

## Have EU Derivative Policy Reforms since the 2008 Financial Crisis Been Designed Effectively?

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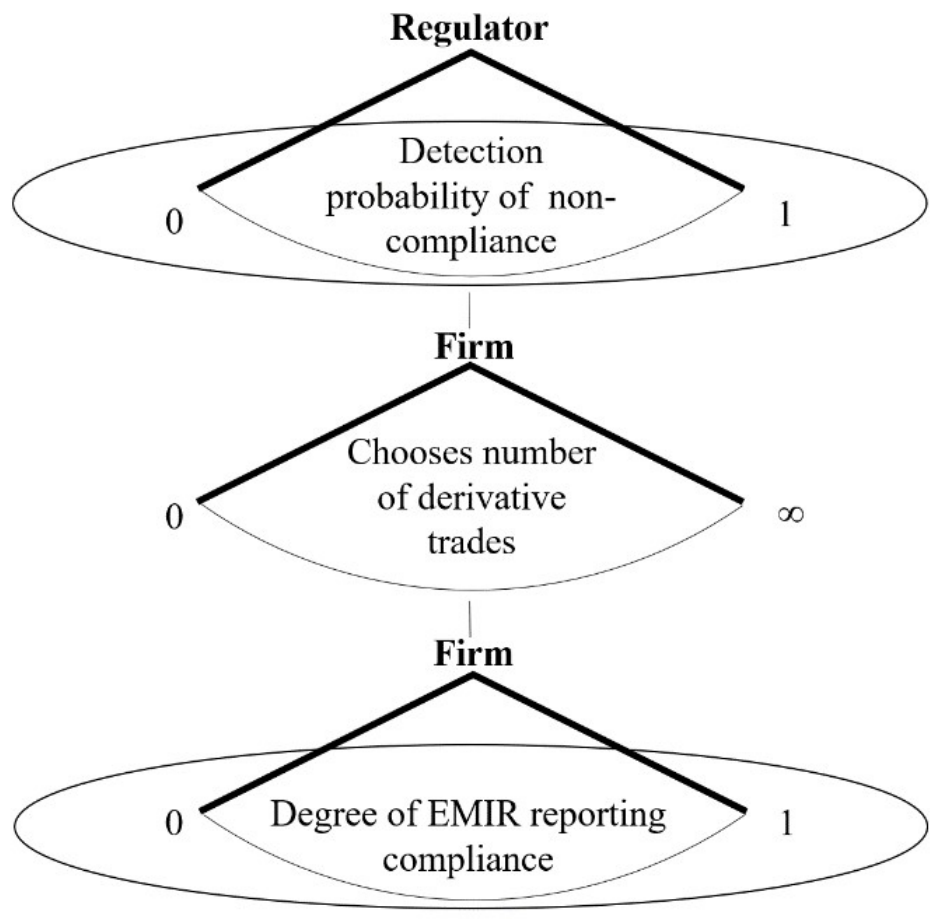


Figure 1: One-period, three stage EMIR reporting game  
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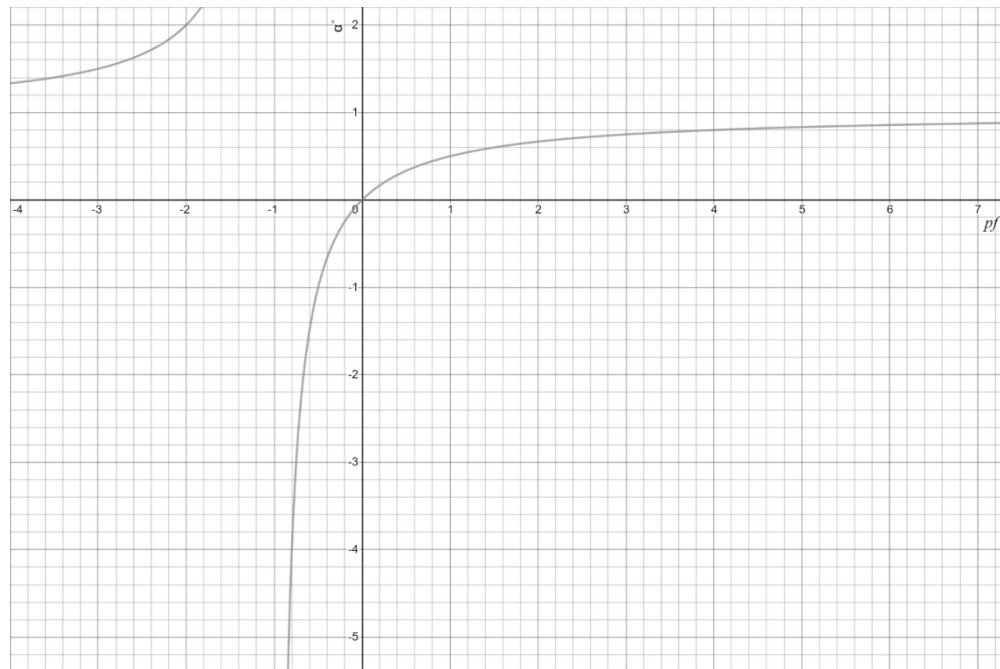


Figure 2: Effect of a change in the factor  $pf$  (x-axis) on optimal firm compliance (y-axis).

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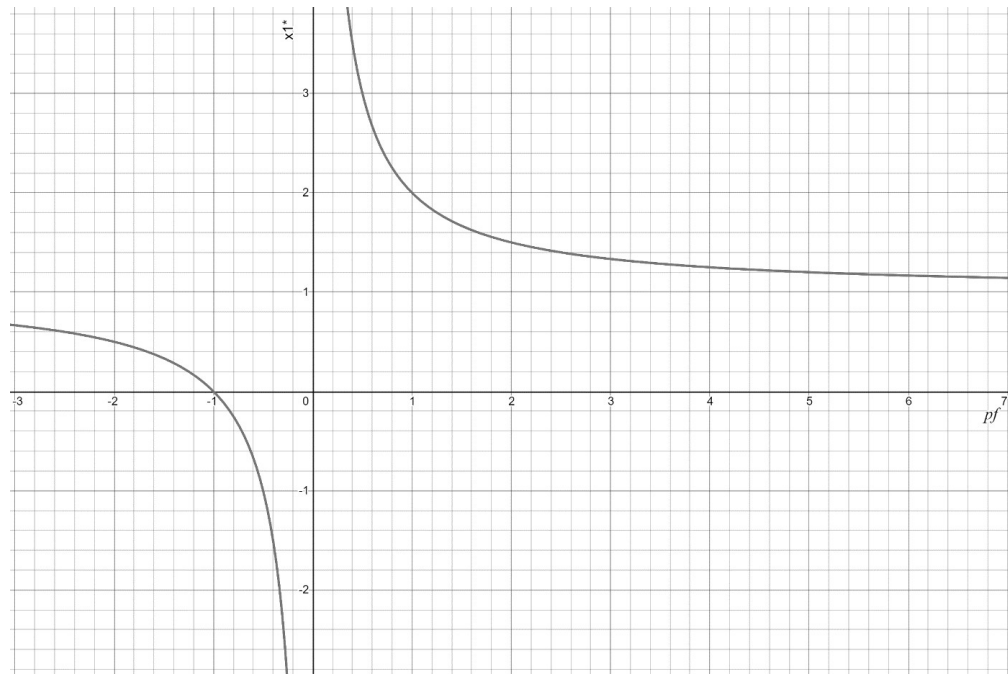


Figure 3: Effect of a change in the factor  $pf$  ( $x$ -axis) on optimal number of derivative trades ( $y$ -axis), *ceteris paribus*.

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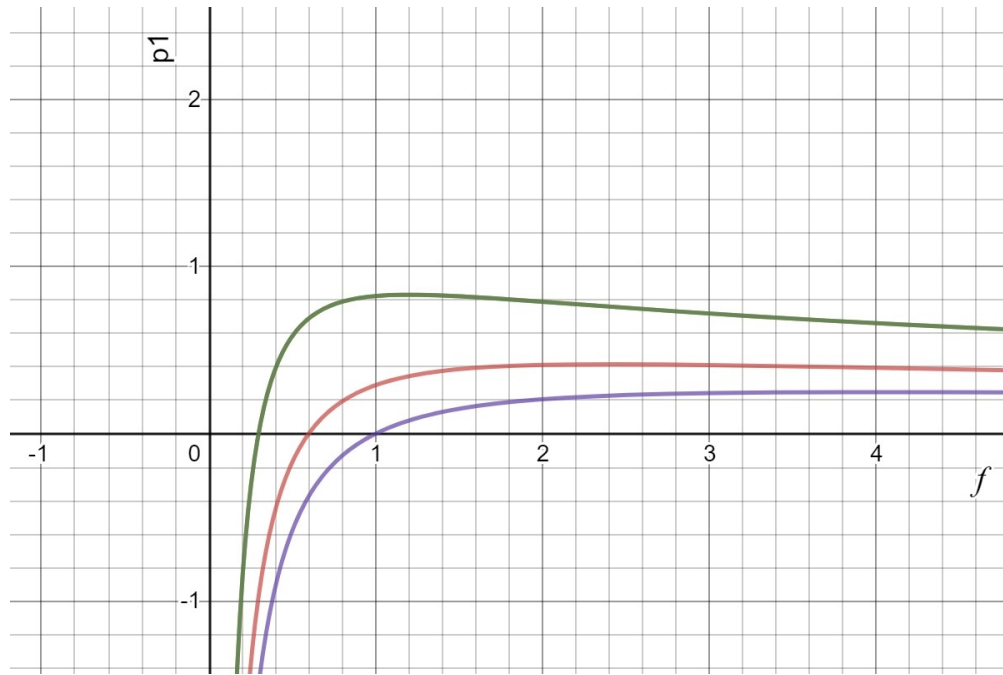


