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UNINTENDED CONSEQUENCES OF THE GLOBAL DERIVATIVES MARKET REFORM

Pauline Gandré, Mike Mariathan, Ouarda
Merrouche and Steven Ongena

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Centre for Economic Policy Research
33 Great Sutton Street, London EC1V 0DX, UK
Tel: +44 (0)20 7183 8801
www.cepr.org

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Abstract

We investigate regulatory arbitrage during the G20's global derivatives market reform. We hand-collect comprehensive data on the staggered reform process and show that its progress is primarily driven by structural time-invariant factors. Following the reform banks shift up to 70 percent of their derivatives activity towards less regulated jurisdictions. This shift is driven by reform items – such as the promotion of central clearing – that are costly, but do not directly benefit them. Subsidiaries in jurisdictions with more regulatory progress shift into riskier portfolios.

JEL Classification: G15, G18, G21, G23, G28

Keywords: Bank Regulation, regulatory arbitrage, OTC markets, Derivatives, Cross-border financial institutions, Financial risk

Pauline Gandré - pgandre@parisnanterre.fr
Uni Paris Nanterre, EconomiX

Mike Mariathasan - mike.mariathasan@kuleuven.be
KU Leuven

Ouarda Merrouche - ouarda.merrouche@eui.eu
EconomiX Uni Paris Nanterre

Steven Ongena - steven.ongena@bf.uzh.ch
University of Zurich and CEPR

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UNINTENDED CONSEQUENCES OF THE GLOBAL DERIVATIVES MARKET REFORM^{*}

Pauline Gandré
*Uni Paris Nanterre,
EconomiX*

Mike Mariathasan
KU Leuven

Ouarda Merrouche[†]
*Uni Paris Nanterre,
EconomiX*

Steven Ongena
*Uni Zürich, SFI,
KU Leuven*

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[†] Corresponding author: ouarda.merrouche@eui.eu, omerrouc@parisnanterre.fr.

“One of the lessons of the crisis is that we must avoid regulatory arbitrage (...) regulators must resist the temptation to offer loopholes creating large regulatory gaps among jurisdictions”

– Former IMF Director D. Strauss-Kahn in 2009 –

1. Introduction

This paper provides evidence on regulatory arbitrage in the context of the G-20’s global derivatives market reform. Launched in 2009, the reform targets the unchecked over-the-counter (OTC) trading that helped to spread losses from the US housing market to the world economy during the financial crisis.³ It was designed to improve transparency and regulatory oversight, and comprises of five building blocks: (i) trade repositories to facilitate surveillance; (ii) central clearing of standardised OTC derivatives to reduce counterparty exposure and facilitate resolution; (iii) exchanges/electronic trading platforms to reduce operational risk, and higher (iv) capital and (v) margin requirements for non-standardised OTC derivatives to buffer losses *ex-post* and align incentives *ex-ante*.

That the blocks have to be separately integrated into (supra)national regulation by participating governments implies that reform progress is heterogeneous across countries and over time. On a decidedly global market like the derivative market, this enables cross-jurisdictional arbitrage; that the reform entails significant costs for banks introduces the corresponding incentives to engage in it.⁴

Consistent with such arbitrage, we find that US dealers exploit a loophole in the Dodd-Frank Act to move their domestically regulated interest rate swap (IRS) activities to less regulated, foreign subsidiaries. The pattern appears to be causal, meaning that dealers actively respond to heavier regulation in the US, and directed towards countries with weaker regulation. In addition, and presumably to compensate for costs they cannot evade by geographic reallocation, we find that subsidiaries in jurisdictions with *more* reform progress also hold overall *riskier* trading portfolios.

³ In a testimony to the Financial Crisis Inquiry Commission on June 30, 2010 Michael Greenberger suggested that “*it is now almost universally accepted that the unregulated multi-trillion dollar OTC CDS market helped foment a mortgage crisis, then a credit crisis, and finally a “once-in-a-century” systemic financial crisis*”. While this assessment has since been refined (e.g., Stulz, 2010), it does convey the sense of urgency and the prevailing consensus at the time.

⁴ Deloitte (2014) estimates the annual costs, for the European derivatives market alone, at 15.5 billion (bn) EUR and attributes 13 bn EUR to OTC transactions. See Figure 1 for a broad categorization of costs across the five reform blocks.

From a regulatory perspective, our results highlight the global risks associated with loopholes in national regulation; from a governance perspective, they emphasize the importance of coordinated and swift action. This is because the geographic reallocation of targeted activities during the implementation of the G-20's derivative market reform is not benign. It increases global financial risk in at least two dimensions: targeted positions are moved to jurisdictions that are less prepared to monitor them and banks compensate for those positions they cannot move by holding riskier alternatives.

For our analysis, we collect publicly available data from the Financial Stability Board (FSB) and build indices of regulatory progress; for each of the reform blocks, across 18 countries and the European Union (EU), and from Q1 2010 to Q4 2016. We combine this information with detailed data on the interest rate swap (IRS) positions of the largest US dealers' foreign subsidiaries (US Fed Forms 2314). These dealers account for 95% of total US activity and thus represent a significant fraction of the global derivatives market.⁵ They were subject to early and stringent domestic regulation under Dodd-Frank, and – suggesting motive and intent to engage in regulatory arbitrage – lobbied heavily for the exemption of their overseas affiliates.⁶

A key challenge for our identification is the concern that countries actively delay the reform to attract US dealers' business. In addition, one might also be worried that unobserved country characteristics simultaneously affect progress of the reform and banks' propensity to invest in a given jurisdiction.

To address these challenges, we show that the drivers of reform progress are primarily structural and broadly associated with institutional quality and the development of local derivatives markets. In our main analysis, explaining US dealers' foreign IRS activities with reform progress abroad, we then include destination country fixed effects to control for time-invariant country characteristics. We also

⁵ According to Calls Report data 95% of derivatives assets is held by the top five US banks.

⁶ See Reuters Special Report "U.S. banks moved billions in trades beyond CFTC's reach", Charles Levinson, August 21st, 2015. US records show 31 meetings between the then chairman of the Commodity Futures Trading Commission (CFTC) Gary Gensler and representatives of the top 5 US banks in 2010, and 462 with other top CFTC officials between October 2010 and December 2013 as the CFTC worked on the new rules on derivatives. The article also points out that those officials who met most frequently with the banks since moved to the industry.

notice that any innocuous reallocation of activities would likely be directed towards jurisdictions with better developed institutions and markets, so that the potential omission of any relevant time-varying measure of institutional quality would work against finding evidence of regulatory arbitrage. To strengthen our analysis further, we also saturate our model with bank*year fixed effects, to control for any bank-time specific reason to move activities abroad, and compare subsidiaries' IRS activities in countries with differential reform progress, before and after important advances in US regulation. We also perform a placebo analysis, using the share of banks' FXS holdings (to which the reform does not fully apply) and instrument reform progress using exogenous measures of political and regulatory independence.

The remainder of the paper is organized as follows. Section 2 relates our analysis to the existing literature on regulatory arbitrage by banks. Section 3 presents our data, Section 4 discusses our econometric setup and identification, and Section 5 presents our results. Section 6 concludes.

2. Related Literature

Our paper broadly contributes to the literature on regulatory arbitrage by banks (e.g., Morrison & White, 2009; Laeven & Levine, 2009; Barth et al., 2014; Mariathasan & Merrouche, 2014). It relates, more specifically, to papers identifying cross-jurisdictional arbitrage (e.g., Buch, 2003, Houston et al., 2012; Ongena et al., 2013; Gao et al., 2018; Temesvary, 2018) and increased risk-taking (Ongena et al., 2013; Barth et al., 2004; Laven and Levine, 2009) in response to costs from tighter regulation.

The papers from this literature that are most closely related to ours are: (i) Houston et al. (2012), who study the impact of cross-border differences in banking regulation over the period 1996-2007, and show that bank capital flows from more restrictive to less restrictive jurisdictions; (ii) Temesvary (2018), who focuses on US banks' international lending flows from 2003 to 2013, and shows that US banks lend less and are less likely to have affiliates in more regulated jurisdictions; and finally, (iii)

Karolyi and Taboada (2015), who, for the period from 1995 to 2012, show that cross-border bank mergers and acquisitions are more likely to involve acquirers in jurisdictions that are more strictly regulated than those of their targets.

