effect. For example, the model is able to produce a decrease in the

[1] Given the size of the sovereign CDS market relative to the amount of reference material, I decide to abstract from the empty creditor problem, a friction that appears to be more relevant in the space of corporate credit. Several papers have studied the effect of CDS trading on corporate credit, such as Ashcraft and Santos (2009) and Subrahmanyam et al. (2014). The former does not find evidence that CDS trading affects the cost of debt financing, while the latter shows that CDS trading increases the credit risk of reference firms.

short-term bond yield of -30 basis points, whereas the observed effect may have been larger than -100 basis points. The data also shows that the slope of the term structure increased after the ban. While long-term bonds are not an explicitly modeled here, I compute shadow prices for long-term bonds and find support for a steeper term structure in incomplete markets.

In a related paper, Ismailescu and Phillips (2015) study the effect of CDS trading on the sovereign bond market, and find that the initiation of CDS trading is associated with a reduction in bond yields. It is unclear, though, why that is the case, as the reason for initiation is difficult to pin down empirically, and the authors do not take a stand on the type of investor heterogeneity leading to trade in the first place. Their empirical findings, however, would be consistent with the second set of asset pricing implications in this paper, in which the dispersion in beliefs while completing the market decreases, being associated with a lower bond yield.

Another closely related paper is Oehmke and Zawadowski (2015). They also model CDS as non-redundant assets, and explore the market frictions of differential liquidity and trading costs between the CDS contract and the underlying bond. Their model produces ambiguous asset pricing implications on the bond yield when restricting the CDS market, as well as ambiguous welfare implications of a CDS ban. As pointed out by Oehmke and Zawadowski (2015), a crucial question is what investors do instead of trading CDS. This can be properly addressed in my paper, showing that agents seek out protection indirectly through rebalancing in the stock and bond market.

Comparing realized utilities delivers results about welfare: Irrational agents are better protected after imposing the CDS ban when the incomplete market effect dominates. While rational investors would benefit from lifting the ban, their gain is not sufficient to compensate irrational investors for their utility loss. The size of the effect depends on how risky the debt contract is. I show that the welfare gain of imposing the ban can be between 1% and 1.5% of current consumption for recovery rates larger than 75%.

Last, but not least, the paper also has several theoretical contributions. First, I extend Brunnermeier and Parker (2005) to incomplete capital markets, gaining new insights into how optimal beliefs depend on capital market design. Second, I extend the capital market in Dieckmann (2011) to cases where the lower bound of the investment opportunity set is risky even in incomplete markets. This adds a dimension to those models where the lower bound of restricted investors is assumed to be riskless, as for example in Gallmeyer and Hollifield (2008) in the case of short-sale constraints in the stock market under heterogeneous beliefs, or in Basak and Cuoco (1998) in the case of limited participation under homogeneous beliefs. Third, I provide another example in which complete markets are not necessarily welfare improving, as in Marin and Rahi (2000) and references therein, by identifying the risks and benefits of this type of financial innovation assuming optimal beliefs.

Of course it might also be of interest what effect the ban has on the CDS market itself, on liquidity, volatility, and on the price informativeness of the remaining contracts. This, however, is not the focus of this paper and cannot be addressed in the model shown here. Papers addressing the questions include Duffie (2011), Kiesel et al. (2015), and Silva et al. (2016).

The following section shows the equilibrium model, introduces the capital market, the notion of optimal beliefs, as well as the welfare criterion. Section 3 shows asset pricing implications in the stock and bond market, depending on whether or not irrational agents revise their beliefs when the ban is imposed. Section 4 shows an empirical validation of the model giving support for one set of asset pricing implications and the corresponding welfare effects.

2 The Model

I present an exchange economy in discrete time. Aggregate output follows a random process, and two heterogeneous agents solve for their optimal consumption profile using the capital market for risk sharing purposes. One dimension in which agents are heterogeneous is their belief about the crash state of the economy. The crash state of the economy is associated with a crises large enough to trigger default on the economy's debt contract. The capital market is solved under two scenarios to be able to address the main question of this paper, one scenario entails complete risk sharing, the other does not allow for trading in a CDS contract insuring the crash state of the economy.

2.1 Exchange Economy

Time is discrete and has three dates, $t \in \{0, 1, 2\}$. Aggregate output follows a trinomial tree, the shocks are R_u, R_d, or R_c. While today's output e_0 is exogenous and certain, $e_t/e_{t-1} = R_u$ and $e_t/e_{t-1} = R_d$ are equally likely with probability $(1-p)/2$. The crash state $e_t/e_{t-1} = R_c$ has probability p, where $p \in (0, 1)$.

The two agents living in this economy derive utility from consuming a fraction of the output in each state. Agent 1 is initially endowed with fraction ϕ of the total wealth in the economy, agent 2 owns $(1-\phi)$, where $\phi \in (0, 1)$. The two agents differ in their assessment of p. Agent 1, the rational agent, derives utility assuming the true probability given by

$$U_1(c, p) = E_p \left[\sum_{j=0}^{2} \beta^j u(c_j) \right]. \tag{1}$$

Agent 2, the irrational agent, derives utility based on a subjective belief, p_2, given by

$$U_2(d, p_2) = E_{p_2} \left[\sum_{j=0}^{2} \beta^j u(d_j) \right]. \tag{2}$$

Agents display the same degree of patience given by β, and the same aversion to risk, γ, defining their utility function given by

$$u(d_j) = (d_j^{1-\gamma} - 1)/(1-\gamma). \tag{3}$$

2.2 Capital Market

The first security agents can use to finance consumption is a dividend paying stock, paying output e in each state and time. I assume the stock to be in unit supply, the value at each node in the tree is to be endogenously determined, including today's value S_0.

The second security allows for borrowing and lending. It is a one-period zero coupon bond, in zero-net supply, paying a face value of 1 in state u and d. However, the contract does not pay the face value in the crash state. In this state the borrower only pays R to the lender, where R stands for the recovery rate taking on values between 0 and 1. While R is an exogenous parameter in this model, the value of the zero-coupon bond throughout the tree including today, B_0, is determined endogenously.

The third security allows agents to insure the crash state, the same state in which default occurs. It is a one-period credit default swap without a payoff in state u and d. However, the CDS contract does pay 1 unit in the crash state. The CDS contract is in zero-net supply, and it's value throughout the tree including today, P_0, is determined endogenously.

Both agents determine their investment policies to finance consumption. There is no need to explicitly introduce a notation for security holdings at this point, they will be explained when showing the results. It is easy to show the capital market above is dynamically complete assuming the zero-coupon bond and the CDS contract exist at all nodes in the tree. Agent 1's optimal consumption profile is given by

$$c^* = \arg\max_c U_1(c, p), \tag{4}$$

subject to a budget constraint in which initial wealth is given by ϕS_0. Similarly, agent 2's optimal consumption profile is given by

$$d^* = \arg\max_d U_2(d, p_2), \tag{5}$$

subject to a budget constraint in which initial wealth is given by $(1 - \phi)S_0$.

Before the CDS ban: An equilibrium in the economy is given by the consumption profiles c^* and d^*, optimal investment policies in the capital market, a price system for the capital market, such that $c + d = e$, the stock market, the bond market, and the CDS market clear.