Figure 4: Effect of fine parameter on optimal detection probability with different detection costs

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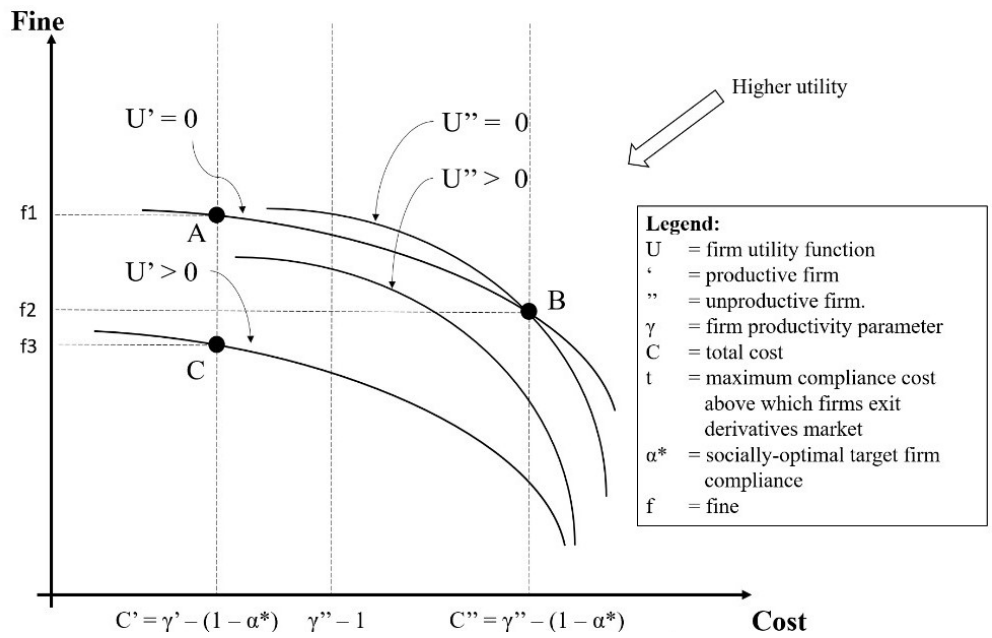


Figure 5: Conditions required to incentivise both firm types to comply optimally

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3 **Have EU Derivative Policy Reforms since the 2008 Financial Crisis Been**  
4 **Designed Effectively? A Theoretical Analysis of EMIR Reporting Requirements**  
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10 **ABSTRACT**

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12 *Purpose:*

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14 In response to the 2008 financial crisis, the EU comprehensively restructured its derivative regulation.  
15 A key component of this new framework is a reporting obligation for every derivative trade. As the  
16 reporting requirement does not involve public disclosure of the information, existing academic analysis  
17 on reporting regulations to-date, which focuses on public disclosure, is limited in predicting the  
18 effectiveness of the reform. In this paper, I develop a theoretical model to assess whether the reform  
19 has been designed effectively based on the regulatory setup in the UK.  
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25 *Methodology:*

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27 Framing the reporting regulation as a moral hazard problem with asymmetric information, this paper  
28 uses a game-theoretical approach to evaluate whether the new derivative reporting obligation effectively  
29 induces firm compliance. I also discuss potential extensions of the derivative reporting model, with  
30 particular emphasis on how the framework could account for heterogeneous firms and different  
31 regulatory tools.  
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36 *Findings:*

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38 Based on the theoretical analysis, this paper finds that while firms are unlikely to comply fully with  
39 derivative reporting requirements, it is possible to induce relatively high firm compliance. Although  
40 this does not mean we are immune from another financial crisis, the derivative reporting requirements  
41 should equip EU regulators to monitor a more transparent and secure derivatives market.  
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46 *Originality:*

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48 This paper provides a theoretical foundation for further study of post-crisis derivative reforms. In  
49 particular, the implications of the model point to an empirical strategy to test the accuracy of the model.  
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51 *Keywords:* Derivatives, Regulation, EU, European Market Infrastructure Regulation, EMIR, Financial  
52 Crisis, Game Theory.  
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54 *Article classification:* Research Paper  
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## 1. INTRODUCTION

Derivatives are financial contracts whose value depend on an underlying asset. They are primarily used to reallocate risk exposures between economic agents. The derivatives market is divided into exchange-traded derivatives (ETDs) and over-the-counter (OTC) derivatives. ETDs are standardised contracts, traded through an intermediary counterparty that guarantees the trade if either counterparty defaults (Chui, 2012). OTC derivatives are agreed bilaterally and can be customised extensively. The size of the global OTC derivatives market was estimated to be \$640tn in 2019 (BIS, 2019), which is almost eight times global GDP (World Bank, 2019). In 2016, the size of the global ETD market was estimated to be around 10% of the global OTC derivatives market. Similarly, the European derivatives market is mainly OTC derivatives (European Commission, 2017).

While providing flexibility, OTC derivatives can create complex hidden networks of interdependence, obscuring the scale and location of risks (European Commission, 2012). According to the official EU report on the 2008 financial crisis, the lack of transparency in the OTC derivatives market is widely considered a significant contributor. The report explains that explosive growth of the highly complex OTC credit derivatives market, combined with the lax regulatory framework, led to widespread uncertainty as to both the size and nature of credit risks globally. As counterparty exposures to OTC derivative risks were unknown, liquidity markets dried up, further intensifying the effects of the collapse of the sub-prime housing market (De Larosiere *et al.*, 2009). Before the 2008 financial crisis, the derivatives market was largely self-regulated, led by banks and industry bodies (Ayadi and Behr, 2009).

Following this EU report, the global G20 committed to improving the transparency and regulatory oversight of the OTC derivatives market. In Europe, this resulted in the European Market Infrastructure Regulation (EMIR). Under EMIR, there are three main requirements: clearing, margining and reporting. Standardised derivatives should be cleared through a central counterparty, which guarantees the trade if either counterparty defaults. Any non-cleared derivatives must be margined; the counterparties must exchange collateral as insurance against counterparty credit risk. Finally, both counterparties are required to report details of the trade to allow national authorities to monitor and reduce systemic risks associated with the derivatives market (European Commission, 2012).

To understand the chosen literature reviewed in the next section, it is important to explain the reporting requirement in more detail. For every agreement, amendment or expiry of a derivatives contract, both counterparties are required to report details who they are trading with and the nature of the trade. The dual nature of reporting **is for data** quality **purposes** and reduces the incentive to omit trades. Firms can choose to delegate the reporting obligation to the other counterparty or a third-party. The delegating firm remains responsible for the accuracy of the reports. There are over 100 fields in each report, although not all fields are applicable to each trade. Reports are submitted to a trade repository, where the data is aggregated and stored. The national regulator for each EU country can access the data to



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3 monitor the derivatives market and individual firm exposures (European Commission, 2012). In the UK  
4 for example, the financial services sector is regulated by the Financial Conduct Authority (FCA).  
5 Unlike most reporting regulations, the information reported is not disclosed publicly. This  
6 fundamentally changes the underlying regulatory mechanism and incentives. As of May 2020, the only  
7 UK enforcement case against a firm for EMIR reporting non-compliance was against Bank of America  
8 Merrill Lynch International (BAML) in 2017 for failing to report almost 70m trades. The FCA imposed  
9 a £34.5m fine (FCA, 2017a).  
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15 Given the effects of the 2008 financial crisis, which are partially due to the lack of transparency in the  
16 derivatives market, it is important that the chosen policy measures in response are effective in  
17 preventing similar crises. However, as I will explain in section 2.2, the effectiveness of disclosure  
18 policies in financial regulation is unclear. My research question is the following:  
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24 *Does the regulatory mechanism underlying EMIR reporting requirements create sufficient economic*  
25 *incentives for firm compliance?*  
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30 To answer this question, I will theoretically model EMIR reporting requirements. To motivate my  
31 research question and theoretical analysis, I will now discuss existing literature on EMIR reporting and  
32 disclosure policies as a regulatory tool.  
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## 38 2. LITERATURE REVIEW

### 39 2.1 EMIR REPORTING

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42 There are a number of issues with EMIR reporting. Firstly, the dual nature of reporting has highlighted  
43 that the data quality is low. ESMA (2018) estimated that 14% of reports could not be paired with the  
44 counterparty report, indicating that basic information was inconsistent between reports. Pérez-Duarte  
45 and Skrzypczynski (2018) found worse pairing rates, with almost 25% of trade reports being unpaired.  
46 A Freedom of Information Act revealed that only 40% of EMIR trade reports matched (Wilkes, 2019),  
47 suggesting that the quality of information submitted was poor, even if the reports could be paired. Given  
48 these pairing and matching rates, it is unlikely that the data can currently be used to accurately assess  
49 systemic financial risk.  
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55 Rousová *et al.* (2015) emphasises logistical issues with EMIR reporting. The counterparties could report  
56 the trade to different entities, hampering the reconciliation of reports. Furthermore, the lack of  
57 harmonisation of reporting requirements across non-EU countries makes aggregation of international  
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3 data difficult, narrowing the scope to assess the global systemic risk of derivative trading (van Lelyveld,  
4 2017).