Although none of these papers studies the derivatives market or focuses on transaction costs – which are crucial on this market – as the driver of regulatory arbitrage, they inform and motivate our analysis. We complement their broader message – that banks engage in arbitrage across different regulatory environments – by studying the derivatives market, a decidedly global and liquid market, on which large, international banks trade highly standardized products. The global nature of this market, in many ways, facilitates arbitrage for banks, and thus helps to focus on the role of regulatory differences. It also links our analysis to theoretical predictions, such as by Morrison & White (2009), that emphasize the advantage of a level playing field in international financial regulation, specifically when capital is mobile; i.e., in a case that is particularly applicable to the global derivatives market.

Our paper further adds to the existing literature by focusing on the post-crisis era. The regulatory response to the crisis, including importantly the OTC derivatives market reform, was designed to contain the cross-border propagation of financial risks. By showing that global risk may actually have increased (at least during the implementation phase of the derivatives market reform), we not only document the continued existence of cross-jurisdictional arbitrage, but also identify the regulatory response – to the extent that it is unevenly implemented – as a source of new, unchecked risks.

Second, our paper contributes to the literature on the benefits and new risks associated with the recent OTC derivatives market reform; the existing literature on the reform is still very scarce. The papers that do exist focus primarily on consequences for market efficiency and systemic risk. Benos et al. (2016), for instance, show that the US regulation on electronic trading of swaps reduces execution costs and thus enhances market liquidity. Faruqui, Huang and Takats (2018), instead, point to the risk of a destabilizing feedback loop between systemically important banks and central clearing counterparties in OTC derivatives markets; other papers assess the effectiveness of the reform in

terms of incentivizing central clearing (Ghamami and Glasserman, 2016) or general financial stability (Duffie, 2017). To the best of our knowledge, however, the literature has neither examined the factors that drive cross-border differences in the implementation of the G-20's derivatives market reform, nor has it linked heterogeneity in adoption to cross-jurisdictional arbitrage and the resulting risks.

By filling this gap, we help policymakers to identify and quantify potentially unintended costs of global regulatory action, that may need to be weighed carefully against the predicted benefits. By identifying mitigating factors, such as a stronger rule of law or deeper and more liquid local markets, we also provide a first step towards potential remedies.

3. Data

3.1. Regulatory Indices

We construct indices of regulatory progress from FSB reports tracking the implementation of the OTC Derivatives Market Reforms. Consistent with the agenda's main blocks, we separately account for progress in: (i) trade reporting, (ii) central counter party (CCP) clearing, (iii) electronic trading, and (iv) capital as well as (v) margin requirements. From the qualitative information in the reports, we construct quantitative indices by assigning values from 0 to 4 to the following circumstances:

- 0: No authority exists to implement the reform and no steps are taken to adopt such an authority.
- 1: A legislative framework is either in force or published for consultation.
- 2: A legislative framework is in force and requirements – at least for some transactions – are published for public consultation.
- 3: Requirements – at least for some transactions – have been adopted.
- 4: Requirements have been adopted for over 90% of transactions.

Values are available for 19 jurisdictions (18 countries + the European Union) and for each quarter between and including Q1 2010 and Q4 2016. We also construct a composite index that is equal to the number of reform blocks for which a country has implemented a fully effective requirement (i.e., for which a sub-index takes on a value of 4). Our indices thus capture depth and scope of reform progress in any given country. Table 1 reports values from Q4 2016, for all countries in our sample and Table 2 identifies the quarter for each country and reform block, in which the respective regulatory requirement became fully effective. They primarily provide evidence of substantial heterogeneity across jurisdictions. We see, for example, that all countries have at least one reform block in full effect by Q4 2016, but that only Japan has completed the implementation of all 5 agenda items. It can also be observed that only 5 jurisdictions (Australia, Japan, Mexico, Switzerland, United States) have fully implemented at least 4 agenda items by Q4 2016, and that these jurisdictions are fairly different in terms of development and/or institutional quality. At the same time, the adoption of the different blocks also fails to follow a clear sequential pattern: Argentina for instance only has capital regulation in full effect, while the Republic of Korea has only fully adopted the trade reporting block. Based purely on these descriptive statistics, it is thus not immediately obvious what drives adoption of the reform in different countries, which motivates our more systematic analysis in Section 5.

While our aggregate index treats the different blocks of the reform homogeneously, it is clear that they differ with respect to their costs for banks. Capital and margin requirements entail significant economic costs for banks, by forcing them to hold positions or raise funding from sources that are not individually optimal. Central clearing regulation, similarly, entails significant costs in terms of collateral and margin requirements, but also imposes requirements in terms of infrastructure investments. The regulation of trade repositories and electronic trading, instead, is less costly, especially for the five large banks in our sample that already have much of the required infrastructure in place. In Figure 1, we broadly categorise the costs of the different reform blocks and list the main cost components.

3.2. Derivative Holdings

To investigate regulatory arbitrage in our main analysis, we combine our reform progress indicators with data on the derivative holdings by foreign subsidiaries of the 5 largest derivatives traders in the US (Bank of America, Citigroup, Goldman Sachs, JP Morgan, Morgan Stanley).⁷ We collect this information from the Federal Reserve System, which provides us with data on the notional values, in particular of the subsidiaries' IRS and FXS positions (US Fed Forms 2314). Our focus on the US is due to the availability of detailed data on the global derivative activity of US banks. It is further motivated by the fact that the US is not only the first country to implement the reform, but also offers a loophole for foreign subsidiaries. US rules, more specifically, apply to overseas branches but not to (de-guaranteed) overseas subsidiaries, which fall under the host country's regulation. More precisely, transaction level requirements do not apply to transactions involving a non-US person that is not a guaranteed or conduit affiliate of a US swap dealer or major swap participant and a non-US swap dealer or major swap participant.⁸ This disparate treatment enables the cross-border arbitrage at the centre of our analysis.

Descriptive statistics in Figures 2 and 3 depict the cross-jurisdictional allocation of US dealers' activities, and their changing positions from before to after adoption of the reform in the US. Figure 2 shows – for each bank – the fraction of the total consolidated IRS position that is held in foreign subsidiaries, for Q1 2010 and for Q4 2015, i.e. before and after Dodd-Frank becoming effective. It is evident that this fraction has increased, with the change being strongest for Citigroup: their positions were entirely concentrated in the US in 2010, since then more than 60% were shifted abroad. In Figure 3, we further illustrate the geographical distribution of these foreign holdings. We see that the change in shares – from 2010 to 2015 – was high in less regulated markets, such as Hong Kong and Mexico.⁹

⁷ These 5 institutions account for about 95% of the total US activity.

⁸ This loophole applies to clearing and swap processing requirements; margin requirements for uncleared swaps; trade execution requirements; and reporting requirements.

⁹ Our data do not separate assets by currency or origin of counterparty. However consistent with the trend in our data and the fact that the loophole applies only to non-US persons a similar trend is observed in aggregate transaction data from the

Finally, Table 3 provides summary statistics for subsidiary-level shares of banks' FXS and IRS positions (our dependent variables). Consistent with Figures 2 and 3, they show (a) that derivatives activity is concentrated in only a few countries, with standard deviations being significantly larger than the means, and the 25th and 50th percentile being nil, and (b) that there is substantial heterogeneity, with pooled standard deviations of 9.5% and 14%.

The overall pattern is clearly suggestive of cross-border arbitrage, but not yet conclusive; this motivates our more comprehensive analysis.

4. Econometric Setup

4.1. Hypotheses & Identification

Our main hypothesis is that tighter regulation induces regulatory arbitrage. We test, more specifically, whether derivative dealers from the US are more likely to hold their IRS positions in foreign jurisdictions that are slow to adopt the G-20 reform. As discussed, US dealers held virtually all of their IRS positions domestically, prior to the Dodd-Frank Act, but moved up to 60% of their positions abroad after its implementation. In identifying whether this reallocation is due to differences in regulatory stringency, we face two main challenges:

1. Because policymakers in the destination countries may choose to relax regulation – or slow down the adaptation of global standards – precisely to attract business from the US, the regulation in these jurisdictions might be endogenous.
2. At the same time, it might be the case that an unobserved factor affects both, progress of the reform *and* US banks' propensity to book positions in a given country.

International Swaps and Derivatives Association (ISDA). ISDA (2014) describes a significant fall in the US banks' share of the global inter-dealer market for IRS in euro but not in US dollars. This results from trades with European counterparties being now mostly booked through US banks' EU subsidiaries and therefore showing up as European banks' transactions.