I am assuming that after the CDS ban is imposed, agents can continue to trade in the stock and the bond market. The CDS market, however, shuts down. Optimal consumption depends on the design of the capital market in this case, in particular on the design of the borrowing and lending contract, such that the lower bound of the investment opportunity set is risky even in the case of incomplete markets.

After the CDS ban: An equilibrium in the economy is given by the consumption profiles c^* and d^*, optimal investment policies in the capital market, a price system for the capital market, such that $c + d = e$, the stock market, and the bond market clear. There are no holdings in the CDS market.

2.3 Optimal Beliefs

The rational agent sits firm with her belief about p. She serves as the econometrician correctly inferring the likelihood of the crash state. The irrational agent, on the other hand, acts according to her subjective belief. While this feature lends the model the usual flair of heterogeneous beliefs, the novelty is that the irrational agent determines her beliefs endogenously. She deviates from p by optimizing

$$p_2^* = \arg\max_{p_2}[U_2(d^*, p_2) + U_2(d^*, p)]. \tag{6}$$

This agent is tempted to deviate from p due to first-order gains in $U_2(d^*, p_2)$ but also faces ex-post costs given by $U_2(d^*, p)$. Please see Brunnermeier and Parker (2005) and Brunnermeier et al. (2007) for a more complete description of optimal beliefs and its motivation, including examples of using optimal beliefs in complete markets. I am assuming that p_2^* remains constant throughout the tree. This is a simplification made for tractability, but it does open up questions about time consistency. The true probability is also assumed to be constant throughout the tree; there is no updating at the intermediate node. Hence, the effects of volatility observed here are entirely due to consumption sharing and do not need to be disentangled from agents' updating their beliefs about p over time.

2.4 Welfare Criterion

To make a statement about the CDS ban's welfare properties, I compare agents' utilities across the two equilibria. This is not straightforward in an economy with heterogeneous belief, given that each agent does the best she can given *her* view of the world. It is easy to show each agent is made better off by lifting the ban when measured through *anticipatory* utilities, such that

$$U_1(c^*_{complete}, p) \geq U_1(c^*_{incomplete}, p),$$
$$U_2(d^*_{complete}, p_2) \geq U_2(d^*_{incomplete}, p_2). \tag{7}$$

Irrational agents, however, will create a cost ex-post realizing they will be wrong about p. A paternal agent can evaluate their indirect utility with respect to the *true* probability, such that

$$U_1(c^*_{complete}, p) \geq U_1(c^*_{incomplete}, p),$$
$$U_2(d^*_{complete}, p) \leq U_2(d^*_{incomplete}, p). \tag{8}$$

To evaluate welfare I first compute the time zero consumption multipliers, k_1 and k_2, equalizing the system of equations in (8), as usually done in this literature. For example, k_1 is the multiplier applied to time zero consumption of agent 1 in the incomplete market, such that her indirect utilities under the ban and under no ban are identical. In other words, if $(k_1 - 1)$ is positive, then she is better off by lifting the ban. The net effect of lifting the ban can then be measured by

$$(k_1 - 1)c^*_{incomplete} + (k_2 - 1)d^*_{incomplete}. \tag{9}$$

Of course this only a task a paternal agent could undertake. We should not expect that a strict Pareto improvement can be achieved. However, a weaker efficiency improvement based on a Kaldor-Hicks transfer payment can possibly be achieved, in which one agent's improvement is sufficiently large to convince the other agent to induce a policy change.

Aside, while the welfare criterion proposed by Brunnermeier et al. (2014) does apply to heterogeneous beliefs models more generally, it seems too high of a hurdle to be applied here. Given that irrational agents know the true probability but decide to act otherwise, I would not expect any convex combination between p and p_2 to be the standard for welfare improvement under optimal beliefs.

3 Asset Pricing and Welfare Implications

The parameters are chosen to mirror a representative EU economy. The economy experiences either an expansion, $R_U = 1.05$, or a slight contraction, $R_D = 0.99$, such that expected annual growth in normal economic times equals 2% with a standard deviation of 3%. Economic output shrinks by 10% in the crash state, $R_C = 0.90$, a value that can be supported by recent observations such as Greece. The likelihood of the crash state is assumed to be 6%, hence a crisis occurs approximately every 17 years. Also, initial output is given by $e_0 = 10$, which is without loss of generalization. The parametrization assures that the output process displays negative skewness.

3.1 Open Interest in CDS

One way to validate the model is to evaluate the degree of open interest in the CDS market. Figure 1 shows the open interest depending on the degree of risk aversion, as well as the likelihood of the second agent. The rational and irrational agent are equally represented in terms of wealth, $\phi = .5$. I showed in the introduction that prior to the ban, the ratio of outstanding CDS over public debt was ranging between 1% and 3%. Given that Debt over GDP tends to be below 100%, at least in normal economic times, we should expect the ratio of CDS outstanding over GDP to be below these levels. This evaluation is independent of the recovery rate of the CDS contract; of course the recovery rate affects the price of each contract, but it also scales the number of CDS contracts leaving the fraction of output held in the contract unaffected.

Open interest appears to be reasonable. The largest holdings can be generated for low degrees of risk aversion, which is expected since investors have a stronger motive for speculation. More dispersion among beliefs generates a larger degree of open interest, where the maximal amount of output held in CDS contracts equates to 2%.

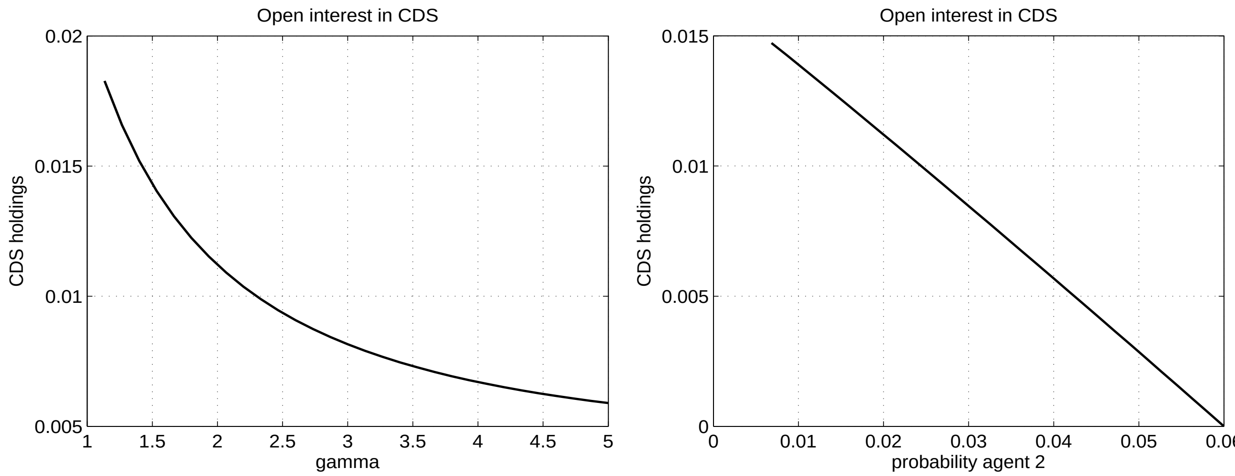

Figure 1: **Open Interest in CDS.** The figures show the equilibrium demand for the CDS contract as a function of risk aversion and the probability of agent 2. On the left, the probability of agent 2 is assumed to be 2%. On the right, the risk aversion coefficient equals 2. CDS holdings are expressed as the fraction of output held in the CDS contract in the complete market.