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7 Unlike for other requirements introduced under EMIR, there are no obvious economic incentives for  
8 firms to accurately report all their derivative trades. For certain commodity derivatives, firms reporting  
9 under EMIR are exempt from reporting exemptions for overlapping regulations such as REMIT  
10 (European Commission, 2014a). However, this does not apply to MiFIR reporting for example, another  
11 large-scale reporting requirement for financial instruments including derivatives (European  
12 Commission, 2014b). It is conceivable that firms may use their EMIR reports for documentation  
13 purposes. Overall, EMIR reporting is primarily a pure cost for firms (FIA, 2019).

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18 In contrast, the Financial Stability Board (2018) finds significant economic incentives for firms to  
19 participate in clearing. For example, capital obtained through clearing is given preferential treatment,  
20 due to the resulting lower risk exposures for the firm. Clearing also allows for various risk management  
21 techniques, such as netting, that reduce counterparty credit risk exposures and therefore a financial  
22 firm's capital requirements (FSB, 2018). The economic case for the margin requirements under EMIR  
23 is less straightforward. However, given that margining is reserved for non-standard trades that cannot  
24 cleared easily, costly margin requirements may be beneficial for financial stability by encouraging firms  
25 to trade in standardised derivatives, which can be cleared. Therefore, economic incentives to margin  
26 are less important than incentives to clear. Additionally, unlike for EMIR reporting requirements, the  
27 clearing and margining requirements do not apply to firms trading in volumes below certain thresholds  
28 (European Commission, 2012). As argued by Levine and Macey (2017) for the US-equivalent of EMIR,  
29 these thresholds and differential treatment of cleared and non-cleared derivatives act as a Pigouvian tax  
30 on systemically important US firms. The social cost of creating systemic risk may not be factored into  
31 firms' business models. By varying the compliance costs according to business activity risk and firm  
32 size, firms are incentivised to avoid creating concentrated risk. However, EMIR reporting requirements  
33 apply equally to both ETDs and OTC derivatives and apply to all firms, contrary to the Pigouvian tax  
34 argument.

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EMIR is a relatively new policy. It is unclear whether the issues with EMIR reporting requirements can  
be ironed out, or whether it is fundamentally flawed. As noted by Claessens and Kodres (2014) in their  
paper on issues with the global regulatory response to the 2008 financial crisis, there is a gap in the  
academic literature on the effectiveness of post-crisis regulations and requirements. While academic  
literature is silent on EMIR reporting, the effectiveness of mandatory disclosure policies in other areas  
of financial regulation are widely discussed. To assess whether literature on other disclosure policies  
could be applied to EMIR reporting, we now look into the academic study of disclosure policies.

## 2.2 MANDATORY DISCLOSURE POLICIES

Mandatory disclosure policies are a common regulatory technique, where private or public institutions are required to reveal information to satisfy a clear regulatory objective (Weil *et al.*, 2006). Proponents argue that they allow market participants to make informed decisions at low cost (Ben-Shahar and Schneider, 2014).

Weil *et al.* (2006) provide a framework to assess the effectiveness of a regulatory disclosure policy. They argue that mandatory disclosure policies are only effective if the resulting information allows both the information users and disclosers to significantly improve their choices at an acceptable cost. More recent papers have largely agreed with this criteria, for example Mitchell (2011), who cautions that “transparency can best be viewed as a “weak” cause of behavioural change.”

Cross-country empirical studies have shown that corporate financial reporting requirements are associated with greater capital market development (Porta *et al.*, 2006), higher market liquidity (Christensen *et al.*, 2016) and lower cost of capital (Hail and Leuz, 2006). However, Leuz and Wysocki (2016) explain that causal effects of disclosure policies are hard to estimate because they are often a response to a major event. For this reason, it is difficult to distinguish between the market reactions to the event and the effect of the disclosure policy itself.

The lack of empirical evidence conclusively supporting disclosure policies is echoed by Ben-Shahar and Schneider (2014). They question whether disclosure policies carry any significant benefits, as the resulting information is often complex and thus difficult to understand. Additionally, they argue that due to the vast number of existing disclosure policies, even if a disclosure policy was effective in isolation, the policies become ineffective when aggregated. The authors acknowledge that this argument is difficult to show empirically, but suggest that the resulting net effect would prove most disclosure policies unjustifiable.

In relation to financial markets, Shen (2011) finds that while incomplete disclosure has been pinpointed as the root cause of the mis-selling of minibonds by Lehman Brothers in Hong Kong, full disclosure would still have been insufficient due to the complexity of the underlying product. The paper suggests that disclosure policies should only be used to supplement rigorous protective regulation. Avgouleas (2009) argues that while the pre-crisis disclosure framework contributed significantly to the 2008 crisis, disclosure policies are not necessarily fundamentally flawed. In particular, he suggests that disclosure policies have clear benefits in some cases, such as market abuse regulation and making capital market more democratic.

Academic papers have theoretically modelled the effects of disclosure policies. Guttentag (2007) develops a model of the relationship between disclosure policies and social welfare. Goldstein and Yang (2017) model the key mechanisms through which disclosure policies affect financial markets,

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3 highlighting several trade-offs needed to assess the optimal level of information disclosure. Hermalin  
4 and Weisbach (2012) present a principal-agent model that demonstrates how, even assuming there is  
5 no direct cost of a disclosure policy, the optimal disclosure level may be bounded. Kanto and  
6 Schadewitz (1997) model the relationship between information and quality in interim reports and the  
7 subsequent stock market reaction. Cohen and Santhakumar (2007) present a theoretical model of  
8 mandatory disclosure policies and bargaining power in environmental regulation. Alvarez and Barlevy  
9 (2015) model how mandatory disclosure policies can limit financial contagion, concluding that there is  
10 only a role for mandatory disclosure when there is sufficient interdependence across banks.  
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16 While these models formalise elements of EMIR reporting that are relevant to assessing its  
17 effectiveness, there are underlying assumptions in each of the models that diminish their applicability  
18 to EMIR. Guttentag (2007), Goldstein and Yang (2017), Kanto and Schadewitz (1997) and Cohen and  
19 Santhakumar (2007) assume that the information is disclosed publicly. As explained previously, in the  
20 case of EMIR reporting, the information is not disclosed publicly but directly to the regulator.  
21 Additionally, models such as the environmental disclosure model by Cohen and Santhakumar (2007)  
22 assume that the negative externality, in their case pollution, is easily quantifiable. This is not the case  
23 with financial stability, limiting the applicability of such models to the case of EMIR reporting. The  
24 models presented by Hermalin and Weisbach (2012) and Cohen and Santhakumar (2007) assume that  
25 the economic agents can influence the extent of disclosures. In the case of EMIR, it would be more  
26 realistic to assume that the disclosure policy is mandated exogenously, as the regulatory requirements  
27 are already in place. These bargaining models typically model the relationship between senior  
28 management and the shareholders, instead of the firm and the government. The model presented by  
29 Alvarez and Barlevy (2015) models how disclosure policies can mitigate information asymmetries  
30 between a bank and its investors. They incorporate a different punishment mechanism than in the firm-  
31 regulator scenario, limiting the applicability of the model.  
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42 A lack of unifying theory of mandatory disclosure mechanisms is echoed by Beyer *et al.* (2010). They  
43 explain that this is because the benefit of mandatory disclosure policies is based on how the welfare  
44 effects of each stakeholder are valued. They also caution that more transparency can be detrimental in  
45 some principal-agent models if more information facilitates collusion between agents. The authors  
46 acknowledge that in some cases no disclosure can be better than a one-tiered approach. For this reason,  
47 they advocate further research into of how one-size-fits-all reporting standards impact differing firms.  
48 Leuz and Wysocki (2016) also see scope for further theoretical research to identify potential regulatory  
49 effects of disclosure policies. They argue this would allow for carefully designed empirical studies to  
50 estimate the causal effects of disclosure policies.  
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In short, current theory and empirical evidence on disclosure policies cannot be directly applied to the  
case of EMIR reporting, due to a different underlying mechanism through which the policy hopes to