To address these challenges, we first show that the drivers of reform progress across countries are primarily structural, which implies that reform progress is unlikely to be affected by (the expectation of) business from the US; this primarily alleviates concerns about reverse causality. Because these structural factors broadly reflect institutional quality and market development, and banks – in the absence of regulatory arbitrage – should move their assets to jurisdictions with stronger and more developed markets and institutions, this first step of our analysis also suggests that we likely underestimate the true magnitude of regulatory arbitrage in our second step.

In this second step, we include structural factors, along with bank*year and – importantly – destination country fixed effects, in regressions explaining the foreign shares – in each of the non-US countries – of US bank holding companies' consolidated swap positions. The variation in foreign swap shares that is explained by regulatory indices is then ideally net of structural factors and due to differences in regulatory progress and stringency between the US (where Dodd-Frank meant the G-20 agenda was in full effect early) and the destination country.

To strengthen our causal interpretation, we take a number of steps to further alleviate issues of reverse causality and omitted variables. First, we also test whether the benefit of less reform progress abroad is more pronounced when more, and more costly, blocks of the reform are adopted in the US. Second, we draw on the existing literature and our first step analysis, and instrument reform progress with measures of the destination countries' political and regulatory independence. Third, we run a "placebo regression" on subsidiaries' FXS positions, because FX swaps – in most countries – are not concerned by 4 of the 5 reform blocks.

In addition to this main analysis, and to provide additional evidence of banks' underlying incentives, we also test a second hypothesis and consider a different dimension of regulatory arbitrage: to the extent that banks are unable to move their derivatives trading abroad, they might also respond to tighter regulation of the derivatives market by engaging in other, riskier but more profitable activities. This would enable them to generate higher returns to compensate for the higher transaction costs

induced by the reform. We test this by analysing the riskiness of subsidiaries' overall trading portfolios, as a proxy for exposure to market risk, in jurisdictions with *more* reform progress.

4.2. Determinants of Reform Progress

To identify the determinants of reform progress, we estimate the following discrete-time multilevel logit model with random effects:

$$\log\left(\frac{p_{i,j,t}}{1-p_{i,j,t}}\right) = \log(d_{i,j,t}) \cdot \alpha + x'_{i,j,t} \cdot \beta + u_i + \varepsilon_{i,j,t} \quad (1)$$

where $p_{i,j,t}$ is the probability of an event – i.e., reform progress – occurring in country i , during interval t of episode j , i.e., the period during which the index remains unchanged; $d_{i,j,t}$ is the cumulative duration by interval t , and $x_{i,j,t}$ is a vector of potentially time-varying covariates that includes cyclical factors, as well as structural variables.

We specifically include the following cyclical variables: GDP growth, non-performing loans (NPL) and the Z-score, to test whether regulators practice regulatory forbearance granting delays in reform implementation in bad economic times and in weaker banking sectors.

In addition, we consider a number of structural variables (derivatives turnover, GDP per capita, banking sector size, regulatory quality, government effectiveness, a dummy indicating whether the central bank shares the responsibility of supervising the banks (1) or is sole supervisor (0), and a proxy for the cost of the 2007-2008 crisis in a given country), to test whether deeper and more liquid derivatives markets, more developed countries and better regulatory environments promote an earlier implementation of the reform.

Macroeconomic data (GDP growth, GDP per capita) are either from the OECD or IMF statistics when not available from the OECD. The turnover of derivatives markets is from the Bank of International

Settlement (BIS)'s Triennial Derivatives Survey. Measures of government effectiveness and regulatory quality, instead, are obtained from the World Bank's Governance Indicators Database. Indicators of the size and soundness of the banking sector are taken from the World Bank Financial Development and Structure database available online. Measures of crisis costs are from the Systemic Banking Crisis Database (Laeven and Valencia, 2013).

For the selection of both cyclical and structural variables, we rely on existing work, studying the adoption of trade reforms, as well as financial and labor market reforms.¹⁰

Finally, the destination country random effects u_i capture unobserved heterogeneity between countries that potentially arises due to the omission of time-invariant variables, and $\varepsilon_{i,j,t}$ is the residual error term. Our coefficient of interest in this model is β , with $\exp(\beta)$ representing the hazard ratio for a one-unit change in the covariates.

4.3. Cross-Jurisdictional Arbitrage

To investigate cross-jurisdictional arbitrage we use data on the derivatives holdings in non-US subsidiaries of the US' 5 largest derivatives traders, and the previously mentioned loophole in the Dodd-Frank Act. This loophole allows subsidiary-level swap holdings to be exempted from US regulation and therefore enables regulatory arbitrage. This is particularly true on a global and homogeneous market like the derivatives market, for which the geographic location in which positions are booked does not matter beyond the regulatory treatment. Building on the suggestive evidence in our descriptive statistics, we run maximum likelihood regressions on a three-dimensional panel, and explain, for each year-quarter (t), the share of each bank (i)'s derivative holdings in country j ($s_{i,j,t}$).

Our main explanatory variables of interest are our indices of reform progress ($l_{j,t}$), but we further include cyclical and structural country-level variables ($x_{i,j,t}$), as well as bank, time, bank*quarter, and/or

¹⁰ See Djankov et al (2017) for a recent review of this literature.

destination country fixed effects (FE) to capture unobserved heterogeneity across banks and time, as well as any time-varying but country-invariant reason for a bank to hold swap positions abroad, and/or all time-invariant characteristics of the destination countries:

$$S_{i,j,t} = I_{j,t} \cdot \alpha + x'_{i,j,t} \cdot \beta + FE + \varepsilon_{i,j,t} \quad (2)$$

In model (2), $x_{i,j,t}$ includes factors that may simultaneously affect the allocation choice of US dealers and the stringency of regulation; they include interest rate volatility, inflation, GDP growth and GDP per capita, log turnover, a measure of political stability, stock market volatility, and banking sector size. Since the dependent variable is a fraction the regressions are weighted by subsidiary portfolio size in order to give more weight to larger subsidiaries.

We further extend the model by interacting $I_{j,t}$ with dummies that are equal to one for all periods after the US enforced, respectively, mandatory trade reporting, central clearing and electronic trading. If the geographic reallocation of US dealers is indeed driven by a higher domestic cost of the reform, the link between reform adoption abroad and subsidiary level IRS positions should be stronger after the US regulation is implemented.

Next, we instrument $I_{j,t}$ in model (2), using measures of regulatory and political independence, primarily to alleviate concerns of reverse causality.¹¹ Our choice of instruments is motivated by the first step of our analysis and existing papers on cross-jurisdictional arbitrage (Houston et al., 2012; Karolyi & Taboada, 2015); it assumes that structural factors, not depending on individual US' dealers swap holdings, likely contribute to reform progress. We specifically use a dummy for whether the central bank in a given country shares the supervisions of banks (1) or is sole responsible of the supervision of banks (0), and the fraction of years since 1776 that a country has been independent. On the one hand, central banks, as the lender of last resort, may be more inclined to accelerate a reform to strengthen the financial sector and curb systemic risk. On the other hand, they may also be

¹¹ The regulatory environment in a given country may respond to changes in flows of foreign activity.

more likely to delay a reform that creates further pressure on fragile banks, especially during a crisis. At the same time, countries that have been independent for a longer period of time have been presumably able to adopt regulations that are more beneficial for their economic development (Karolyi & Taboada, 2015).¹²

4.4. Alternative Form of Arbitrage

Finally, we also investigate whether exposure to tighter domestic regulation of the derivatives market affects the riskiness of US banks' foreign subsidiaries in the same jurisdiction. We specifically test whether banks compensate for the additional cost of regulation by pursuing a more aggressive investment strategy in the same country. To do this, we repeat our estimation of model (2) but replace the share of derivative holdings with the 4-quarter rolling standard deviation of returns on subsidiaries' trading portfolios.¹³ The focus on market risk is motivated by the assumption that banks would first try to replace (costly) IRS positions, with similar – albeit unregulated and possibly riskier – derivative holdings, and only resort to other forms of compensation (e.g., via fee income) thereafter. We control for additional determinants of returns volatility, namely leverage and asset quality.

5. Results

5.1. Reform Progress

We first report results for model (1), which explains the determinants of reform progress across our 19 jurisdictions. Table 4 provide discrete time proportional hazard model estimates for factors contributing to the implementation of the G20 reform. In this baseline specification, GDP growth

¹² The existing literature also proposes additional instruments, such as the number of crisis in a given country, but we found them to be weak instruments in our sample.