3.2 Optimal Beliefs

Imposing the objective of optimal beliefs as in equation (6) leads to two main insights. First, optimal beliefs about the crash state are *lower* than the objective probability. Second, optimal beliefs in the incomplete market are lower than in the complete market.

As can be seen on the right of Figure 2, the optimal belief of agent 2 in the complete market is 4.35%, confirming the intuition brought forward by Brunnermeier and Parker (2005). It is *optimal* for agent 2 to underestimate the true probability due to the effect on anticipatory utility.

The optimal belief is independent of the recovery rate which is consistent with our understanding that the security design should not matter under full risk sharing. This does not apply in the incomplete market, where the optimal belief *does* depend on the recovery rate. Notable is also the boundary solution in Figure 2. It is possible to show that the optimal belief takes on values in the open interval of (0,1) with complete risk sharing. However, this can not be shown in the incomplete

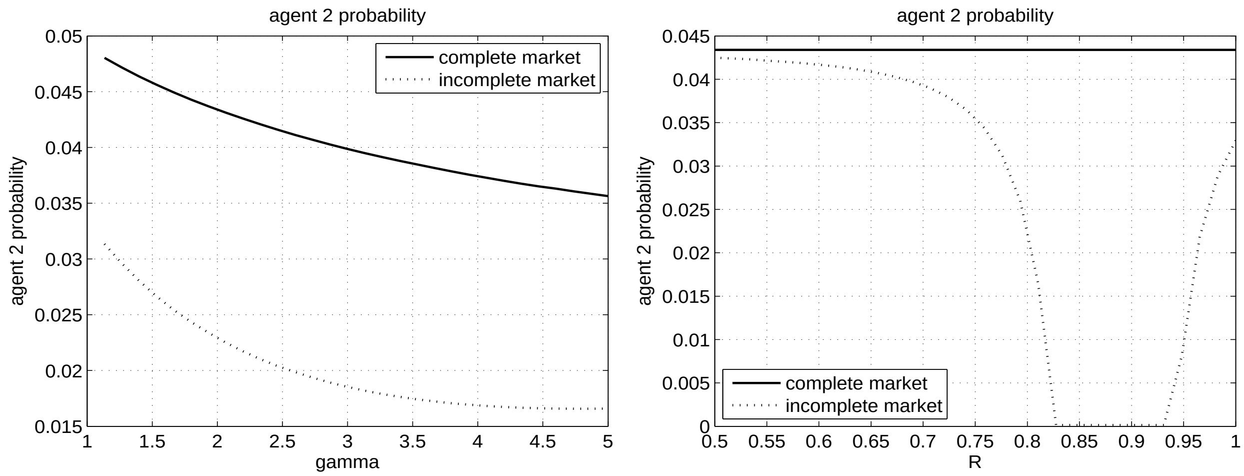

Figure 2: **Optimal Beliefs of the Crash State.** The figures show the beliefs of agent 2 according to the objective function in equation (6), as as a function of risk aversion and the recovery rate. On the left, the recovery rate is assumed to be 80%, on the right, the risk aversion coefficient equals 2.

market; the optimal belief can be the boundary solution, assumed to be .0001, for the range from 83% and 94% in this numerical example.

I also find that optimal beliefs are decreasing in gamma. While a higher degree of risk aversion tends to decrease the motive for speculation holding p_2 constant, it can increase the motive for speculation in this setting because it is optimal to underestimate the crash probability even further.

3.3 Stock and Bond Market - Effect 1

I first focus on the implications due to incomplete markets holding beliefs constant, and then add the change in beliefs in next subsection.

Prior to the ban, agents invest in the stock market according to their wealth distribution. Half of the stock market value is held by agent 1 and 2, respectively, due to $\phi = .5$. There is no borrowing and lending, as can be seen in Figure 3. Since agents agree on all features of the economy except p_2, trading in the CDS contract occurs only to implement the desired consumption profile in the crash state. This is convenient because all CDS holdings are *naked*, they are not used to protect bond holdings.

After the ban, agents are forced to share risk through two securities, the bond and the stock market. Not surprisingly, if debt is riskless or recovery rates are very high, then the rational agent is lending to the irrational agent while reducing her stock market exposure. In the extreme case of $R = 1$, this can even lead to a situation where the irrational agent holds almost all of the stock.

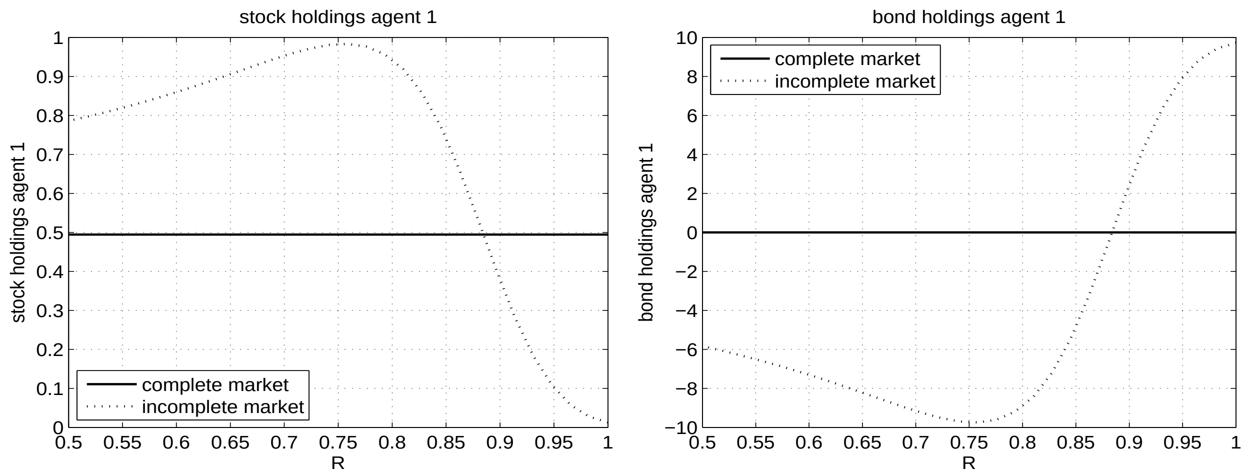

Figure 3: **Stock and Bond Market Holdings.** The figures show the optimal portfolio policies of agent 1 across the two markets while holding p_2 constant, p_2 is assumed to be 2%. The x-axis is the recovery rate of the bond contract, the risk aversion coefficient equals 2.