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3 achieve transparency. The overview above highlights the gap in academic literature of non-public  
4 disclosure policies. To accurately assess the effectiveness of the design of EMIR reporting, we need a  
5 new model of the relationship between the reporting firm and the regulator that reflects the setup of the  
6 regulation.  
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### 10 **3. Methodology**

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12 In this paper, I use game theory to model the actions of the regulator and the reporting firm within the  
13 legislative framework set out under EMIR. This allows us to understand the optimal decisions of each  
14 agent subject to the optimal actions of the other agent. Game theory is a particularly useful method in  
15 this setting because both agents are self-interested and rational.  
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19 To model the firm-regulator EMIR reporting game, we divide the decisions made by each agent into  
20 three stages. This allows us to determine how much information each agent knows when they make a  
21 decision, which affects any constraints on their optimal decision. We distinguish at each stage whether  
22 the decision made is visible to the other agent. We use backward induction to solve for the optimal  
23 actions of each agent, which is the standard method for solving sequential games (Osborne, 2009).  
24 Backward induction starts at the final decision in a game, working backwards to deduce the optimal  
25 decision of each agent subject to the decisions made so far.  
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30 Within each stage of the game, we use constrained optimisation to maximise the utility of each agent.  
31 This allows us to incorporate any restriction on decision-making based on the EMIR reporting  
32 framework to account for any limitations from the actions of the other agent. As derivative reporting by  
33 firms and the monitoring of derivatives reporting by the regulator are costly for the respective agent,  
34 we can maximise the utility of each agent by minimising their costs. We follow the standard cost  
35 minimisation methodology which is explained in more detail in Pemberton and Rau (2015).  
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40 The subsequent analysis is set out as follows. In section 4.1, I explain the setup of the model. In section  
41 4.2, I solve the EMIR reporting model step-by-step using backward induction and constrained  
42 optimisation. Section 5 discusses the implications of the model; section 6 extends the model to  
43 heterogeneous firms and section 7 concludes.  
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## 50 **4. ANALYSIS**

### 51 **4.1 OVERVIEW**

52 We will base the EMIR reporting model on the regulatory setup in the UK. The regulatory objectives  
53 of the FCA, the UK financial services regulator, are public and clear. They would like to “protect  
54 consumers”, “protect financial markets” and “promote competition” (FCA, 2019a). A more transparent  
55 derivatives market contributes to these goals by increasing financial stability through better oversight  
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of a historically risky market. We can reasonably assume that the primary objective of the firm is to make profits, and by association minimise costs. In this case, they would like to choose the number of derivative trades and degree of EMIR reporting compliance to minimise costs and maximise profits.

EMIR reporting can be viewed as a moral hazard problem. The regulator would like firms to provide complete and accurate information on their derivative trades. The firms would like to minimise the costs associated with this business activity. However, both agents face imperfect information. The regulator cannot directly observe whether the information is complete or accurate given the vast number of reports, the complexity of the underlying product and that firms self-report. Similarly, the firm cannot directly observe the probability of being caught if they do not comply. Although the FCA publishes an annual business plan, the precise resource allocations and priorities of the regulator are not public.

Figure 1 illustrates the one-period, three stage EMIR reporting game, which we will solve using backward induction. Note that the circles symbolise an **information asymmetry** at that stage. Starting in the final stage, the firm chooses how much they would like to comply with EMIR reporting requirements, which is hidden from the regulator. Based on this, the firm chooses how many derivative trades to undertake, which is visible to the regulator. The regulator forms an expectation of firm compliance, in part based on the disclosed number of trades and chooses a detection probability for any non-compliance, which is associated with a fine.

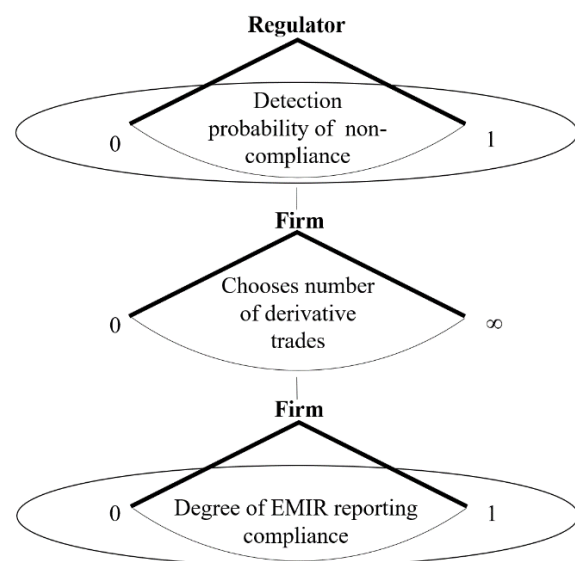


Figure 1: One-period, three stage EMIR reporting game

As the reporting requirements are the same for all types of derivatives, we will not distinguish between derivative types. Based on the BAML non-compliance enforcement case, we assume that the regulatory tool available is a fine and associated non-compliance detection probability. In UK financial regulation, fines for regulatory breaches are determined based on the principles outlined in the FCA handbook (FCA, 2020). Fines are also not the only regulatory tool available to the regulator. While a firm may be able to roughly estimate how the regulator will punish any non-compliance, there is significant leeway for the regulator to take action they deem appropriate to maintain financial stability (FCA, 2020). For ease of analysis, we assume that firms are risk-neutral. As in the figure above, we assume that the regulator observes how many trades the firms undertakes. As both counterparties are required to report, it is likely that the regulator observes at least one side of the trade, even if the quality of the report is low. Additionally, the regulator could use information on the frequency of derivative trading from other

regulations, such as MiFIR for example, which focuses on identifying market abuse (European Commission, 2014b).

## 4.2 EMIR REPORTING MODEL

We look at the setting of one firm and one regulator. In section 4.2.1, the firm chooses to what extent they would like to comply with EMIR reporting requirements, but this is hidden from the regulator. Based on this, in section 4.2.2, the firm chooses the number of derivative trades it would like to undertake. In section 4.2.3, the regulator determines how much to prioritise EMIR reporting by choosing the non-compliance detection probability, which is hidden from the firm. Based on this game setup, we can formalise this principal-agent problem mathematically.

### 4.2.1 STAGE 3: EMIR REPORTING COMPLIANCE

The firm would like to choose a level of EMIR reporting compliance,  $\alpha \in [0,1]$ , to minimise their costs. Their cost function has two inputs: derivative trading,  $x_1$ , and all other business activities,  $x_2$ . We denote the input price of all other business activities as  $w_2$ . We assume that EMIR reporting is the only cost to derivative trading for firms. In a first stage, we assume the number of derivatives trades a firm undertakes is exogenous. Finally, we assume that the cost of compliance increases exponentially as the firm approaches full compliance. While primarily a technical assumption to ensure that the cost function is twice-differentiable, it may be reasonable given the complexity of derivatives and the extent of the reporting details required under EMIR. As the firm approaches full compliance, the costs associated with designing IT systems that accurately assess and report each trade for example may increase significantly. For simplicity, we assume this results in the input cost of compliance,  $\alpha$ , being squared. Based on these assumptions, the firm has the following cost function,  $C(\alpha)$ :

$$C(\alpha) = \alpha^2 x_1 + w_2 x_2$$

The probability of being fined for any non-compliance,  $p \in [0,1]$ , is unknown to the firm. However, we assume they can approximate the relationship between non-compliance, number of trades affected and the resulting fine. For this, we introduce a constant fine parameter  $f > 0$ . Once again, to ensure twice-differentiability, we assume the firm expects higher non-compliance to be punished exponentially more severely. Given the cumulative risks of non-compliance to maintaining a transparent derivatives market, this seems to be a reasonable assumption in line with punishment guidelines set-out in the FCA handbook (FCA, 2020). Based on this, the firm approximates the fine mechanism as follows:

$$F(\alpha) = (1 - \alpha)^2 f x_1$$

Using  $C(\alpha)$  and  $F(\alpha)$ , we can construct the firm's expected disutility function,  $G(\alpha)$ :

$$\begin{aligned} G(\alpha) &= (1-p)C(\alpha) + p[C(\alpha) + F(\alpha)] \\ &= (1-p)[\alpha^2x_1 + w_2x_2] + p[\alpha^2x_1 + w_2x_2 + (1-\alpha)^2fx_1] \\ &= \alpha^2x_1 + w_2x_2 + p(1-\alpha)^2fx_1 \end{aligned}$$

The firm would like to choose the value for  $\alpha$  that minimises their expected disutility. To find this optimal compliance level,  $\alpha^\circ$ , we differentiate  $G(\alpha)$  with respect to  $\alpha$  and set  $G'(\alpha)$  equal to zero:

$$\begin{aligned} G'(\alpha) &= 2\alpha x_1 - 2p(1-\alpha)fx_1 && | \text{ Set } G'(\alpha) = 0 \\ 2\alpha x_1 &= 2p(1-\alpha)fx_1 && | \div 2x_1 \\ \alpha &= pf - \alpha pf && | + \alpha pf \\ \alpha^\circ &= \frac{pf}{1+pf} && (9) \end{aligned}$$

The optimal firm compliance is positively associated with the extent of the fine,  $f$ , and the non-compliance detection probability,  $p$ . As  $f$  and  $p$  are non-negative, in this model full compliance ( $\alpha^\circ = 1$ ) is only optimal if the fine is infinitely large. This is illustrated graphically in figure 2.