¹³ To give less weight to periods when dealers' derivative activity is smaller, we weight estimates by total derivatives notional by subsidiary and quarter.

captures cyclical factors and GDP per capita secular factors. The dependent variable is a dummy for a 1-unit increase in the regulatory indices. Panel A reports results using contemporaneous covariates and Panel B lagged covariates to alleviate reverse causality. Column 1 reports results for the overall reform index and each subsequent column corresponds to a different reform block. We do not include a column for margin requirements as too few countries implemented this block by the end of 2016.

In Panel A we find that GDP per capita is an overall more important and robust driver of reform progress than GDP growth. This suggests that differences in reform progress across countries are better explained by secular differences than by economic fluctuations and thus more likely to persist over time. This remains true for the trade repository and central clearing counterparty blocks of the reform, if we use lagged explanatory variables in Panel B. With a one standard deviation increase in GDP per capita corresponding to a 2.7 ($\exp(1.597) \cdot 0.546$) times higher probability of reform progress (in Panel A, column 1), the effect is also large in magnitude.

We further observe that an increase in log cumulative duration since the last change of the regulatory index is positively and significantly related to the log-odds of the subsequent change. In other words, reform progress is more likely after a longer period of inertia.

In Table 5 we consider more specific cyclical and structural/secular factors. We find that developed and liquid derivatives markets (Log Turnover), as well as better regulatory quality and government effectiveness are positively associated with reform progress and, more specifically, with a higher likelihood of progress in central clearing and electronic trading. A higher crisis cost is associated with progress in central clearing regulation as well. The negative effect of the number of past crisis is consistent with the expectation that past crises have triggered tighter reform in the past; this, in turn, reduces the likelihood of future crises and the need for additional reform. In our sample, however, this effect is only significant for the CCP block. Banking sector size, instead, appears irrelevant, while a central bank sole supervisor of banks increases the speed of reform progress, most significantly of electronic trading regulation.

Contrary to the structural factors, the role of cyclical factors is less robust across different model specifications and regulatory blocks. A 1-unit increase in GDP growth, for instance, is positively and significantly associated with progress in the electronic trading index, but negatively (and less significantly) with progress on trade reporting. The share of non-performing loans (NPLs), on the other hand, is positively but not significantly related to any of the progress sub-indices, but negatively related to overall reform index. While having a broken system following a crisis helps to initiate reforms, it also delays the actual implementation and impairs enforcement. Finally, the Z-score for the banking sector seems to be linked to reform progress through the regulation of electronic trading, suggesting that higher risk-taking in the banking sector accelerates reform.

We conclude that secular factors dominate as explanatory variables, with measures of institutional and market development/quality behind most of the reform progress. This motivates our use of destination country fixed effects in the analysis of regulatory arbitrage. As previously discussed, it also suggests that any innocuous reallocation of activities would likely be directed to jurisdictions with more developed markets and institutions and thus *more* reform progress.

5.2. Regulatory Arbitrage

5.2.1. Benchmark

Table 6 presents the results for our main hypothesis, which uses the global derivative regulation index as the main regressor to explain foreign subsidiary shares of US traders' global IRS activity. For our pooled sample, we find reform progress in a given country to be negatively associated with the fraction of US banks' IRS activity in this country.

Our results indicate that more advanced host-country regulation corresponds to less activity from US dealers, which is consistent with the literature on banks' international activity and cross-border regulatory arbitrage (e.g., Houston et al., 2012; Karolyi and Taboada, 2015; Temesvary, 2014, 2015,

2018). The finding is robust to the introduction of control variables, which are motivated by this existing literature, and which capture the demand for derivative products and/or US banks' derivatives activity abroad. The variables include Log GDP per capita, GDP growth, and the size and liquidity of the local derivatives market (Log Turnover), i.e. the variables from our first step, as well as the volatilities of the short-term interest rate (which would provide a motive for trading derivatives) and the stock market, inflation, measures of political stability, and the size of the banking sector.

The finding is also robust to successively saturating the model with bank and quarter fixed effects, bank*quarter fixed effects, and quarter, bank and host country fixed effects.

What changes across specifications is the magnitude of the predicted effect. The most basic model, with only bank and quarter fixed effects suggests that a 1-unit increase in the reform index in a given country is associated with a decrease of 0.113 in the fraction of US dealers' IRS activity in that country. When we add the cyclical and structural control variables from the first step of our analysis, the point estimate drops to -0.080, in the specification with quarter and bank*quarter fixed effects, and to -0.025 in the model with bank, quarter, and country fixed effects. Of the cyclical variables, only inflation seems to be negatively related to the IRS positions, although the coefficient becomes insignificant in our most complete model specification. The size of the domestic banking sector has a negative effect on the presence of US dealers suggesting that higher competition from domestic banks reduces the entry of US banks.

In the specification without country fixed effects the structural variables are also positively related to subsidiary-level IRS holdings, which is in line with our prediction that banks – in the absence of regulatory arbitrage – should be attracted by more developed markets. The specification with bank, quarter, and country fixed effects (and the coefficient of -0.025 on the reform index), instead, provides our most conservative point estimate. With the average fraction of US dealers' IRS activity in a given country equal to 0.022, however, even this suggests that the effect is economically significant.

For our preferred specification, which includes additional measures of institutional and market development (political stability, stock market volatility, banking sector size), we predict a slightly stronger decrease of 0.030. This is consistent with our prediction that omitting these additional regressors works against finding evidence of regulatory arbitrage (although the only individual coefficient that is robustly significant is the one on the systemic size of the banking sector, which actually appears to deter geographic reallocation into the jurisdiction).

In Table 7 we further investigate the link between foreign subsidiary shares and individual reform blocks and find central clearing regulation, arguably the costliest block, to be the most relevant one. A 1-unit increase in the corresponding reform index corresponds to foreign subsidiary shares that are at least 0.107 lower. There is also some evidence that the regulation of electronic trading may actually help to attract rather than deter business from US dealers. The corresponding estimates are not statistically significant but generally plausible, considering that electronic trading regulation is unlikely to impose significant additional costs on the most advanced US traders, while clearly improving the trading environment through reduced operation risk and higher transparency and liquidity.

5.2.2. Robustness

For additional robustness, we interact our reform index with dummies that are equal to one after the successive tightening of US regulation; we specifically include such dummies for mandatory trade reporting, central clearing and electronic trading regulation in the US. The results are reported in Table 8 columns I and II. We find that the link between foreign subsidiary shares and the reform index is strongest after the US enforced mandatory central clearing, whether or not country fixed effects are included. This is consistent with Table 7 and the fact that this is the costliest reform block.

In line with the existing literature on cross-border arbitrage, we also instrument the overall reform index using measures of political and regulatory independence; specifically, we include a dummy for when the central bank shares the banks' regulatory oversight, and the fraction of years since 1776

that a country has been independent.¹⁴ The reported first-stage F-statistic shows that the instruments are strong and the Hansen J statistic that the instruments are valid. That our results remain robust indicates that our results are not plagued by reverse causality and warrants our (intuitive) causal interpretation.

Further strengthening this interpretation, we also run a “placebo regression” using the foreign subsidiary share of the US dealers’ FX swap activity, to which the reform blocks on electronic trading, CCP clearing and capital regulation do not apply.¹⁵ It seems that neither the overall reform index, nor any of the indices for the individual blocks is associated with the US dealers’ subsidiaries’ FX swap positions; this helps to eliminate concerns that dealers may have shifted their IRS positions for unobserved reasons that affect swap holdings more generally and supports the view that we observe evidence of regulatory arbitrage.

5.2.3. Mitigating Factors

To better understand the systemic implications of our findings, and to clarify the role of institutional quality, we consider the interaction of our progress indicator with different measures of institutional/governance and market quality (Table 9) that we obtain from the World Bank’s Governance Indices.¹⁶

Consistent with our previous observation, we find that a stronger rule of law and stronger government effectiveness appear to curb regulatory arbitrage (columns I and II). That is, US dealers are less likely to move their IRS positions to destinations with lax regulation if institutions are stronger. The same is true – albeit insignificantly – for regulatory quality, although US dealers are – for a given level of the

¹⁴ Other instruments, used for example in Karolyi & Taboada (2015), show up as weak instruments in our sample, so that we restrict our analysis to these two.

¹⁵ We thank participants at the BCBS-CEPR 2019 Workshop on the “Impact of regulation in a changing world” for pointing this out.

