THE IMPACT OF POST 2008 FINANCIAL CRISIS REGULATIONS ON ORGANIZED EXCHANGE MARKETS OF INTEREST RATE DERIVATIVES IN THE UNITED STATES

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Abstract

The aftermath of 2008 financial crisis highlighted the necessity to properly regulate the OTC derivatives market. Both the U.S. and the European Union agreed on new regulatory measures to (1) mandatorily trade standardized OTC derivatives through central clearing parties (CCPs), (2) increase capital and collateral requirements for non-centrally cleared derivatives and (3) report trading activities for both OTC and cleared deals. This paper examines by multivariate regression analysis the impact of the new regulation on the largest and first regulated derivatives market, the U.S., specifically in organized exchange market of interest rate derivatives, also taking into account the possible impact of the U.S. economy and monetary policy to this market, measured by GDP and federal funds rates respectively. Considering the difficulties imposed by the new regulations, the expected outcome would be to disincentivize bilaterally trading activities and increase the dealing through organized exchange along time. The research findings show that the outcome of organize-exchange traded interest rate Options and Futures, for both short-term and long-term maturities, is positively related to the U.S. GDP. Monetary policy showed to be not statistically significant to the market studied outcome. Most importantly, rather than the most expected outcome, the start of the regulation is shown to lower, not raise the interest rate derivatives traded in organized exchange.

Keywords: CCPs, crisis, Derivatives, GDP, Interest Rate, OTC

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Resumo

A consequência da crise financeira de 2008 ressaltou a necessidade de regular propriamente o mercado bilateral de derivativos. Ambos Estados Unidos e União Europeia acordaram em novas medidas regulatórias para (1) mandaticiamente negociar os derivativos bilaterais padrão através de câmaras de compensação, (2) aumentar exigência de capital e colateral para derivativos não negociados em câmaras de compensação, e (3) reportar negociações para ambos mercados de bilaterais e através de camaras de compensação. Esta dissertação examina através de análises de regressões multivariadas o impacto da nova regulação no maior e primeiramente mercado de derivativos regulado, Estados Unidos, especificamente no mercado de derivativos de taxas de juros em câmaras de compensação, também levando em consideração o possível impacto da economia dos Estados Unidos e sua política monetária, medidos através do PIB e taxas de fundos federais respetivamente. Considerando as dificuldades impostas pela nova regulação, o resultado esperado seria o desincentivo da negociação bilateral e o aumento de negociações através de câmaras de compensação ao longo do tempo. Os resultados da pesquisa mostram que o resultado das Opções e Futuros de taxas de juros negociados em câmaras de compensação, ambos para curta e longa maturidade, é positivamente relacionado com o PIB dos Estados Unidos. Entretanto, a política monetária mostrou não ser estatisticamente relevante para o mercado estudado. Mais importante, ao invés do resultado esperado, o começo da regulação mostrou diminuir, não aumentar os derivativos de taxa de juros negociados em câmaras de compensação.

Palavras-chave: câmaras de compensação, crise, derivativos, PIB, taxa de juros, bilateral

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1. INTRODUCTION

What started as the bursting of the U.S. housing bubble in 2007, led to a global economic downturn, leading to the widely known 2008 financial crisis. The primarily cause of the crisis, which led the U.S. economy to recession, was the financial deregulation and the derivatives usage in the mortgage market.

The 2008 global financial crisis shed light on the importance of the derivatives usage, and specially the lack of regulation on that market. In this sense, in the 2009 G20 Summit in Pittsburgh, the G20 leaders agreed on several measures to promote stricter regulation to the derivatives markets, especially for the over the counter (OTC) market.

In the U.S., the reforms began to be implemented in July 2010, when the Dodd-Frank Wall Street Reform and Consumer Protection Act (DFA) were signed. A few years later, in August 2012, the European Parliament and the Council of Ministers also agreed on the European Market Infrastructure Regulation (EMIR).

Both regulations highlighted the importance of central clearing houses (CCPs) on the market and made mandatory the clearing of certain derivatives products. Also, the new regulations imposed higher capital and collateral requirements when trading derivatives bilaterally. Thus, it is arguable to what extent trading derivatives on OTC market would be preferable than doing it in the organized exchange market.

Considering the new scenario since regulations took place in 2010 in the U.S., this study aims to understand if the regulations really changed the notional amounts traded in organized exchanges when comparing the market before (2000-20009) and after (2010-2019) regulations, considering that new regulations could disincentivize dealing in OTC market and increase trading through organized exchange. More specifically, this study analyses the interest rate derivatives market, taking into account not only the beginning of regulations, but also the evolution of the U.S. economy along the years measured by the GDP and the changes in the monetary policy, represented by the federal fund interest rates from 2000 to 2019.