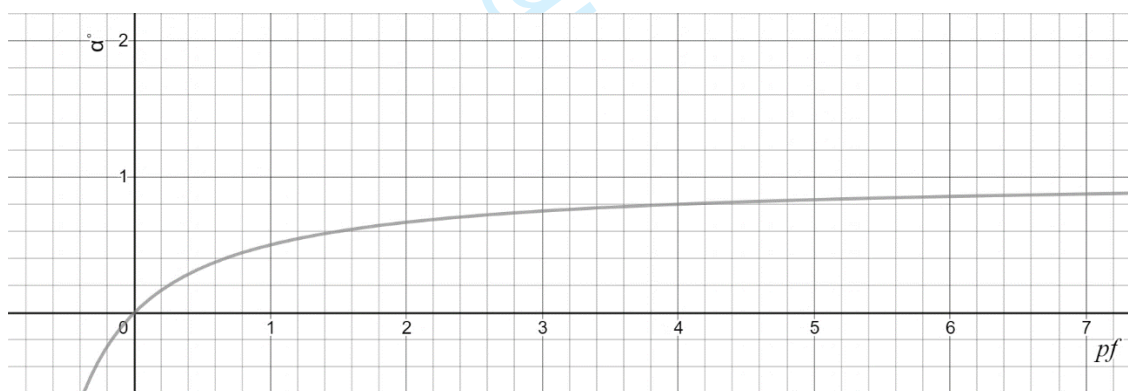


Figure 2: Effect of a change in the factor  $pf$  ( $x$ -axis) on optimal firm compliance ( $y$ -axis).

It is important to note that in this setup, optimal firm compliance is independent of the number of trades the firm undertakes. This is largely due to the chosen functional forms, and may not hold in the real world. It is conceivable that the non-compliance detection probability  $p$  is dependent on the number of derivative trades. In UK financial regulation for example, smaller firms are grouped together based on their business model, whereas larger financial firms are monitored individually by dedicated teams (FCA, 2019b). Therefore, there is most likely a link between firm size, the number of derivatives they trade in and how closely their derivative reporting is scrutinised.

To verify that equation (9) is a minimum for the expected disutility function  $G(\alpha)$ , we calculate the second derivative:



$$G''(\alpha) = 2x_1 + 2pf x_1$$

As the number of derivative trades  $x_1$ , the non-compliance detection probability  $p$  and the fine parameter  $f$  are strictly non-negative, the second derivative is positive, meaning  $G'(\alpha) = 0$  is a minimum.

#### 4.2.2 STAGE 2: NUMBER OF DERVIATIVE TRADES

We now endogenize the number of trades. To do this, we plug the optimal compliance level,  $\alpha^\circ$ , from equation (9) back into  $G(\alpha)$ :

$$G(\alpha) = \alpha^2 x_1 + w_2 x_2 + p(1 - \alpha^\circ)^2 f x_1 \quad (10)$$

By factorising equation (10), the problem becomes a standard cost minimisation question with cost function  $C(x_1, x_2)$ :

$$C(x_1, x_2) = \hat{w}_1 x_1 + w_2 x_2 \quad \text{where } \hat{w}_1 \equiv \alpha^{\circ 2} + p(1 - \alpha^\circ)^2 f$$

For ease of derivation, we assume that the firm has a Cobb-Douglas production function, where  $q$  is equal to output and  $\beta \in [0, 1]$  is a constant. Output is difficult to define in financial services. In this case, output is the cumulation of all of a financial firms' business activities.

$$\min_{x_1 x_2} \hat{w}_1 x_1 + w_2 x_2 \text{ subject to } x_1^\beta x_2^{1-\beta} = q$$

As detailed by Pemberton and Rau, (2015), we can solve this cost minimisation problem using Lagrange's method of undetermined multipliers. Let  $L(x_1, x_2, \lambda)$  be the Lagrangian function, where  $\lambda$  is the Lagrange multiplier:

$$L(x_1, x_2, \lambda) = \hat{w}_1 x_1 + w_2 x_2 - \lambda [x_1^\beta x_2^{1-\beta} - q]$$

By differentiating  $L$  with respect to  $x_1$ ,  $x_2$  and  $\lambda$ , we obtain the conditions for a critical point:

$$\frac{\partial L}{\partial x_1} = \hat{w}_1 - \lambda \beta x_1^{\beta-1} x_2^{1-\beta}$$

$$\frac{\partial L}{\partial x_2} = w_2 - \lambda (1 - \beta) x_1^\beta x_2^{-\beta}$$

$$\frac{\partial L}{\partial \lambda} = x_1^\beta x_2^{1-\beta} - q$$

Setting each equal to zero and rearranging:

$$\hat{w}_1 = \lambda \beta x_1^{\beta-1} x_2^{1-\beta} \quad (11)$$

$$w_2 = \lambda (1 - \beta) x_1^\beta x_2^{-\beta} \quad (12)$$

$$x_1^\beta x_2^{1-\beta} = q \quad (13)$$

As the isoquants of a Cobb-Douglas function are negatively sloped and convex, the first-order conditions (equations (11), (12) and (13)) are sufficient for a minimum (Pemberton and Rau, 2015).

To solve for cost-minimising  $x_1$ , divide (11) by (12) and simplify:

$$\frac{(11): \hat{w}_1}{(12): w_2} = \frac{\lambda \beta x_1^{\beta-1} x_2^{1-\beta}}{\lambda (1-\beta) x_1^\beta x_2^{-\beta}} = \frac{\beta x_2}{(1-\beta) x_1}$$

Rearranging for  $x_1$ , subbing into (13) and then solving for cost-minimising  $x_2$ :

$$x_1 = \frac{w_2 \beta}{\hat{w}_1 (1-\beta)} x_2 \quad (14)$$

$$q = \left[ \frac{w_2 \beta}{\hat{w}_1 (1-\beta)} x_2 \right]^\beta x_2^{1-\beta}$$

$$q = \left[ \frac{w_2 \beta}{\hat{w}_1 (1-\beta)} \right]^\beta x_2^\beta x_2^{1-\beta}$$

$$x_2^* = \frac{q}{\left[ \frac{w_2 \beta}{\hat{w}_1 (1-\beta)} \right]^\beta} \quad (15)$$

We plug (15) back into (14) to solve for cost-minimising  $x_1$ :

$$\begin{aligned} x_1^* &= \frac{w_2 \beta}{\hat{w}_1 (1-\beta)} \frac{q}{\left[ \frac{w_2 \beta}{\hat{w}_1 (1-\beta)} \right]^\beta} \\ &= q \left[ \frac{w_2 \beta}{\hat{w}_1 (1-\beta)} \right]^{1-\beta} \end{aligned}$$

Substituting  $\hat{w}_1$  for its definition (equation (10)):

$$x_1^* = q \left[ \frac{w_2 \beta}{\alpha^2 + pf(1-\alpha)^2 (1-\beta)} \right]^{1-\beta}$$

At optimal firm compliance  $\alpha^\circ$  from equation (9):

$$x_1^* = q \left[ \frac{w_2 \beta}{\left( \frac{pf}{1+pf} \right)^2 + pf \left( 1 - \frac{pf}{1+pf} \right)^2 (1-\beta)} \right]^{1-\beta} \quad (16)$$

The optimal number of trades increases with the cost of alternative business activities,  $w_2$ , and with total output of the firm,  $q$ . Additionally, the optimal number of trades is infinite if the expected punishment  $pf$  is zero. Ceteris paribus, the change in the optimal number of trades decreases rapidly with a higher expected punishment  $pf$ , although, as illustrated in figure 3, there are decreasing effects of a higher punishment on the optimal number of trades. As the expected punishment is a proxy for the

cost of derivative trading, this result would be particularly important if the cost of reporting varied across derivatives with different associated systemic risk. As in US derivative regulation and other elements of EMIR, the EMIR reporting requirement would act as a Pigouvian tax on higher risk derivatives. Different reporting requirements across derivative types would not necessarily enhance the quality of reports, but would provide an incentive for the market to trade in historically safer derivatives.



Figure 3: Effect of a change in the factor  $pf$  (x-axis) on optimal number of derivative trades (y-axis), *ceteris paribus*.