¹⁶ *Government effectiveness* captures perceptions of the quality of public services, the quality of civil service and its degree of independence from political pressures, the quality of policy formulation and implementation, and the credibility of the government’s commitment to such policies. *Regulatory quality* captures perceptions of the ability of the government to formulate and implement policies and regulations that permit and promote private sector development.

reform – seemingly attracted by higher regulatory quality (column III). The depth and liquidity of the local IRS market also reduces arbitrage (column IV), presumably because it implies lower transaction costs on the local market at any given step of reform progress.

5.2.4. Alternative Form of Regulatory Arbitrage

While we have so far focused on geographical arbitrage, other forms of regulatory arbitrage are starting to emerge, with an acceleration since 2016 as the US and other countries (Canada and Japan) progress with the implementation of margin and capital requirements. We describe them briefly and shed light on potential implications that ought to keep regulators vigilant.

(i) Risk-shifting

Partial loopholes imply that banks may not be able to geographically evade stronger regulation for certain assets or currencies and may thus need to compensate for the corresponding costs through different channels; e.g. by taking risks to maintain a target return on equity. To assess the significance of this form of arbitrage we analyze how the volatility of a foreign subsidiaries' trading portfolio relates to progress of the derivatives market reform.

To measure risk-taking, we use the 4-quarter rolling standard deviation of return on trading assets and control for leverage and asset quality. Our results in Table 10 show that this risk-shifting channel is significant, i.e. that US subsidiaries do indeed hold riskier trading portfolios in jurisdictions that have progressed further on the derivatives market reform. The result holds in our benchmark WLS specification (column I) and are economically relevant, albeit marginally significant statistically, with the effect being particularly strong after the US enforces mandatory electronic trading regulation (column II).

The 2SLS estimate is higher in magnitude, which is consistent with the fact that measurement error attenuates our benchmark estimates.

We conclude that subsidiaries are indeed also more likely to increase risk-taking in countries where costly reform blocks are more advanced.

(ii) Migration to shadow banks

Another emerging form of arbitrage is the transfer of activity to unregulated entities.¹⁷ In the US for example exemptions concern small depository institutions, non-bank financials, and captive finance groups. A plausible consequence of such exemption is the migration of derivatives activities away from banks to non-bank market participants. Aggregate data from the Bank of International Settlement (BIS) triennial survey reveal that in 2019 shadow banks, including hedge funds and other non-bank financial institutions accounted for more than 50 percent of IRS trading, this never happened before (see BIS, 2019). There are multiple inefficiencies associated with such mutations: a reduction of products available to end-users as small dealers are not able to offer the range of products and services previously offered by large institutions; heightened liquidity fragmentation; and reduced liquidity. One positive aspect of such mutation may be that credit risk is now spread across a larger pool of market participants. However, that may be an illusion if few large banks remain the sole provider of liquidity to the second-tier dealers.

(iii) Futurization

As swap markets become more regulated than futures markets, an unexpected innovation is the creation of swap-futures that mimic the service offered by swaps but come in form of exchange-traded futures. Futures have lower margin requirements, softer reporting and compliance obligations, and less frequent reporting. Albeit still at an early stage¹⁸ the migration from swaps to futures poses several policy problems. This form of regulatory arbitrage undermines the objectives of reaching greater transparency and reducing systemic risk. Swap-like futures will keep opaque pricing and wider bid/ask spreads which were an impediment to price discovery before the crisis. Then with lower

¹⁷ See Financial Times « Derivatives Move from Banks to the Shadows », September 11 2013.

¹⁸ So far futurization has concerned chiefly the energy sectors (gas and electric power) in North America.

futures margins, the stability of futures clearing houses is increasingly at risk as volumes of transactions cleared soar.

6. Conclusion

Indicators of progress for the implementation of the OTC derivatives market reform, which we build based on FSB Reports, reveal unequal progress of the reform agenda across G20 countries. These differences in the timing of adoption appear to be mainly explained by secular differences in institutions quality and governance. US banks, for which we observe derivatives holdings at the foreign subsidiary level, appear to have taken advantage of these cross-country disparities and a loophole in the Dodd-Frank Act – and moved their IRS activity to less tightly regulated foreign affiliates. To the extent that they are unable to evade the local regulation of their IRS positions by geographic reallocation, they also appear to compensate for the cost of the reform by adopting riskier trading portfolios.

These findings are driven by those blocks of the reform that are costliest for banks, most notably central clearing. They become stronger as regulation in the US tightens but can be mitigated by a stronger rule of law, more effective governments, and more developed derivative markets in the foreign jurisdiction. The importance and role of structural factors for reform progress eliminates concerns about reverse causality; if one expects that any innocuous reallocation of positions by banks would target jurisdictions with better developed governance and markets, it also alleviates concerns about omitted variables. Jointly, this suggests that our estimates indeed reflect a causal relationship and may actually provide a lower bound for the true effect. Even at this lower bound, however, our estimates indicate that differences in regulatory tightness have an economically significant effect on banks' geographic reallocation of their IRS portfolio.

Our results therefore provide evidence of cross-jurisdictional arbitrage in the context of the G-20's OTC derivatives market reform that seems to increase global financial risk on at least two dimensions:

the geographic move of risky IRS positions into jurisdictions that are less equipped to oversee them, and the shift, within subsidiaries, towards riskier trading portfolios. They therefore suggest: (a) that cross-jurisdictional arbitrage occurs not only in response to bank capital regulation, but also when regulatory action primarily affects transaction costs, as is the case on the derivatives market, (b) that cross-jurisdictional arbitrage prevails in the post-crisis era, and (c) that global reforms, like the G-20's derivatives market reform, may not only fail to curb cross-jurisdictional arbitrage, but might bring about new, perhaps unchecked, risks.

These risks need to be weighed carefully against the expected benefits of any global reform. Our findings therefore call for increased international coordination and risk-monitoring and suggest that the global regulation of OTC derivatives markets should ideally be accompanied by greater surveillance to identify emerging risks.

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Figure 1. Reform Costs

Regulatory block	Cost components	Costs
Trade repository	Infrastructure (IT), maintenance, access	\$*
Central clearing	Collateral, margins, IT	\$\$\$\$
Electronic trading	IT, maintenance, access (transitional and fixed)	\$*
Capital requirement	Economic	\$\$\$\$
Margin requirement	Economic	\$\$\$\$

(*) Can be reduced for small participants.

Figure 2. The shift abroad (Q1 2010 – Q4 2015).

The evolution in the share of interest rate swap activity operated abroad is shown for the top 5 US dealers (95% of total US activity): Bank of America, Citigroup, Goldman Sachs, JP Morgan and Morgan Stanley. Fractions were calculated with data from the FED Financial Statement of Foreign Subsidiaries of US Banking Organizations and from the FED Consolidated Financial Statement for Holding Companies. They are equal to the sum of the interest rate swap activity by each of the banks' foreign subsidiaries over total consolidated interest rate swap activities (resp. over total consolidated foreign exchange swap activities) of the bank taken from the calls reports.

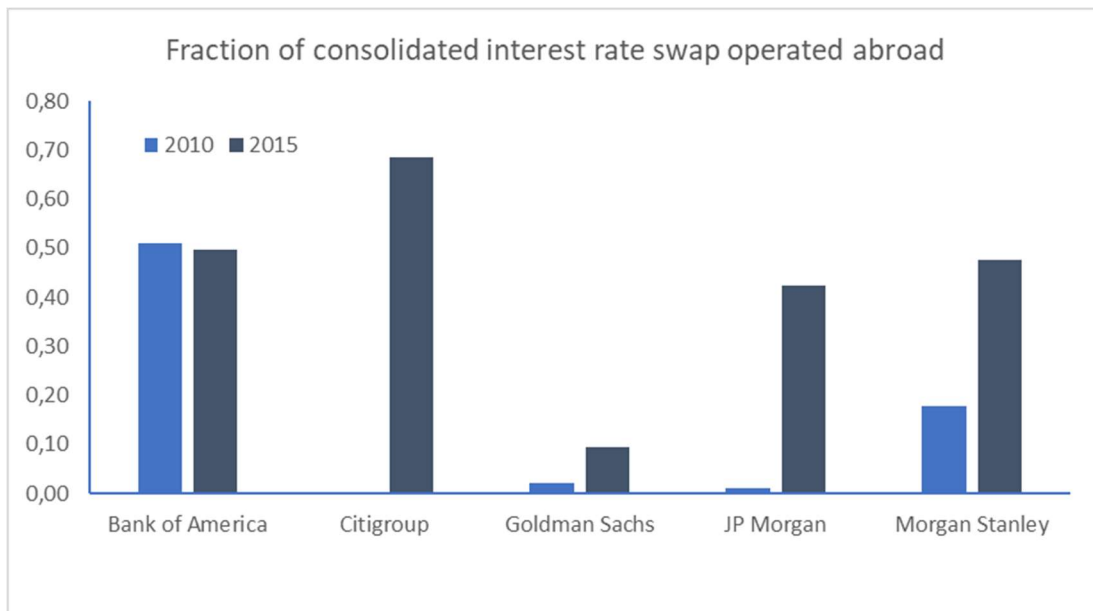


Figure 3. Location of US Banks' Interest Rate Swap Activity (Q1 2010 – Q4 2015).