On section 2, Literature Review, we will discuss the goals of the new regulations alongside with the denominated regulators for both U.S. and European Union markets. In addition, the role and structure of the clearing houses in both markets will be explained in detail, alongside with further discussions of liquidity improvement that they could provide to the market. We will also present the current and past scenario of interest rate derivatives around the world, from 2000 to 2019, and for the same period, discuss the evolution of U.S. GDP and interest rate.

For this study, four different multivariate regression analysis were performed considering as dependent variables the turnover notional amounts of (1) interest-rate derivatives of short-term, (2) interest-rate derivatives of long-term, (3) interest-rate future contracts and (4) interest-rate option contracts traded in organized exchanges from 2000 to 2019. As independent variables, analysed in those scenarios are the U.S. GDP, U.S. federal funds rates and the beginning of regulation as a dummy variable.

According to the results of the multivariate regression analysis presented on section 4, we can conclude that the exchange-traded interest-rate derivatives of short-term, long-term, Options and Futures grew across time alongside with the U.S. economy measured by GDP, meaning that this variable was statistically significant in the analysis. Meanwhile, the changes in monetary policy, interest-rates controlled by the FED from 2000 to 2019, were not statistically significant in relation to all the types of interest-rate derivatives studied.

Finally, and most important, results showed that even though the impact of the start of the regulations was statistically significant, an important negative relationship is identified. In conclusion, the study showed that the start of regulation did not increase the notional turnover amount of interest-rate derivatives in organized exchanges as would be expected, but actually had a negative effect on the market

2. LITERATURE REVIEW

2.1 THE REGULATION AND THE REGULATORS

After the 2007-2008 global financial crisis, weaknesses posed by over-the-counter (OTC) derivative securities market generated a consensus that reforms on the market should be done in order to mitigate systemic risk, improve transparency, and protect against market abuse, as analysed by Bellia et al. (2017).

In this sense, the G20 Leaders in the 2009 G20 Summit in Pittsburgh agreed to reforms to OTC derivatives markets, which in general are divided in three central elements.

The first element is that all standardized OTC derivatives should be cleared through central clearing counterparties (CCP), instead of trading bilaterally and out of sight of the public. Standardized derivatives are now required to be traded on regulated exchanges or swap execution facilities, reducing risk in the financial system. The importance of these main players on derivatives market will be further discussed in this article. (FSB, 2009)

The second element is that the non-centrally cleared derivatives should be subject to higher capital and collateral requirements, creating a cost incentive in favour of central clearing and reducing counterparty credit risk in the bilateral market. (BCBS and IOSCO, 2015).

The third important element regards to the reporting of trading activities, both of OTC and cleared deals, which improves the lack of market transparency, one of the drivers to the financial crisis. The aim of a more transparent market is also to increase the competition resulting in better pricing to the marketplace, lowering costs for businesses and consumers.

As a response to the reforms agreed and its central elements, both the United States and the European Union created regulations for each local derivatives market. In the United States, Congress signed the Dodd-Frank Wall Street Reform and Consumer Protection Act (DFA) into law in July 2010. In August 2012, the European Parliament and the Council of Ministers also agreed on the European Market Infrastructure Regulation (EMIR) (Bellia et al., 2017). The G20 OTC derivatives market reform agenda has reshaped the structure of these markets in recent years, even though the speed of implementation of the reforms has varied across jurisdictions.

In accordance with the Dodd-Frank Wall Street Reform and Consumer Protection Act, the Commodity Exchange Act (CEA) established a new regulatory framework for swaps and security-based swaps, bringing a comprehensive reform to the regulation of swaps. The Commodity Exchange Act (CEA) regulates the trading of commodity futures in the United

States and establishes the statutory framework under which the CFTC operates. This amendment aimed to enhance the Commodity Futures Trading Commission's (CFTC) rulemaking and enforcement authorities with respect to registered entities and intermediaries subject to the Commission's oversight. Currently, the CFTC's regulatory authority oversees the more than $400 trillion swaps market. The CFTC also conducts several studies and reports on a wide variety of issues that affect the derivatives market. (CFTC, 2022a)

In 2012, the European Union adopted the European Market Infrastructure Regulation (EMIR), developed by the European Securities and Market Authority (ESMA), also imposing the three main requirements for the local derivatives market, as previously done in the United States. The European Securities and Markets Authority (ESMA) is an authority that "contributes to safeguarding the stability of the EU's financial system by enhancing the protection of investors and promoting stable and orderly financial markets". In this sense, EMIR was also developed for European derivatives market with the same goals of reducing the counterparty credit risk and increasing transparency in the OTC derivatives markets, therefore mitigate credit risk. (ESMA, 2022; see also Central Bank of Ireland, 2022)