#### 4.2.3 STAGE 1: NON-COMPLIANCE DETECTION PROBABILITY

We assume the regulator forms an expectation of compliance based on the above analysis of the firm's problem. At first glance, this may seem to violate the imperfect information assumption. However, we have assumed that the number of trades is not hidden from the regulator. Therefore, based on the number of trades, the regulator can infer some information about the firm's cost minimisation decision. This is similar to an assumption made in Crew and Parker (2006)'s information revelation model in which the regulator can use their knowledge of the firm's disutility of effort function to infer the level of effort provided by the firm. This model is considered in section 6. We can also justify the assumption using insights from game theory. Even with information asymmetries, if the game structure is known, players can still know what the other players will do in equilibrium. Specifically, according to Osborne (2009), to find a Nash equilibrium in an imperfect information setting, we need two assumptions. Firstly, we assume that each player is acting optimally at all times given their beliefs of the other player's actions. Secondly, we assume that each player's beliefs about the other player's actions are correct in equilibrium. In other words, if the objectives of each of the players are clear, we can find an equilibrium where each player is responding optimally to their beliefs of the actions of the other player's actions. It is important to note that this assumption does not rule out the regulator's expected firm compliance being wrong. Otherwise, we would be modelling a perfect information setting.

To determine the non-compliance detection probability  $p$  that maximises social welfare, we use a simple social welfare loss function,  $H(p)$ , based on Becker and Landes (1974). We assume there is an exogenous target compliance level,  $\alpha^* \in [0,1]$ . The social benefit of EMIR reporting is the target compliance level less any firm non-compliance based on optimal firm compliance from equation (9) and the cost of non-compliance detection.

We assume the cost of detection is a linear function scaled by a cost parameter  $c$ :

$$\begin{aligned} H(p) &= \alpha^* - (1 - \alpha^*) - cp \\ &= \alpha^* - (1 - \frac{pf}{1+pf}) - cp \end{aligned}$$

The regulator maximises social welfare with respect to the detection probability,  $p$ :

$$\begin{aligned} H'(p) &= \frac{f}{1+pf} - \frac{pf^2}{(1+pf)^2} - c \\ &= \frac{f}{(1+pf)^2} - c \end{aligned}$$

To find the maximum, set  $H'(p)$  equal to zero and rearrange:

$$\begin{aligned} \frac{f}{(1+pf)^2} &= c \\ \frac{f}{c} &= (1+pf)^2 \\ \frac{f}{c} &= 1 + 2pf + p^2f^2 \quad \rightarrow f^2p^2 + 2pf + \left[1 - \frac{f}{c}\right] = 0 \end{aligned}$$

Using the quadratic formula:

$$\begin{aligned} p &= \frac{-2f \pm \sqrt{(2f)^2 - 4f^2\left[1 - \frac{f}{c}\right]}}{2f^2} \\ p_1 &= \frac{-2f + \sqrt{(2f)^2 - 4f^2\left[1 - \frac{f}{c}\right]}}{2f^2} = \frac{-2f + \frac{2f^2}{\sqrt{c}}}{2f^2} = \frac{-2f + \frac{2f^2}{\sqrt{c}}}{f^2} = \frac{f^2}{\sqrt{c}f^2} - \frac{1}{f} \\ p_1 &= \frac{1}{\sqrt{cf}} - \frac{1}{f} \tag{17} \\ p_2 &= \frac{-2f - \sqrt{(2f)^2 - 4f^2\left[1 - \frac{f}{c}\right]}}{2f^2} = \frac{-2f - \frac{2f^2}{\sqrt{c}}}{2f^2} = \frac{-\frac{f^2}{\sqrt{c}} - f}{f^2} = -\frac{f^{3/2}}{\sqrt{c}f^2} - \frac{1}{f} = -\frac{1}{\sqrt{cf}} - \frac{1}{f} \end{aligned}$$

As probabilities are constrained between zero and one and the cost and fine parameters are non-negative,  $p_2$  is not a feasible solution to our problem. To ensure  $p_1$  is the critical point that maximises the social welfare function  $H(p)$ , we look at the critical point at the second derivative  $H''(p)$ :

$$H''(p) = -\frac{2f^2}{(1+pf)^3}$$

$$\rightarrow \text{At } p_1: -\frac{2f^2}{\left(1 + \left[\frac{1}{\sqrt{cf}} - \frac{1}{f}\right]f\right)^3} = -\frac{2f^2}{\left(\frac{f}{\sqrt{cf}}\right)^3} = -\frac{2f^2(cf)^{\frac{9}{2}}}{f^3} = -2c^{\frac{3}{2}}f^{\frac{1}{2}} < 0 \text{ for all } c, f > 0$$

The second derivative demonstrates that we have found an appropriate critical point for our analysis, where the social welfare function is concave. The socially-optimal non-compliance detection probability, (17), depends negatively on the cost of detection. The optimal detection probability initially increases with the fine parameter  $f$ , before decreasing after a certain point. As illustrated in figure 4, this turning point, marked black, depends on the cost parameter. The graph also shows how a higher cost parameter significantly reduces the optimal non-compliance detection probability for all values of the fine in this model. If the cost of detection is too high, the model implies that, to promote higher social welfare, the regulator should allocate its limited resources elsewhere.

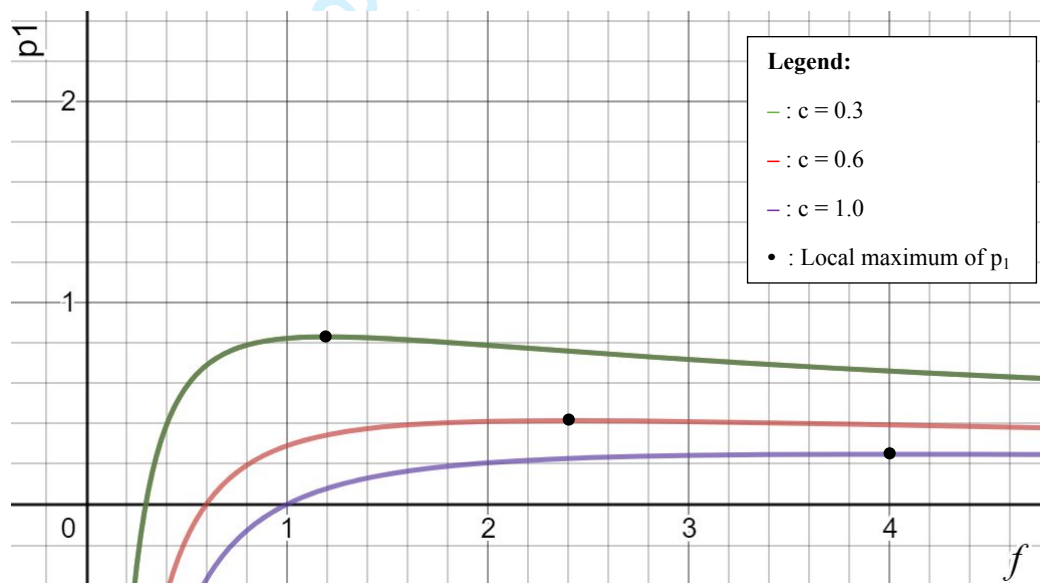


Figure 4: Effect of fine parameter on optimal detection probability with different detection costs

The social welfare function,  $H(p)$ , has a local maximum at:

$$\begin{aligned} H(p_1) &= \alpha^* - \left(1 - \frac{p_1 f}{1 + p_1 f}\right) - c p_1 \\ &= \alpha^* - \left(1 - \frac{\left(\frac{1}{\sqrt{cf}} - \frac{1}{f}\right)f}{1 + \left(\frac{1}{\sqrt{cf}} - \frac{1}{f}\right)f}\right) - c \left(\frac{1}{\sqrt{cf}} - \frac{1}{f}\right) \\ &= \alpha^* - \left(1 - \frac{\frac{\sqrt{f}}{\sqrt{c}} - 1}{\frac{\sqrt{f}}{\sqrt{c}}}\right) - \frac{\sqrt{c}}{\sqrt{f}} + \frac{c}{f} \\ &= \alpha^* + \frac{c}{f} - \frac{2\sqrt{c}}{\sqrt{f}} \end{aligned}$$

Based on this, the effects of higher fines and higher detection costs on social welfare are ambiguous. The precise effects depend on how they are scaled in both relative and absolute terms.

We can summarise the key steps from the above analysis:

1. The firm chooses their optimal compliance level subject to detection and fine parameters

$$\alpha^{\circ} = \frac{pf}{1+pf} \quad (9)$$

2. Based on this, the firm chooses the number of derivative trades to undertake in order to minimise their costs:

$$x_1^* = q \left[ \frac{w_2 \beta}{\left(\frac{pf}{1+pf}\right)^2 + p \left(1 - \frac{pf}{1+pf}\right)^2 f^{(1-\beta)}} \right]^{1-\beta} \quad (16)$$

3. The regulator chooses a non-compliance detection probability to maximise social welfare, subject to their beliefs of the firm's optimal compliance choice:

$$p_1 = \frac{1}{\sqrt{cf}} - \frac{1}{f} \quad (17)$$

## 5. DISCUSSION

This discussion is divided into three stages: implications of the analysis, limitations of the EMIR reporting model and possible extensions of the model to address these limitations. In section 6, I will use the example of heterogeneous firms and using different regulatory tools to illustrate how these extensions could be done.