Figure 3 presents the change (in percentage points) of US banks' consolidated interest rate swap activity in each country of the world between Q1 2010 and Q4 2015. In a given country, this share is calculated as the interest rate swap activity of the top 5 US dealers in this country relative to their total interest rate swap activity multiplied by 100. Categories are based on quantiles for non-zero data. Source: FED Financial Statement of Foreign Subsidiaries of US Banking Organizations and FED Consolidated Financial Statement for Holding Companies and Calls reports.

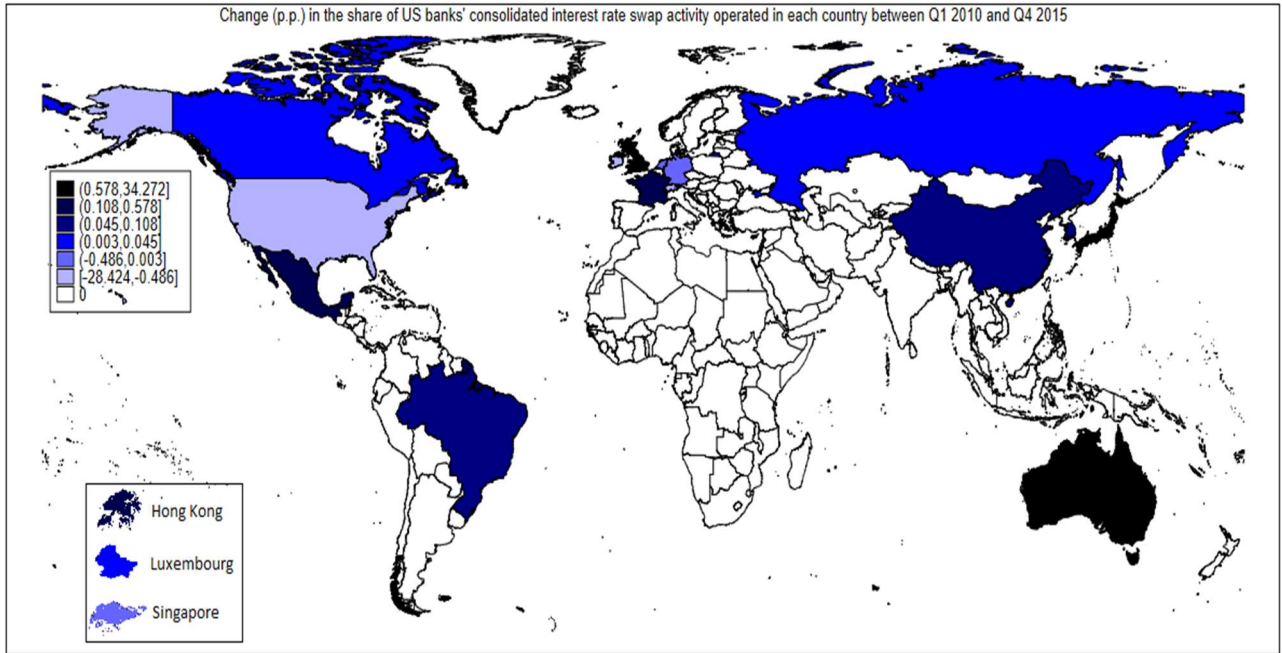


Table 1. Regulatory Indices (Q4 2016)

This table presents the values of the regulatory indices for each country as of Q4-2016. *Trade reporting*, *Central counterparty clearing*, *Electronic trading*, *Capital requirements*, and *Margin requirements* are all indices that measure progress in each individual area of the OTC derivative market regulation using FSB progress reports for the G20 countries. The indices take integer values between 0 and 4, where 0 corresponds to cases in which no authority exists to implement the reform and no steps are taken to adopt such an authority and 4 corresponds to instances with a legislative framework in which standards/requirements are in place for over 90% of all transactions. *The Derivreg index* is the number of sub-indices that have reached value 4.

Country	Trade reporting	Central counterparty clearing	Electronic trading	Capital requirements	Margin requirements	Derivreg index
Argentina	3	3	3	4	1	1
Australia	4	4	4	4	3	4
Brazil	4	4	1	4	1	3
Canada	4	3	2	4	4	3
China	4	4	4	1	0	3
European Union	4	4	3	4	2	3
Hong Kong	3	4	1	4	2	2
India	4	3	3	4	3	2
Indonesia	4	3	4	1	1	2
Japan	4	4	4	4	4	5
Mexico	4	4	4	4	1	4
Republic of Korea	4	3	0	3	1	1
Russia	4	2	1	4	2	2
Saudi Arabia	4	1	1	4	1	2
Singapore	4	4	1	4	3	3
South Africa	2	2	1	4	2	1
Switzerland	3	4	4	4	4	4
Turkey	3	1	1	4	1	1
United States	4	4	4	3	4	4

Table 2. Quarter of Adoption

This table presents the quarters in which the regulatory progress (sub-)indices reach value 4 (the maximum). The indices are defined as in Table 1.

Country	Trade reporting	Central counterparty clearing	Electronic trading	Capital requirements	Margin requirements	Date the Derivreg index reaches 4
Argentina				Q1 2013		
Australia	Q1 2014	Q4 2014	Q2 2016	Q1 2013		Q2 2016
Brazil	Q1 2010	Q4 2014		Q1 2013		
Canada	Q4 2014			Q1 2013	Q1 2016	
China	Q1 2013	Q3 2014	Q3 2013			
European Union	Q1 2014	Q1 2016		Q1 2014		
Hong Kong		Q2 2016		Q1 2013		
India	Q3 2012			Q1 2013		
Indonesia	Q1 2013		Q1 2013			
Japan	Q3 2012	Q3 2012	Q3 2015	Q1 2013	Q1 2016	Q3 2015
Mexico	Q1 2013	Q2 2016	Q2 2016	Q1 2016		Q2 2016
Republic of Korea	Q3 2012					
Russia	Q4 2015			Q1 2013		
Saudi Arabia	Q1 2013			Q1 2013		
Singapore	Q2 2015	Q4 2014		Q1 2013		
South Africa				Q1 2013		
Switzerland		Q1 2016	Q1 2016	Q1 2013	Q1 2016	Q1 2016
Turkey				Q4 2015		
United States	Q1 2012	Q3 2012	Q3 2013		Q2 2016	Q2 2016

Table 3. Descriptive Statistics

Country-level*bank variables and subsidiary level data are quarterly data extracted from US form 2314 and cover the period Q1 2010 to Q4 2016. Consolidated data are from Calls reports. Country-level macroeconomic data are from the OECD database. Volatility is calculated as the 4-quarter rolling standard deviation of returns on trading assets (ROA). Sharpe ratio is ROA divided by volatility. 4-quarters rolling standard deviations are also used to calculate interest rate, exchange rate volatility, and stock market volatility. Turnover is from the BIS derivatives database (in million USD). Indices of political stability and no violence, government effectiveness and regulatory quality are from the World Bank Governance database.