However, the results critically depend on the recovery rate; to such an extent, that lower recovery rates can reverse the holdings. As the debt contract becomes more risky, it is optimal for the rational agent to lend less but increase her stock market holdings. There is also a solution in which the recovery rate leads to zero borrowing and lending, at approximately 87%, where risk is optimally shared though the stock market only, leading to the same stock market holdings as prior to the ban. All graphs in this section assume the lowest recovery rate to be 50%. While this is close to haircut values observed by Cruces and Trebsch (2013) for a large set of sovereign defaults, lower recoveries can of course occur in reality. In this model, and below $R = 50\%$, however, the bond market becomes significantly more risky than the stock market, which might not be the most realistic scenario.

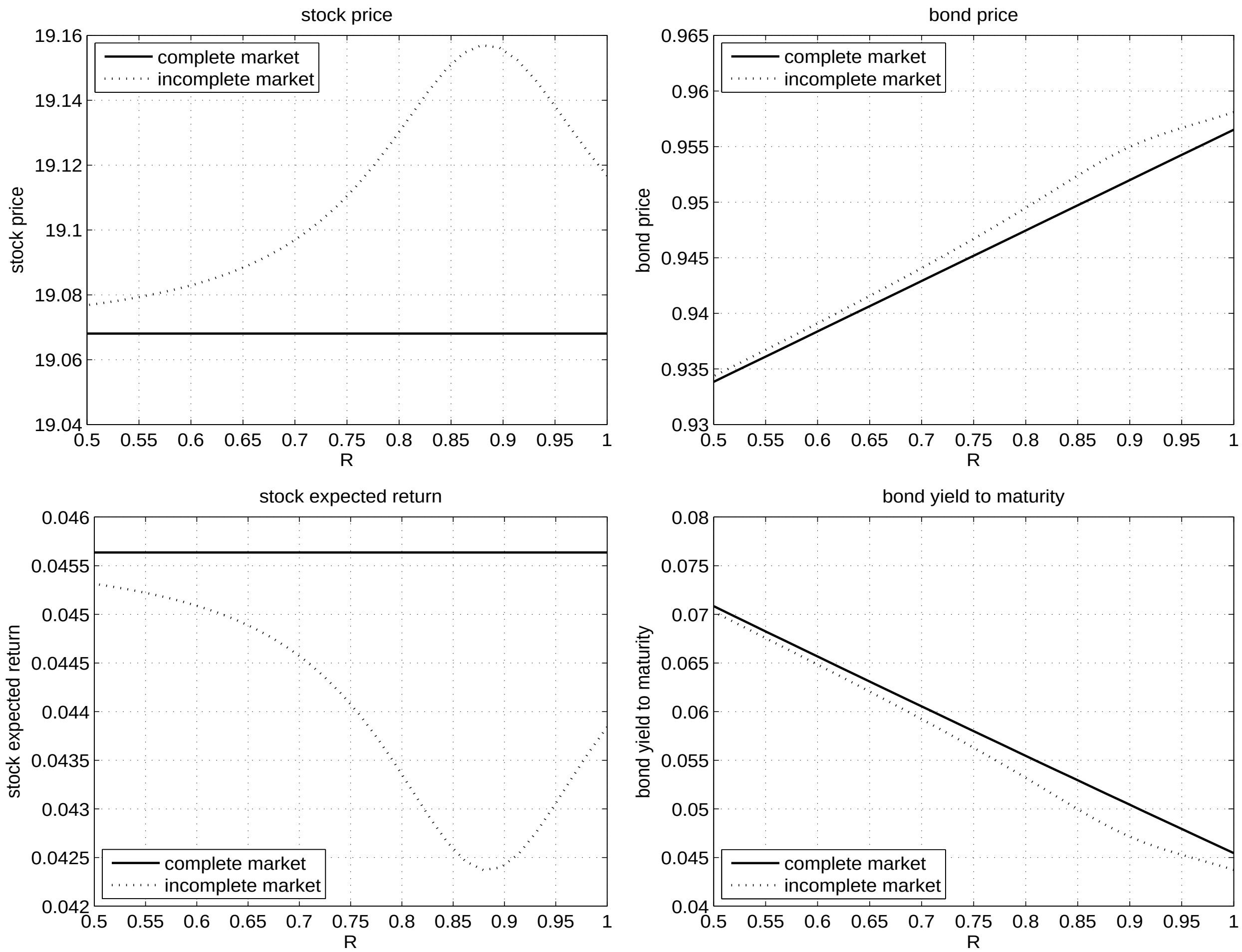

Figure 4: **Stock and Bond Market Prices.** The figures show the value of stock and bond across the two markets while holding p_2 constant, p_2 is assumed to be 2%. The x-axis is the recovery rate of the bond contract, the risk aversion coefficient equals 2.

Figure 4 shows the pricing implications of the CDS ban. Unambiguously, prices increase after the ban. The limited possibilities to implement agents views' in the incomplete market are associated with *lower* expected returns in the stock market, consistent with the price increase.

The largest effects can be seen with recovery rates in the 80% range, where expected returns diminish by up to 30 basis points. Not surprisingly, the yield to maturity in the bond market depends on the recovery rate such that agents require a higher yield the less is recovered in default. In addition, the yield to maturity is *lower* for all values of recovery after the ban. As with equity, the effects are stronger in the 80% range, where the yield is up to 30 basis points lower as compared to prior to the ban.

3.4 Stock and Bond Market - Effect 1 and 2

We know from section 3.2 that optimal beliefs of agent 2 are lower in the incomplete market. A reader might be tempted to infer the results above simply amplify in the same direction if this effect is taken into account. Such intuition, however, can be misleading. For example, the price of the stock is increasing in the level of p_2; although the amount of exogenous risk does not change, endogenous consumption risk is larger for larger degrees of heterogeneity about the crash state, yielding a higher risk premium and therefore a lower stock price. Hence, it could happen that both effects offset each other.

General insights about portfolio holdings remain the same, but the levels do amplify slightly. There remains a threshold in recovery rates below which agent 1 is a borrower instead of being a lender, in the incomplete market. Debt is becoming increasingly risky below that threshold, and the rational agent is better off accepting the crash risk through the stock market. This can even lead to a levered position in the stock market when recovery rates drop below 83%.

The impact of the CDS ban on prices remains unambiguous. However, this time in the opposite direction, i.e. prices decrease after the ban is imposed. The irrational agent is even more optimistic about the crash state when the capital market is incomplete. For example, between 83% and 94% recovery, the irrational agent acts as if the crash state is non-existent and the rational agent takes