There are four main implications of above analysis. Firstly, in the model, firms will never provide full compliance unless they believe the fine parameter  $f$  is infinite. Therefore, an expectation of full compliance from the regulation may be unrealistic, particularly with such a new, complex and regularly amended and updated regulation.

Secondly, equation (16), showing the firm's optimal number of trades, suggests that getting firms to comply in the first place is the main challenge. All subsequent increases in firm compliance have a smaller effect on the firm's business decision in terms of the optimal number of derivative trades. Therefore, while a socially-optimal level of firm compliance around one may be unattainable, the model suggests that it is possible to induce firms to a relatively high extent.

Thirdly, as long as the firm believes they are likely to be caught if they do not comply, it is optimal to comply. If the objectives of the regulator are clear and in line with the socially-optimal EMIR reporting target compliance, EMIR reporting requirements are designed to induce a non-zero compliance level

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3 incentivised by the regulator to be as high as possible. Based on the modelling above, EMIR reporting  
4 requirements should enhance the transparency of the derivatives market.  
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7 Finally, equation (16) points to a possible empirical strategy for detecting non-compliant firms.  
8 Specifically, the equation suggests that firms that undertake a large number of derivative trades are  
9 either very efficient in complying with EMIR reporting requirements at low cost or do not comply with  
10 the requirements and therefore can trade in derivatives cheaply. Identifying firms that are particularly  
11 active in derivatives markets, while controlling for firm efficiency would be a possible empirical  
12 strategy for evaluating EMIR reporting compliance. While this may be a feasible strategy for academic  
13 study of the effectiveness of EMIR reporting, it may not be a good strategy for the regulator to detect  
14 non-compliance, as firms could change their behaviour in response to avoid detection. Aside from using  
15 EMIR reporting data, another empirical approach would be analysing the EMIR reporting breaches.  
16 Whenever a firm identifies an error in their reporting, they are obligated to report the breach to the  
17 regulator (European Commission, 2012). For example, reported breaches could be used as a proxy for  
18 firm non-compliance.  
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26 I have identified seven main limitations of the EMIR reporting model:  
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- 29 • The model is a one-period, three-stage game that does not account for learning by the firm or  
30 the regulator.
- 31 • Risk aversion and irrationality of either agent are not incorporated in the model. While risk  
32 neutrality and rational agents are standard assumptions in many economic models, given the  
33 information sets and resulting uncertainty, they may not be reasonable assumptions for EMIR  
34 reporting.
- 35 • Socially-optimal target compliance,  $\alpha^*$ , is determined exogenously. While the above analysis  
36 suggests that an excessive expectation of firm compliance may be unrealistic, the model does  
37 not provide insight into how to determine a socially-optimal target level of firm compliance.
- 38 • The model does not differentiate between different derivatives types. As highlighted in the  
39 introduction, all derivatives are subject to the EMIR reporting requirement. However, if the  
40 model is extended to endogenize socially-optimal target compliance, the differences in riskiness  
41 by derivative types would be important to determine the welfare effects of non-compliance for  
42 each derivative type.
- 43 • The one-firm one-regulator setup may miss general equilibrium effects when scaling up the  
44 problem to a many-firms one-regulator problem.
- 45 • In this model, fines are the only regulatory tool available to the regulator. In practice, the FCA  
46 has many possibilities, such as suspending firms from undertaking certain activities or  
47 deauthorising individuals or firms from participating in regulated financial markets (FCA,  
48 2017b).  
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- The model does not account for heterogeneity in the firm efficiency or size.

Extending the EMIR reporting model to multiple time periods would allow agents to base their actions on past beliefs and signals. With multiple time periods, we could model reputational effects to create a more representative picture of how agents behave in reality. There are many models of reputation in imperfect information games to base an extension of the EMIR reporting model on, which can be extended to include discounting over time and many agents (Cripps, 2006). I would expect incorporating reputational effects to increase compliance over time as long as the regulator consistently signals that maintaining a transparent derivatives market is a regulatory priority.

Given the extent of uncertainty in the EMIR reporting model, it could be important to incorporate risk aversion. Tax evasion principal-agent models with risk averse agents, first analysed by Allingham and Sandmo (1972) and Yitzhaki (1974), model a comparable imperfect information setting to EMIR reporting. These model and subsequent extensions by Gordon (1989), who includes reputational effects, and by Bernasconi (1998), who focuses specifically on the relationship between risk aversion and tax evasion, for example, provide a useful starting point for including risk aversion in the imperfect information model. Given that EMIR reporting contributes to financial stability, I would expect risk aversion to increase compliance, both to avoid being fined and to contribute to a safer derivatives market as a market participant.

Ideas from behavioural economics may also provide interesting extensions to the EMIR reporting model. It may not be that firms rationally choose not to comply to a certain degree. Instead, it is possible that the same heuristics and biases that appear when agents make decisions under uncertainty, first presented by Tversky and Kahneman (1974), may play a role in explaining issues with EMIR reporting compliance. One possible extension would be using models of references dependence to analyse the impact of the BAML non-compliance fine (FCA, 2017a) on the regulator's reputation and consequential firm compliance decisions. The application of behavioural economic concepts to firms is not widely explored in academic literature, although Armstrong and Huck (2010) provide insight into why the idea of an irrational firm may be viable and relevant for economic modelling. Extending regulatory models to include concepts from behavioural economics may be a promising avenue for further research.

To endogenize the socially-optimal target compliance level, we would need either theoretically model or empirically quantify the benefits and costs of EMIR reporting to society. It is likely that the burden of EMIR reporting costs trickles down to consumers in the form of higher prices for financial services. Therefore, the welfare costs are largely composed of the compliance costs and any Pareto distortions arising from how these costs fall on consumers. There may also be political implications if the regulator were to advocate a socially-optimal target compliance level below full compliance. As mentioned **previously**, the benefit of disclosure policies to society, in this case preventing a financial crisis, is difficult to quantify (Beyer *et al.*, 2010), (Leuz & Wysocki, 2016). Assessing the socially-optimal target



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3 level of EMIR reporting compliance would require careful weighting of the welfare benefits for many  
4 different stakeholders.  
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7 Extending the EMIR reporting model to account for different derivative types would involve expanding  
8 the production function to more than two inputs. Exemplary models for this type of extension include  
9 Liu *et al.* (2012) and Kiser (2004). As highlighted in the discussion of equation (16) in section 4.2.1, I  
10 would expect that differentiating between derivatives would provide support for varying reporting  
11 requirements to act as a Pigouvian tax to maximise social welfare.  
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15 To account for potential general equilibrium effects, the EMIR reporting model could be extended to  
16 many firms as illustrated by the general equilibrium models by Lehmus (2011) and Reiter (2009).  
17 Modelling financial stability as a public good may also be an interesting perspective when scaling up  
18 the EMIR reporting model to many market participants. This would incorporate incentives to ‘free-ride’  
19 on the financial stability provided high-quality reporting by other market participants, a potential effect  
20 the current one-firm-one-regulator model omits.  
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23  
24 Incorporating all regulatory tools available to the regulator would likely overcomplicate the EMIR  
25 reporting model. One extension could be allowing the fine parameter to be negative, i.e. to subsidise  
26 firms that provide high compliance. Accurately determining the value of the subsidy would be subject  
27 to the same issue of unobserved EMIR reporting quality. Xepapadeas (1991) models combining fines  
28 and subsidies to reduce carbon emissions under imperfect information. Sappington and Sibley (1988)  
29 model optimal subsidy design when, as with EMIR reporting, the firms cost structure is unknown. Crew  
30 and Parker (2006) illustrate how to design contracts to induce optimal regulatory compliance when the  
31 compliance costs are subsidised.  
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35 Given the diversity of firms in the financial services industry, it is important to understand how different  
36 firms could be incentivised to comply with EMIR reporting. In addition to incorporating subsidies,  
37 Crew and Parker (2006)’s information revelation model how to model firms with different efficiency  
38 levels. In essence, we are extending a moral hazard problem to include adverse selection. As Crew and  
39 Parker model incentive design under imperfect information, I originally considered basing the EMIR  
40 reporting model on their information revelation model. However, there are intricate assumptions in their  
41 model that do not apply to EMIR reporting. For this reason, I opted for a game-theoretical approach.  
42 Nevertheless, Crew and Parker’s model, primarily used to study quality-of-service regulation, provides  
43 a starting point for an extended EMIR reporting model.  
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## 56 6. EXTENSION TO HETEROGENEOUS FIRMS AND COMPLIANCE SUBSIDIES