Variable	Mean	Standard deviation	25th percentile	50th percentile	75th percentile
Dependent variables					
<i>Country-level*bank variables</i>					
Fraction of bank's IRS activity in a given country	0,022	0,095	0,000	0,000	0,001
Fraction of bank's FXS activity in a given country	0,032	0,140	0,000	0,000	0,003
<i>Subsidiary-level variables</i>					
Returns on trading assets (ROA)	0,037	0,181	-0,008	0,008	0,048
Volatility of ROA	0,098	0,332	-0,008	0,009	0,049
Sharpe ratio	1,024	1,017	0,188	1,010	1,709
<i>Consolidated level</i>					
Returns on assets	2,221	1,026	1,539	2,141	2,635
Volatility	2,231	0,716	1,747	2,051	2,485
Sharpe ratio	1,011	0,363	0,717	1,104	1,309
Explanatory variables					
<i>Country-level variables</i>					
GDP growth	0,680	0,940	0,200	0,600	1,100
Log GDP per capita	10,275	0,546	9,828	10,492	10,709
Inflation	2,558	2,546	0,881	2,156	3,615
Log turnover IRS	9,869	1,937	8,171	10,393	11,100
Log turnover FXS	11,445	1,375	10,377	11,595	12,427
Interest rate volatility	4,096	6,469	0,677	1,671	4,461
Exchange rate volatility	0,026	0,013	0,018	0,026	0,033
Regulatory quality	0,765	0,884	-0,004	0,796	1,691
Government effectiveness	0,865	0,838	0,073	0,758	1,627
Political stability and no violence	0,17	0,81	-0,52	0,25	0,93
Stock market volatility	20,86	6,27	16,18	20,26	25,13
Banking sector assets/GDP	108,70	55,02	62,24	112,30	143,90
<i>Subsidiary-level variables</i>					
Log total assets	15,970	1,745	14,792	15,813	17,190
Equity/assets	0,358	0,284	0,131	0,265	0,524
Impaired loans/total assets	0,000	0,001	0,000	0,000	0,000

Table 4. Timing of the Reform

This table reports discrete time proportional hazard model estimates of factors that affect the timing of derivatives markets reforms. Each column corresponds to results relating to each of the 4 blocks of the reform: trade repositories (TR), central counterparties (CCP), electronic trading platforms (ETP), and capital requirements (KA). Standard errors (not reported) are clustered by country*year; * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$.

Panel A

	I DERIVREG	II TR	III CCP	IV ETP	V KA
GDP growth	0.237 (0.332)	-0.512 (0.186)***	-0.284 (0.283)	0.457 (0.234)*	-1.025 (2.678)
Log GDP per capita	1.597 (0.886)*	2.750 (1.732)+	4.208 (1.626)***	1.604 (0.930)*	9.808 (37.438)
Log duration	6.823 (2.843)**	6.902 (1.525)***	5.580 (2.277)**	1.411 (0.372)***	40.452 (343.438)
Constant	-36.731 (15.077)**	-47.038 (19.102)**	-59.887 (23.524)**	-24.788 (9.528)***	-202.210 (1,249.877)
<i>N</i>	560	354	502	527	375

Panel B

	I DERIVREG	II TR	III CCP	IV ETP	V KA
GDP growth t-1	-0.399 (0.364)	0.534 (0.435)	-0.315 (0.301)	0.218 (0.217)	11.773 (42.785)
Log GDP per capita t-1	1.220 (0.938)	3.333 (1.721)*	4.090 (1.627)**	1.352 (0.893)	-0.849 (2.287)
Log Duration	7.270 (4.078)*	6.877 (1.478)***	5.430 (2.157)**	1.452 (0.405)***	2.807 (11.780)
Constant	-33.840 (19.051)*	-53.550 (18.814)***	-58.026 (23.028)**	-22.052 (9.000)**	-62.097 (235.273)
<i>N</i>	559	352	500	525	373

Table 5. Determinants of the timing of reform: additional explanatory variables.

This table reports estimates of variables added one at a time in the regressions reported in Table 4. Z-score is an accounting-based measure of the distance to default of the banking sector. Higher z-score means greater stability. NPL is the ratio of banks total overdue loans divided by total assets. Log Turnover is the log of the turnover in million USD of derivatives markets in a given country. Regulatory quality and government effectiveness are from the World Bank governance indicators database. Crisis cost proxies, based on output loss and public debt rise, are from the Laeven and Valencia database. Results for lagged NPL and Z-score are presented in parentheses. Standard errors (not reported) are clustered by country*year.

<i>Covariates</i>	I DERIVREG	II TR	III CCP	IV ETP	V KA
Secular factors					
Log Turnover	0.787**	1.163	1.972***	0.740***	0.284
Regulatory quality	1.216*	1.159	5.291	1.267*	0.624
Government effectiveness	1.613**	1.605	3.706*	1.687*	0.736
Crisis cost (output loss)	-0.009	0.159	0.192*	0.030	0.057
Crisis cost (public debt rise)	-0.019	0.189	0.211**	0.025	0.069
Number of crisis 70s-90s	0.768	0.058	-1.932***	-0.241	0.651
Banking sector assets/GDP	0.002	0.023	0.011	0.008	-0.003
Central bank regulator	-2.661***	-2.194	-1.221	-2.044***	-0.713
Cyclical factors					
NPL (lagged)	-0.488* (-0.583)	0.039 (0.107)	0.265 (0.293)	0.124 (0.168)	0.536 (0.690)
Z-score (lagged)	0.470** (0.536*)	0.650 (0.838)	0.152 (0.224)	0.243** (0.297***)	0.299 (0.230)

Table 6. Regulatory Arbitrage

The dependent variable is a dealer's IRS activity in a given foreign country divided by total (consolidated) interest rate swap in a given quarter. The sample covers the foreign subsidiary activity of the top 5 US dealers over 2010 Q1-2015 Q4. Activity is measured by notional. The Derivreg index covers 5 areas: trade reporting, central clearing, electronic trading, and capital requirement. The index takes integer values between 0 and 4: it takes value 0 when regulation is not enforced in any of the 4 areas and value 4 when regulation is enforced and implemented in all 4 areas. *Inflation* is measured as the year-on-year growth rate of the CPI. *Log(GDP per capita)* is the logged gross domestic product at purchasing power parity divided by population. *GDP growth* is measured as the year-on-year percent change in GDP at constant prices. *Log(turnover)* is the logged daily average turnover of OTC interest rate swaps (in million USD), i.e., the total amount of IRS contracts traded in a day at the country level. See Table 1 for the sources and definitions of the variables. Estimates are weighted by dollar amounts of interest rate swap notional to give more weight to larger subsidiaries. Standard errors clustered by country*year are reported in parentheses. ***, **, * respectively indicate statistical significance at 1%, 5% and 10% level.

	I	II	III	IV	V	VI
Derivreg index	-0.113 (0.044)**	-0.107 (0.053)**	-0.080 (0.029)***	-0.025 (0.015)*	-0.032 (0.012)**	-0.030 (0.016)*
Inflation			-0.084 (0.018)***	-0.020 (0.008)**	-0.030 (0.010)***	-0.016 (0.018)
Log GDP/capita			0.341 (0.148)**	-0.640 (0.435)	-0.503 (0.189)**	0.229 (0.437)
GDP growth			-0.023 (0.014)	-0.006 (0.015)	-0.011 (0.017)	-0.031 (0.023)
Log turnover			0.056 (0.007)***	0.348 (0.060)***	0.104 (0.018)***	-0.128 (0.053)**
Interest rate volatility			0.081 (0.020)***	0.013 (0.011)	-0.007 (0.007)	-0.012 (0.007)*
Political stability					0.090 (0.138)	0.195 (0.228)
Stock market volatility					-0.006 (0.004)	-0.013 (0.011)
Banking sector assets/GDP					-0.001 (0.001)*	-0.006 (0.002)***
<i>Bank FE</i>	yes	no	no	yes	yes	yes
<i>Quarter FE</i>	yes	no	no	yes	yes	yes
<i>Bank*quarter FE</i>	no	yes	yes	no	no	no
<i>Country FE</i>	no	no	no	yes	no	yes
<i>R²</i>	0.56	0.70	0.82	0.82	0.82	0.83
<i>N</i>	950	950	931	931	610	610

* $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$

Table 7. Regulatory arbitrage: response to individual regulatory blocks

The dependent variable is a dealer's IRS activity in a given foreign country divided by total (consolidated) interest rate swap in a given quarter. The sample covers the foreign subsidiary activity of the top 5 US dealers over 2010 Q1-2015 Q4. Activity is measured by notional. Trade reporting, Central clearing, Electronic trading, and Capital requirement are the regulatory blocks' progress indices. The indices take integer values between 0 and 4 with higher values meaning greater progress. The other variables are defined as in Table 6. Estimates are weighted by dollar amounts of interest rate swap notional to give more weight more weight to larger subsidiaries. Standard errors clustered by country*year are reported in parentheses. ***, **, * respectively indicate statistical significance at 1%, 5% and 10% level.