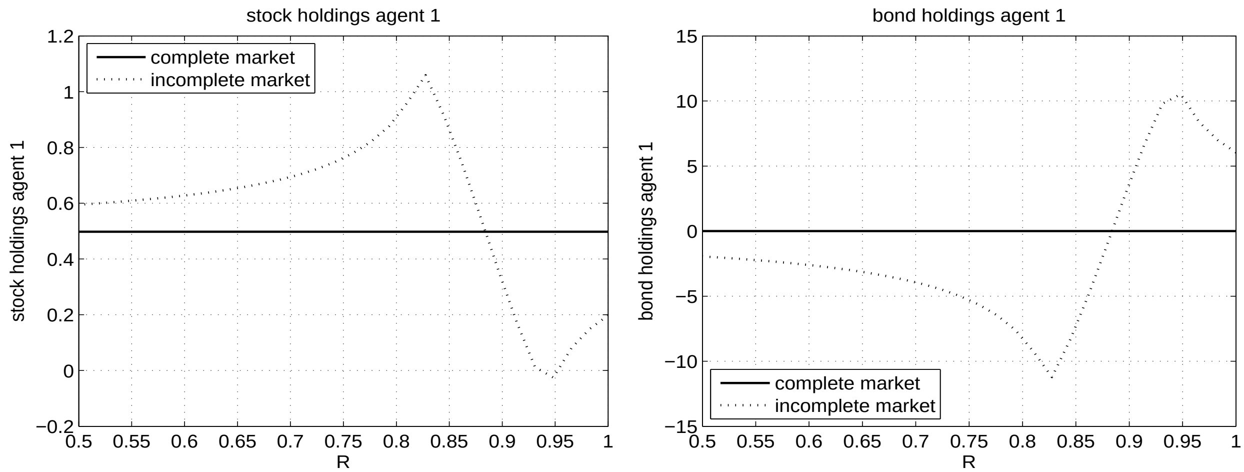

Figure 5: **Stock and Bond Market Holdings.** The figures show the optimal portfolio policies of agent 1 across the two markets, beliefs about p_2 are optimal, probabilities are shown on the right of Figure 2. The x-axis is the recovery rate of the bond contract, the risk aversion coefficient equals 2.

advantage of this. This allows for a more volatile consumption policy where risk premiums, for stock and bond, are larger and therefore prices lower. I find this channel overcompensates the effect shown earlier, such that expected returns and bond yields are larger in the incomplete market. The impact is smaller in size for recovery rates below 75%. For recovery rates larger than 75%, however, expected returns increase by as much as 38 basis points, and the yield to maturity in the bond market is up to 35 basis points larger after the ban is imposed.

3.5 Welfare Implications

Figure 7 shows the welfare properties as determined by a paternal agent assuming that agent 1 knows the true probability of the crash state. This is the equivalent to section 3.3, in which agent 2 does not change her belief after imposing the ban. I find that incomplete markets are welfare improving in all cases. Agent 2 incurs a welfare loss eventually realizing her belief was not optimal ex-post. However, being forced to share risk through the bond and stock market limits her ability to explicitly share consumption risk for the crash state. This limitation is beneficial since it protects

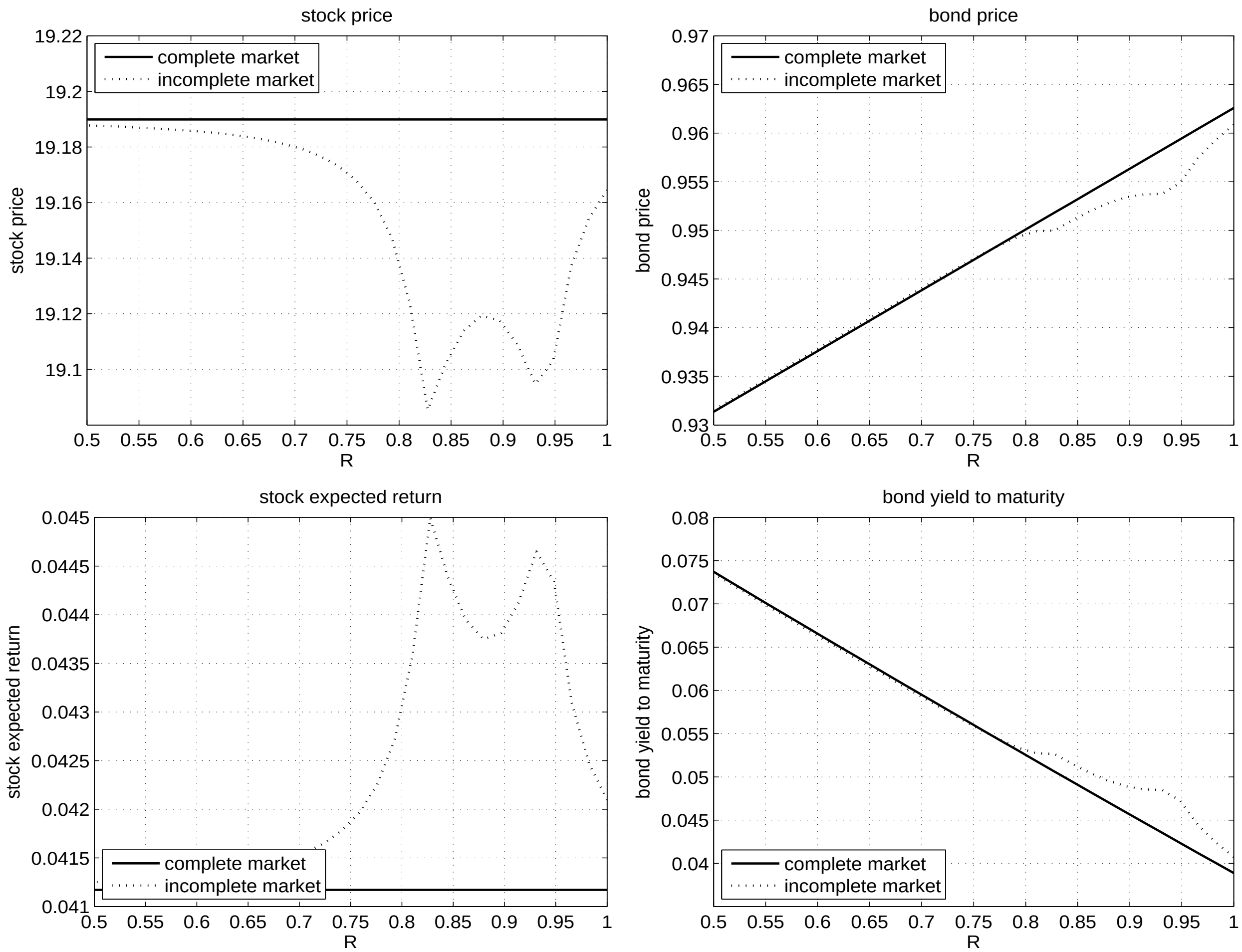

Figure 6: **Stock and Bond Market Prices.** The figures show the value of stock and bond across the two markets, beliefs about p_2 are optimal, probabilities are shown on the right of Figure 2. The x-axis is the recovery rate of the bond contract, the risk aversion coefficient equals 2.

her from larger wealth transfers in the CDS market. Agent 1, on the other hand, is better off lifting the ban since she is able to extract some wealth from agent 2. This gain, however, is not sufficient to compensate agent 2 for her utility loss. In other words, there is no consumption transfer that agent 1 can afford paying to agent 2 trying to convince her to change policy.