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58 The idea of this extension is not to replicate the above analysis with more complicated functional forms.  
59 Instead, I will extend certain elements of the model, while simplifying other to gain insight into the  
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3 general results that may come from an EMIR reporting model with heterogeneous firms and compliance  
4 subsidies.  
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7 The regulator would like to design an incentive scheme that induces firms to reveal how much they are  
8 complying with EMIR reporting requirements when the quality of reporting is hidden from the  
9 regulator. As before, we assume compliance with EMIR reporting requirements,  $\alpha$ , and any non-  
10 compliance fines,  $f$ , are the only costs to firms when trading in derivatives. To incentivise firm  
11 participation in the derivatives market, the regulator compensates the firm for any compliance costs  
12 resulting from EMIR reporting requirements. However, the regulator does not know the cost function  
13 that determines a particular compliance cost reported by a firm. If a cost  $C(\alpha)$  is observed, the regulator  
14 does not know whether it is an efficient firm providing high compliance or an inefficient firm providing  
15 low compliance. The regulator presumes that the firm would like to minimise effort, and we assume the  
16 regulator knows the firm's disutility of compliance function  $\psi(\alpha)$ .  
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23 As in Crew and Parker's model, for mechanical reasons, we assume that the regulator prefers higher  
24 fines to lower fines. This was one of the key assumptions for the Crew and Parker model which is  
25 incompatible with EMIR reporting. As explained previously, higher fines can result in Pareto  
26 distortions. Additionally, in the UK for example, the FCA does not receive fine revenue, so they do not  
27 have budgetary motivations to issue higher fines.  
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32 As before, we assume the regulator can determine a socially-optimal target compliance level  $\alpha^*$ . We  
33 assume there are two types of firms, efficient firms that can comply with EMIR reporting requirements  
34 at a low cost and inefficient firms that incur high compliance costs. By nature, efficient and inefficient  
35 firms are endowed with cost parameters  $\gamma'$  and  $\gamma''$  respectively, where  $\gamma' < \gamma''$ . To avoid  
36 overcomplicating the problem with assumptions on the efficiency of financial firms across all business  
37 activities, in this extension of the EMIR reporting model, we introduce simplified cost functions that  
38 focus solely on the cost of EMIR reporting. Efficient and inefficient firms have cost functions  $C'(\alpha)$   
39 and  $C''(\alpha)$ , respectively.  
40  
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$$45 \quad C'(\alpha) = \gamma' - (1 - \alpha)$$

$$46 \quad C''(\alpha) = \gamma'' - (1 - \alpha)$$

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49 To ensure socially-optimal compliance from both firm types, the regulator must offer two types of  
50 contracts with appropriate incentives.  
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53 We assume both firm types have the following utility function, where  $t$  is a profit parameter and  $f$  a fine  
54 for non-compliance:  
55  
56

$$57 \quad U = t - \psi(\alpha) - f$$

We assume firms make a positive profit from derivative trading without regulatory compliance costs. Therefore, they will participate in derivative trading as long as  $U \geq 0$ .

Based on this, the regulator offers a contract to firms with two components:

1. Engage a firm to trade in derivatives, and observe the compliance cost reported by the firm.
2. Pay the compliance cost and fine the firm for any non-compliance, i.e.  $\alpha < 1$ .

When designing appropriate contracts for efficient and inefficient firms, the main issue for the regulator is that efficient firms should report a lower compliance cost at  $\alpha^*$ . As we assume the regulator covers this cost entirely, efficient firms may pretend to be inefficient to receive a higher compensatory payment.

It is helpful to visualise the ideal contracts graphically. From a firm's perspective, higher costs and a higher fine are both economic 'bads'. Therefore, in figure 5, utility is decreasing along both the x- and y-axis and the indifference curves are inverted.

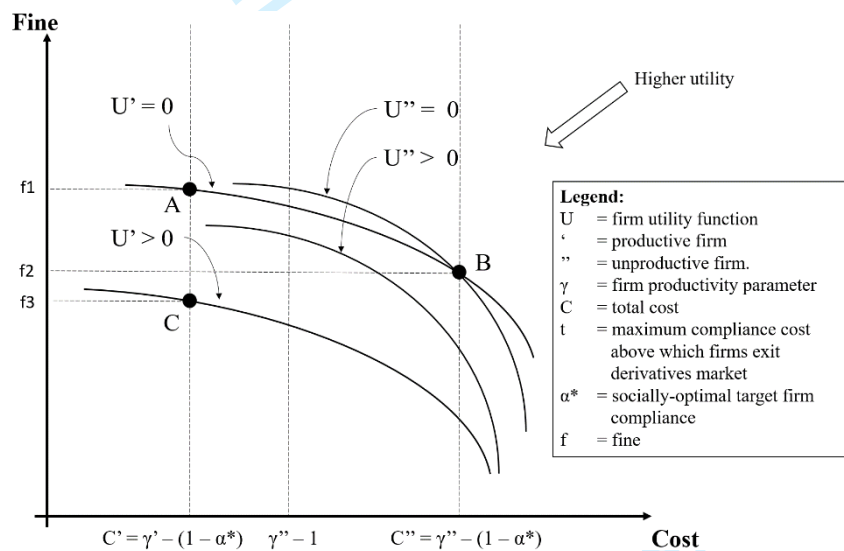


Figure 5: Conditions required to incentives both firm types to comply optimally

For efficient firms, a marginal fine increase is more costly relative to higher compliance compared to the inefficient firm. Therefore, the efficient firm would be more willing to trade-off higher compliance for a lower fine than the inefficient firm. For this reason, the indifference curves are flatter for efficient firms than inefficient firms.

The regulator could offer the two contracts (A, B). The efficient firm would then be indifferent between optimal and sub-optimal EMIR reporting compliance. To ensure both firms choose the contracts designed for socially-optimal compliance of their efficiency type without any further assumptions, the regulator must offer a contract to efficient firms where  $U > 0$ . A possible set of contracts could be the two contracts (B, C). The efficient firm will choose contract C, as it is on a lower disutility curve. The

inefficient firm cannot choose C as the costs are below  $\gamma'' - 1$ , the costs the regulator would observe if they provided no compliance. Therefore, the inefficient firm would choose contract B.

We can also illustrate the specific conditions for a feasible set of contracts using individual rationality and incentive compatibility constraints. In this case, the individual rationality constraints ensure that the two firm types participate in derivatives trading. The incentive compatibility constraints ensure each firm type chooses the correct contract designed to incentivise socially-optimal compliance  $\alpha^*$ .

Individual rationality constraints:

$$U' \geq 0 \quad (18)$$

$$U'' \geq 0 \quad (19)$$

Incentive compatibility constraints:

$$\gamma'' - 1 > \gamma' - (1 - \alpha^*) \quad (20)$$

$$U'(C', f3) > U'(C', f1) \quad (21)$$

Equations (18) and (19) ensure firms get non-negative utility from derivative trading. Equation (20) shows under which conditions inefficient firms would then choose the contract under which they would provide socially-optimal compliance. The left-hand side of (20) represents the cost to inefficient firms if they provide no compliance ( $\alpha = 0$ ). If the cost of providing socially-optimal compliance for efficient firms is greater than this, inefficient firms may pretend to be an efficient firm, but offer no compliance. Equation (21) says that for the efficient firm to be incentivised to provide socially-optimal compliance, they need to gain positive utility from trading in derivatives.

There are two main takeaways from this illustrative extension to the EMIR reporting model. Firstly, with heterogeneous firms, it is even more important for the regulator to use observable metrics to infer information about unobservable characteristics of the reporting firms. It is also crucial for the regulator to be able to accurately map these observed characteristics into their expected unobservables. Secondly, it may also be necessary for the regulator to compensate firms for the costs of EMIR reporting, particularly if they want firms to provide full compliance.

Overall, the EMIR reporting model can be extended to analyse elements EMIR reporting requirements in more detail. However, extending the model to resolve all the limitations above at once would have an impact on the simplicity of the model and therefore the clarity of the results.

## 7. CONCLUSION

EMIR was the European response to the role of OTC credit derivatives in the 2008 financial crisis. A key element of this regulatory framework is a reporting requirement for each derivative trade. Academic papers and governmental reports have documented a number of issues with EMIR reporting requirements. There is a lack of consensus in academic literature on the effectiveness of public disclosure policies. Due to a different underlying regulatory mechanism in EMIR reporting, it is unclear whether previous theoretical and empirical findings on disclosure policies can be applied to EMIR reporting. To determine the effectiveness of the design of EMIR reporting requirements, this paper presents an imperfect information model of EMIR reporting. Using the example of heterogeneous firm efficiency, I also illustrate how the EMIR reporting model can be extended to account for some of the limitations of the model based on other theoretical models in academic literature. Based on the EMIR reporting model, this paper finds that while firms are unlikely to comply fully with EMIR reporting requirements, it is possible to induce firms to a relatively high extent. As long as the firm believes that the cost of non-compliance detection is not too high for the regulator, they are incentivised to comply. Based on the theoretical models developed in this paper, EMIR reporting requirements are not fundamentally flawed. As long as the regulatory objectives are clear, firms should move towards an equilibrium of providing socially-optimal compliance, trading in the number of derivatives that balances the profits that can be made with the associated compliance costs. Although this does not mean we are immune from another financial crisis, more effective EMIR reporting requirements should equip European regulators to monitor a more transparent and secure derivatives market.

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