	I	II	III	IV
Trade reporting	0.118 (0.073)	0.149 (0.071)**	-0.005 (0.058)	-0.012 (0.047)
Central clearing	-0.150 (0.061)**	-0.192 (0.063)***	-0.107 (0.043)**	-0.142 (0.041)***
Capital requirements	-0.150 (0.117)	-0.033 (0.103)	-0.112 (0.102)	0.056 (0.099)
Electronic trading	0.013 (0.038)	0.028 (0.041)	0.030 (0.040)	0.049 (0.032)
Inflation (%)			-0.091 (0.016)***	-0.095 (0.017)***
Log(GDP per capita)			0.351 (0.116)***	0.292 (0.143)**
GDP growth (%)			-0.024 (0.014)*	-0.037 (0.013)***
Log(turnover)			0.050 (0.005)***	0.057 (0.006)***
Interest rate volatility			0.073 (0.015)***	0.079 (0.020)***
<i>Bank FE</i>	yes	no	yes	no
<i>Quarter FE</i>	yes	no	yes	no
<i>Bank*Quarter FE</i>	no	yes	no	yes
R^2	0.57	0.71	0.70	0.83
N	950	950	931	931

* $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$

Table 8. Robustness to alternative method

The dependent variable is a dealer's IRS activity in a given foreign country divided by total (consolidated) interest rate swap in a given quarter. The sample covers the foreign subsidiary activity of the top 5 US dealers over 2010 Q1-2015 Q4. Activity is measured by notional. US TR, US CCP, and US ETP, are dummy variables that take value one after the US enforced mandatory trade reporting, central clearing, and electronic trading, respectively. The other variables are defined as in Table 6 and Table 7. Estimates are weighted by dollar amounts of interest rate swap notional (or fx swap notional) to give more weight to larger subsidiaries. Standard errors clustered by country*year are reported in parentheses. ***, **, * respectively indicate statistical significance at 1%, 5% and 10% level.

	I	II	III	IV	V Placebo	VI Placebo
	US adoption	US adoption	2SLS	2SLS	FX swaps	FX swaps
Derivreg	0.043 (0.051)	0.042 (0.025)*	-0.127 (0.028)***		0.035 (0.042)	0.023 (0.084)
Derivreg*US TR	-0.038 (0.021)*	-0.009 (0.008)				-0.030 (0.046)
Derivreg*US CCP	-0.120 (0.051)**	-0.060 (0.028)**				0.031 (0.048)
Derivreg*US ETP	0.025 (0.044)	-0.016 (0.016)				0.040 (0.037)
Inflation (%)	-0.085 (0.017)***	-0.018 (0.008)**	-0.034 (0.009)***	-0.035 (0.008)***	-0.032 (0.019)*	-0.038 (0.022)*
Log(GDP per capita)	0.310 (0.111)***	-0.656 (0.428)	-0.309 (0.062)***	-0.182 (0.109)*	4.076 (1.007)***	4.189 (0.975)***
GDP growth (%)	-0.013 (0.015)	-0.005 (0.015)	0.007 (0.010)	-0.024 (0.018)	-0.068 (0.019)***	-0.069 (0.019)***
Log(turnover) IRS	0.047 (0.006)***	0.335 (0.057)***	0.079 (0.012)***	0.085 (0.009)***		
Interest rate volatility	0.081 (0.015)***	0.018 (0.011)	-0.008 (0.007)	-0.007 (0.009)		
Trade reporting				0.058 (0.039)		
Central clearing				-0.179 (0.052)***		
Capital requirements				-0.061 (0.056)		
Electronic trading				0.043 (0.032)		
Log(turnover) FXS					0.207 (0.077)***	0.203 (0.076)***
Exchange rate volatility					-6.059 (4.610)	-5.396 (4.821)
<i>Bank FE</i>	yes	yes	yes	yes	yes	yes
<i>Quarter FE</i>	yes	yes	yes	yes	yes	yes
<i>Country FE</i>	no	yes	no	no	yes	yes
F test 1 st stage pvalue			0.000	0.000		
Hansen J statistic			0.17	0.77		
<i>R</i> ²	0.71	0.82	0.82	0.81	0.89	0.89
<i>N</i>	931	931	818	818	937	937

* $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$

Table 9. Mitigating factors

The dependent variable is a dealer's IRS activity in a given foreign country divided by total (consolidated) interest rate swap in a given quarter. The sample covers the foreign subsidiary activity of the top 5 US dealers over 2010 Q1-2015 Q4. Activity is measured by notional. Rule of law measures confidence in contract enforcement and property rights. Government effectiveness measures the quality of public services and policy. And regulatory quality measures perception of government capacity to implement sound regulations. The other variables are defined as in Table 6 and Table 7. Estimates are weighted by dollar amounts of interest rate swap notional to give more weight to larger subsidiaries. Standard errors clustered by country*year are reported in parentheses. ***, **, * respectively indicate statistical significance at 1%, 5% and 10% level. All regressions include dealer, year-quarter, and country fixed effects.

	I	II	III	IV
Derivreg	-0.150 (0.031)***	-0.136 (0.039)***	-0.103 (0.029)***	-0.395 (0.068)***
Inflation (%)	-0.037 (0.009)***	-0.045 (0.011)***	-0.032 (0.008)***	0.008 (0.007)
Log(GDP per capita)	-0.344 (0.467)	-0.459 (0.413)	-0.518 (0.436)	-0.576 (0.340)*
GDP growth (%)	-0.001 (0.017)	-0.000 (0.015)	0.001 (0.016)	0.001 (0.012)
Log(turnover) IRS	0.025 (0.070)	0.010 (0.066)	-0.024 (0.054)	0.331 (0.043)***
Interest rate volatility	-0.011 (0.007)	-0.011 (0.007)	-0.009 (0.006)	0.010 (0.010)
Derivreg*Rule of law	0.068 (0.026)**			
Rule of law	-0.059 (0.295)			
Derivreg*Government effectiveness		0.057 (0.028)**		
Government effectiveness		-0.107 (0.124)		
Derivreg*Regulatory quality			0.039 (0.025)	
Regulatory quality			0.340 (0.162)**	
Derivreg*Log(turnover) IRS				0.031 (0.005)***
R^2	0.83	0.83	0.83	0.84
N	789	789	789	931

* $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$

Tables 10. Risk-Shifting

The dependent variable is the 4-quarter rolling standard deviation of the return on the trading portfolio of a dealer's subsidiaries in a given foreign country. The sample covers the foreign subsidiary activity of the top 5 US dealers over 2010 Q1-2015 Q4. Activity is measured by notional. The explanatory variables are defined as in Table 6 and Table 7. Estimates are weighted by dollar amounts of interest rate swap notional to give more weight to larger subsidiaries. Standard errors clustered by country*year are reported in parentheses. ***, **, * respectively indicate statistical significance at 1%, 5% and 10% level. All regressions include dealer, year-quarter, and country fixed effects.

	I	II	III	IV
	WLS	US adoption	2SLS	2SLS
Derivreg	0.022+ (0.014)	-0.004 (0.030)	0.217 (0.108)**	0.198 (0.094)**
Inflation (%)	0.001 (0.010)	-0.005 (0.010)	0.011 (0.024)	0.009 (0.025)
Log(GDP per capita)	0.010 (0.005)*	0.010 (0.005)*	-0.091 (0.121)	-0.070 (0.098)
GDP growth (%)	0.020 (0.377)	0.016 (0.365)	0.035 (0.022)	0.051 (0.024)**
Derivreg*US TR		-0.005 (0.010)		
Derivreg*US CCP		0.029 (0.032)		
Derivreg*US ETP		0.037 (0.020)*		
Equity/assets	-0.126 (0.078)	-0.129 (0.077)	0.054 (0.212)	0.357 (0.241)
Log(assets)	-0.016 (0.029)	-0.020 (0.029)	0.050 (0.024)**	0.045 (0.024)*
Impaired loans/assets	8.382 (16.013)	5.415 (16.753)	-8.560 (18.327)	-52.875 (37.924)
<i>Bank FE</i>	no	no	yes	no
<i>Quarter FE</i>	no	no	yes	no
<i>Bank*quarter FE</i>	yes	yes	no	yes
<i>Country FE</i>	yes	yes	no	no
F test 1 st stage pvalue			0.025	0.007
Hansen J statistic			0.72	0.93
R ²	0.60	0.60		
N	723	723	640	640

* $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$