The net effect is not small. For recovery rates between 75% and 100%, the welfare gain of imposing the ban is between 1% and 1.5% of current consumption. Interesting to note is the strong dependency on risk aversion, in that the welfare gain of imposing the ban is larger for lower levels

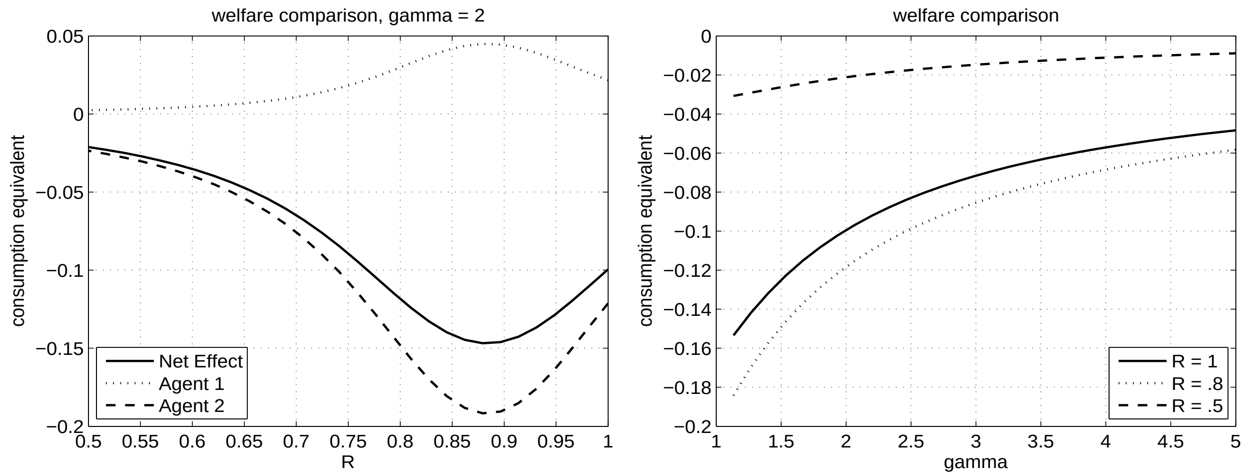

Figure 7: **Welfare Comparison - Effect 1.** The figures show the consumption equivalents while holding p_2 constant, p_2 is assumed to be 2%. The left graph shows the effect on agents 1 and 2 and the net effect, depending on the recovery rate. The right graph shows the net effect depending on risk aversion.

of risk aversion. Since lower degrees of risk aversion lead to a larger size of the CDS market, the ban appears more effective in low gamma economies. For example, assuming a recovery rate of 80%, the welfare gain doubles from .8% to 1.6% when risk aversion decreases from 3.5 to 1.5.

Figure 8 shows the welfare properties while both channels are at work, the incomplete market and the change in beliefs. Now, lifting the ban can be welfare increasing because of the reduction in dispersion in beliefs. Incomplete markets still protect the irrational agent from ex-post costs. However, the upward revision in beliefs can have an impact on utility large enough to overcompensate the former. The net effect is ambiguous. There is a range of recovery rates where the upward revision in beliefs is not sufficient to induce a gain, i.e. between 85% and 90%.

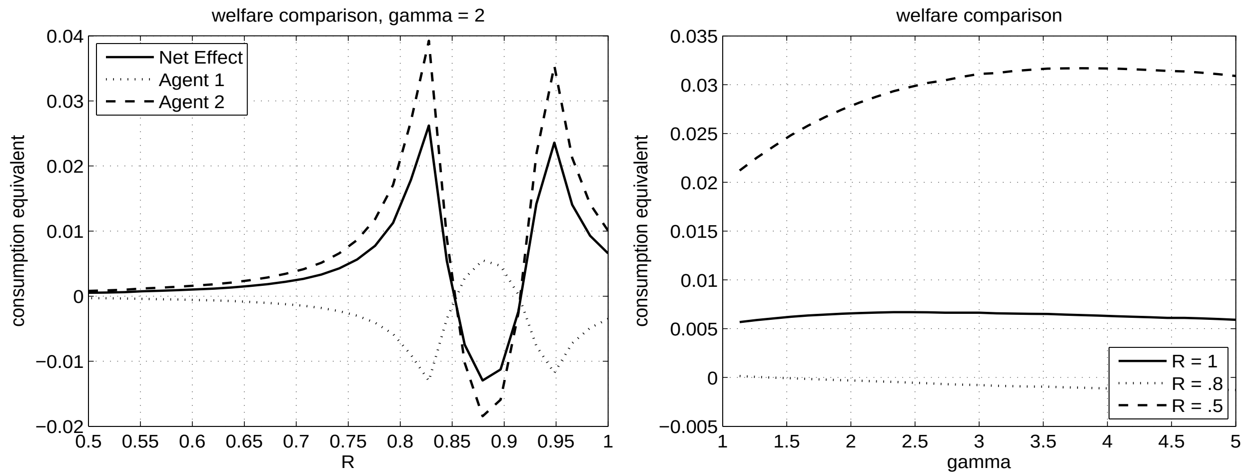

Figure 8: **Welfare Comparison - Effect 1 and 2.** The figures show the consumption equivalents while beliefs about p_2 are optimal, probabilities are shown on the right of Figure 2. The left graph shows the effect on agents 1 and 2 and the net effect, depending on the recovery rate. The right graph shows the net effect depending on risk aversion.

4 Empirical Validation

A test of the model is carried out based on the countries mentioned in the introduction, i.e the countries with the largest CDS net notional amount outstanding subject to a ratio of amount over public debt outstanding of at least 1%. The stock market is given by the MSCI local equity index, the bond yield is given by the 1-year yield implicit in the government term structure, as reported by Bloomberg. To control for the general macroeconomic environment, I employ the MSCI global equity index, the gold price, and the EUR/USD exchange rate as additional explanatory variables. The data consists of weekly observations between Jan 21, 2011 and Dec 12, 2013.

I test the policy adoption relative to countries that were not affected by the CDS ban. I selected the 10 countries with the largest net notional amount outstanding in the second quarter of 2011, according to DTCC. Not all of those 10 can be used in some of the tests since a complete time series of the dependent variable could not be constructed. For example, for Argentina, the Philippines, and South Africa, I was not able to record a complete term structure of short term bonds to identify a reliable 1-year yield. As one might consider this control group to be exposed to different economic conditions than the treatment group, it is important to include the control variables mentioned in the previous paragraph.

It does not seem appropriate to utilize an event study approach that would identify specific dates on which the impact of the CDS ban occurred. The long period between announcement and implementation led to an unwinding of existing positions over several months and, to a slower transition from complete to incomplete market. *Post ban* is an indicator variable assuming the value of 1 starting Oct 21, 2011, and onwards. *EU member* is an indicator variable assuming the value 1 if the respective country is covered by the ban, and *EU Post ban* is the interaction among the two. Table 2 shows the results of a pooled regression; country-specific results are shown in the Appendix.

EU member states show positive equity returns relative to the control countries. Although the statistical significance is weak, the magnitude of the effect is not small; .3% when measured as weekly returns. The effect is slightly smaller when comparing the averages of the country-specific regressions: EU member states experience an increase of .17%, while control countries experience an increase of .05% only, as can be seen in Table 3 in the Appendix.

Since these are realized returns, I interpret this as evidence that equity values are *higher* after adopting the CDS ban. In accordance with Section 3.3, we should therefore expect stock market volatility to the be lower, consistent with lower expected returns. To test this, I use a measure of realized volatility as a dependent variable, equal to the squared MSCI returns of the respective country. Control variables are also squared. Regression results show that realized volatility is indeed *lower* after adopting the policy, and the effect is highly statistically significant.

	EU member	Post ban	**EU Post ban**	Controls	N	R^2
realized return	-0.156%	-0.046%	**0.295%**	Yes	3080	41.40%
t-stat	-0.881	-0.301	**1.452**			
realized vola	0.011%	0.028%	**-0.032%**	Yes	3080	25.07%
t-stat	0.865	2.549	**-2.171**			
yield changes	0.035	0.003	**-0.057**	Yes	2590	4.60%
t-stat	0.997	0.099	**-1.431**			
yield level	-0.167	-0.341	**-1.677**	Yes	2590	25.70%
t-stat	-0.751	-1.674	**-6.589**			
slope	-0.094	-0.460	**0.690**	Yes	2590	10.11%
t-stat	-1.460	-7.772	**9.346**			

Table 2: **Post-ban Effect.** Table shows results of a pooled regression of EU member states and non-EU states. The data consists of weekly observations between Jan 21, 2011 and Dec 12, 2013. Post announcement is the time period starting Oct 21, 2011. T-statistics are shown below the point estimate.

I then test the policy adoption on yield changes as the dependent variable. Country-specific regressions show that the average drop in yield is 4.3 basis points per week for EU member countries, compared to .6 basis point for control countries. The country showing the largest drop in yield is Portugal, which is also the country with the largest amount of CDS relative to debt outstanding. Pooled regression results show an effect of -5.7 basis points, the result is weakly statistically significant.

Using the level of yields as a independent variable leads to a more definite insight: I find a highly significant decrease of the short-term yield of EU member states relative to the control countries, the point estimate is 167 basis points. This is further support for the hypotheses in Section 3.3, where irrational agents underestimate the default state and do not revise their beliefs after adopting the ban.

4.1 Slope of the term structure

Table 2 also shows that although the level of yields has decreased, the slope of the term structure has increased, i.e. by 69 basis points for EU member countries post introduction of the ban. The slope is measured as the 5-year yield implicit in government bonds minus the 1-year yield, as reported by Bloomberg.

This is a result that occurs outside of the model since agents can only trade in one-period bonds. However, I can compute shadow prices of multi-period bonds given the optimal consumption values. Specifically, I compute the price of a two-period zero coupon bond paying 1 unit in the no-default states, and R in the crash state of the economy. In the intermediate time step, the bond pays the recovery rate as a fraction of face value in the crash state.

The model predicts an inverted term structure, a common feature in models with heterogeneous agents. More importantly, the slope is *steeper* in the incomplete market for a large range of recovery

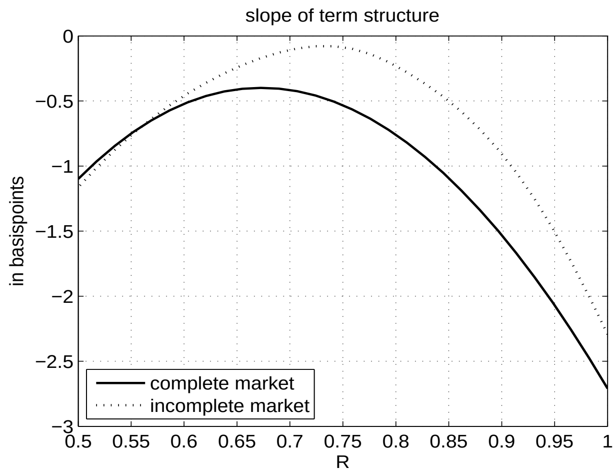

Figure 9: **Slope of the Term Structure.** The figure shows the yield of a 2-year bond minus the yield of a 1-year bond while holding p_2 constant, p_2 is assumed to be 2%. The x-axis is the recovery rate of the bond contract, the risk aversion coefficient equals 2.

rates and assuming effect 1 only, thereby in support of the empirical observation. The result is ambiguous though, and the channel through which it occurs it likely to be the evolution of rational versus irrational agents over time, in particular the longer survival of irrational agents in incomplete markets.

5 Conclusion

The asset pricing implications of the model are ambiguous. Imposing a CDS ban on the capital market can lead to an increase or decrease of borrowing rates, depending on whether or not investors become more optimistic after the ban. However, the data between 2011 and 2013 give additional insight, consistent with the prediction that stock market values increase, expected returns decrease, and borrowing rates are lower after adoption of the ban.

The findings of the paper support EU Regulation 236. Irrational investors who act according to optimal beliefs would start selling naked CDS after lifting the ban. However, they will be wrong ex-post – and the cost associated with this is greater than the benefit that rational investors could extract. Hence, incomplete markets appear welfare improving, at least for now.

My paper does not model the survival of investors under optimal beliefs. On one hand, we would expect the ban might slow down selection given that incomplete markets can protect irrational agents, as in Blume and Easley (2006). On the other hand, selection might accelerate as differences in beliefs tend to increase after the ban. Even though EU Regulation 236 can be welfare improving over a short-time horizon under optimal beliefs, one needs to investigate further whether this result holds over the long-run. This question can not be addressed in the current model given its short-time horizon and is deserving of a survival study, possibly in a separate paper.

Appendix

	intercept	post ban	MSCI	gold	fx rate
Federal Republic of Germany	-0.001	0.001	1.286	-0.035	1.070
	-0.712	0.562	24.055	-0.798	12.523
French Republic	-0.002	0.001	1.217	-0.023	1.011
	-1.194	0.584	25.140	-0.568	13.065
Republic of Austria	-0.007	0.005	1.299	-0.018	1.147
	-2.039	1.299	15.203	-0.260	8.397
Kingdom of Norway	-0.001	-0.001	1.079	0.143	0.776
	-0.254	-0.265	17.319	2.795	7.797
Kingdom of Belgium	-0.001	0.003	0.932	-0.015	0.587
	-0.352	0.827	13.139	-0.266	5.177
Portuguese Republic	-0.003	0.000	0.848	-0.009	0.804
	-0.796	-0.047	9.462	-0.119	5.608
Ireland	0.003	-0.002	1.190	-0.094	0.486
	0.983	-0.597	14.121	-1.352	3.605
Kingdom of Spain	-0.001	-0.002	1.198	-0.216	1.505
	-0.284	-0.345	11.740	-2.578	9.233
Republic of Italy	-0.003	0.000	1.314	-0.180	1.499
	-0.866	0.048	14.868	-2.473	10.611
Republic of Finland	-0.005	0.005	1.393	0.110	0.871
	-1.595	1.202	15.424	1.482	6.039
Kingdom of Denmark	-0.005	0.008	0.785	0.065	0.330
	-1.666	2.200	9.862	0.993	2.596
average	**-0.24%**	**0.17%**			
Argentine Republic	-0.008	0.004	1.087	-0.032	0.421
	-1.135	0.513	5.984	-0.213	1.451
Commonwealth of Australia	-0.001	-0.001	1.144	0.274	-0.025
	-0.293	-0.241	16.438	4.801	-0.229
Republic of Indonesia	0.003	-0.004	0.128	-0.091	0.204
	0.505	-0.612	0.773	-0.667	0.771
Japan	-0.001	0.001	0.749	-0.039	-0.524
	-0.496	0.416	10.358	-0.655	-4.534
Republic of Korea	-0.002	0.001	1.046	0.178	-0.176
	-0.509	0.275	9.684	2.002	-1.018
United Mexican States	-0.001	0.000	1.124	0.087	0.207
	-0.415	0.120	12.860	1.210	1.481
Republic of the Philippines	0.002	0.000	0.637	0.130	-0.635
	0.433	0.004	5.933	1.469	-3.699
Russian Federation	-0.005	0.002	1.148	0.208	0.401
	-1.157	0.517	10.870	2.398	2.373
Republic of South Africa	-0.002	0.001	0.994	0.275	-0.104
	-0.633	0.169	10.735	3.615	-0.700
average	**-0.15%**	**0.05%**			

Table 3: **Equity returns Post-Ban.** The table shows country-specific regressions of EU member states and non-EU states. The data consists of weekly observations between Jan 21, 2011 and Dec 12, 2013. Post announcement is the time period starting Oct 21, 2011. T-statistics are shown below the point estimate. The dependent variable in all cases is the MSCI (local) index, control variables are the change in the MSCI (global), the gold price, and the EUR/USD exchange rate.

	intercept	post ban	MSCI	gold	fx rate
Federal Republic of Germany	-0.006	-0.001	0.758	-0.602	2.457
	-0.572	-0.086	2.973	-2.869	6.028
French Republic	-0.006	0.001	0.448	-0.148	1.652
	-0.480	0.039	1.268	-0.510	2.928
Republic of Austria	-0.012	0.004	-0.414	-0.954	2.361
	-0.607	0.188	-0.773	-2.164	2.756
Kingdom of Norway	-0.018	0.008	1.481	-0.254	3.392
	-0.923	0.379	3.720	-0.804	5.342
Kingdom of Belgium	-0.007	-0.002	-3.124	0.016	-1.148
	-0.205	-0.050	-3.304	0.021	-0.760
Portuguese Republic	0.318	-0.426	-2.971	1.856	-15.485
	1.830	-2.108	-0.653	0.496	-2.129
Ireland	-0.014	-0.016	-5.086	2.432	-16.654
	-0.081	-0.076	-1.127	0.660	-2.325
Kingdom of Spain	0.001	-0.007	-4.113	1.498	-7.703
	0.014	-0.109	-2.716	1.203	-3.182
Republic of Italy	0.026	-0.033	-4.469	1.990	-5.613
	0.560	-0.610	-3.650	1.978	-2.869
Republic of Finland	-0.006	-0.002	0.353	-1.044	3.061
	-0.470	-0.161	1.045	-3.761	5.669
Kingdom of Denmark	-0.010	0.001	1.146	-0.744	3.970
	-0.735	0.069	3.254	-2.571	7.054
average	**0.024**	**-0.043**			
Commonwealth of Australia	-0.007	-0.018	2.608	-0.768	3.036
	-0.340	-0.800	5.181	-1.857	3.773
Republic of Indonesia	-0.021	0.037	-1.334	-1.135	-0.113
	-0.481	0.709	-1.143	-1.184	-0.061
Japan	-0.001	0.000	0.014	-0.032	0.020
	-0.542	0.193	0.454	-1.283	0.423
Republic of Korea	0.012	-0.020	0.135	-0.687	1.488
	0.858	-1.266	0.382	-2.364	2.634
United Mexican States	-0.013	0.007	-0.304	0.218	-0.583
	-0.948	0.456	-0.960	0.871	-1.182
Russian Federation	0.038	-0.042	-1.082	-0.337	-0.534
	1.377	-1.283	-1.481	-0.561	-0.457
average	**0.001**	**-0.006**			

Table 4: **Yield Changes Post-Ban.** The table shows country-specific regressions of EU member states and non-EU states. The data consists of weekly observations between Jan 21, 2011 and Dec 12, 2013. Post announcement is the time period starting Oct 21, 2011. T-statistics are shown below the point estimate. The dependent variable in all cases is the change in the 1-year yield of the respective country, or the 2-year yield if unavailable. Control variables are the change in the MSCI global, the gold price, and the EUR/USD exchange rate.

References

Ashcraft, A., and J. Santos, 2009, "Has the CDS market lowered the cost of corporate debt?" *Journal of Monetary Economics*, 56, 514–523.

Basak, S., and D. Cuoco, 1998, "An Equilibrium Model With Restricted Stock Market Participation," *Review of Financial Studies*, 11, 309–341.

Blume, L., and D. Easley, 2006, "If you're so smart, why aren't you rich? Belief selection in complete and incomplete markets," *Econometrica*, 74, 929–966.

Brunnermeier, M., C. Gollier, and J. Parker, 2007, "Optimal Beliefs, Asset Prices, and the Preference for Skewed Returns," *American Economic Review*, 97, 159–165.

Brunnermeier, M., and J. Parker, 2005, "Optimal Expectations," *American Economic Review*, 95, 1092–1118.

Brunnermeier, M., A. Simsek, and W. Xiong, 2014, "A welfare criterion for models with distorted beliefs," *Quarterly Journal of Economics*, 129, 1753–1797.

Cruces, J., and D. Trebsch, 2013, "Sovereign Defaults: The Price of Haircuts," *American Economic Journal: Macroeconomics*, 5, 85–117.

Dieckmann, S., 2011, "Rare Event Risk and Heterogeneous Beliefs: The Case of Incomplete Markets," *Journal of Financial and Quantitative Analysis*, 46, 459–488.

Duffie, D., 2011, "Is there a case for banning short speculation in sovereign bond markets?" *Financial Stability Review*, 14, 55–59.

Gallmeyer, M., and B. Hollifield, 2008, "An Examination of Heterogeneous Beliefs with a Short-Sale Constraint in a Dynamic Economy," *Review of Finance*, 12, 323–364.

Ismailescu, I., and B. Phillips, 2015, "Credit default swaps and the market for sovereign debt," *Journal of Banking and Finance*, 52, 43–61.

Kiesel, F., F. Luecke, and D. Schiereck, 2015, "Regulation of uncovered sovereign default swaps - evidence from the European Union," *Journal of Risk Finance*, 16, 425–443.

Marin, J., and R. Rahi, 2000, "Information Revelation and Market Incompleteness," *Review of Economic Studies*, 67, 455–481.

Oehmke, M., and A. Zawadowski, 2015, "Synthetic or Real: The Equilibrium Effects of Credit Default Swaps on Bond Markets," *Review of Financial Studies*, 28, 3303–3337.

Schulz, M., and N. Wammen, 2012, "Regulation (EU) No 236/2012 of the European parliament and of the council of 14 March 2012 on short selling and certain aspects of credit default swaps," *Official Journal of the European Union*, 86, 1–24.

Silva, P., C. Vieira, and I. Vieira, 2016, "The EU ban on uncovered sovereign credit default swaps: Assessing impacts on liquidity, volatility, and price discovery," *Journal of Derivatives*, 23, 74–98.

Subrahmanyam, M., D. Tang, and S. Wang, 2014, "Does the tail wag the dog? The effect of Credit Default Swaps on Credit Risk," *Review of Financial Studies*, 27, 2926–2960.