2.2. POST REGULATIONS IMPORTANT POINTS OF DISCUSSION

2.2.1. THE ROLE OF CLEARINGHOUSES (CCPs)

In accordance with the development of the 2008 financial crisis and the regulations adopted in the United States and in the European Union, the Central Clearing Parties (CCPs), or also called clearinghouses, became the centre of exchange for all standardized over the counter (OTC) derivatives transactions (BIS, 2014).

The primary function of a clearinghouse is to ensure that participants' positions are properly settled, by gathering information on trades to calculate the participants' net positions, while also adjusting the exposure of participants by granting short-term credit. In addition, as recognized by Bliss and Steigerwald (2006), a clearinghouse also provides several interrelated services to the market, including credit risk management, delegated monitoring, and liquidity enhancement.

Given the increasing importance of central clearing parties (CCPs), they have been studied both theoretically and empirically by several authors over the years. One example is the theoretical analysis of Koeppl et al. (2011), in which the authors point out how CCPs are able to limit the probability of market participants defaulting (credit risk management) and also the benefit of

monitoring, given that trades are automatically processed and cleared within the system. Thus, they conclude that an optimal clearing arrangement is to provide liquidity to participants in the form of lower short-term credit cost, while ensuring incentives for carrying out and settling transactions.

Another benefit of CCPs is the greater netting efficiency which also reduces counterparty credit risk. According to the cost comparison performed by Ghamami and Glasserman (2017), greater netting efficiency also lowers margin and capital requirements. Theoretically, CCP clearing all types of derivatives would achieve maximal netting efficiency.

On the other hand, there are ongoing debates regarding the counterparty-risk trade-offs involved in central clearing, regarding not only the increasing number of CCPs on the market, but the introduction of single asset class clearing. Duffie and Zhu (2011) provide a framework considering that a high number of multiple CCPs in a market would cause central clearing to lose its netting advantage, increasing collateral demand and counterparty exposures at the same time.

Considering that the key determinant of collateral demand is netting, Duffie et al. (2015) also take into account the number of CCPs and the different types, "specialized" and "non-specialized" CCPs. In this sense, their conclusion is that "non-specialized" CCPs (that clear all types of assets class, not being restricted to only one, like CDS) are shown to be less efficient in collateral use due to lost opportunities of netting efficiency across asset classes, when compared with "specialized" CCPs that focus on clearing just one type of asset class and have lower collateral demand.

Considering that the regulations adopted in the United States and in the European Union aim to create cost incentive for central clearing (see BIS (2014) and BCBS and IOSCO (2015)), the BIS performed a study in 2014 and identified that the main drivers for the decision to clear are margin costs and capital costs. Despite the fact that clearing is mandatory for standardized over the counter (OTC) derivatives, it is still an open question when is a deal sufficiently "standardized" to be mandatorily cleared and also the willingness to of counterparties to do so, instead of counterparties transacting fully bilaterally.

In this sense, studies like Menkveld et al. (2015) concluded that the preference of bilateral trading and the lack of voluntary clearing is due to the perception of market participants that CCP costs can be higher than its benefits. However, considering the structure of costs post-reform of non-centrally cleared derivatives, CCPs costs should be even higher than, for

example, bank´s costs that include collateral cost (initial margin requirement) and capital costs (counterparty default risk capital charge and CVA risk capital charge) in order to choose not to clear (BIS ,2014).

2.2.1.1. CCPs IN THE UNITED STATES

The Commodity Futures Trading Commission (CFTC) is an independent government agency that regulates the U.S. derivatives markets, including futures, options, and swaps. The CFTC´s mission is "to promote the integrity, resilience, and vibrancy of the U.S. derivatives markets through sound regulation". The CFTC organization is led by the Chairman and consists in the offices of the Chairman and Commissioners as well as the agency's 13 operating divisions and offices. (CFTC, 2022b)

One of the Operating Divisions & Offices of CFTC is the Division of Clearing and Risk (DCR). The DCR oversees (1) derivatives clearing organizations (DCOs), DCO clearing members, other market participants that may pose risk to the clearing process; and (2) the clearing of swaps, futures, and options on futures. DCR is also responsible for risk oversight of clearing processes, including Futures Commission Merchants (FCMs) clearing members, non-FCM clearing members and also swap dealers and large traders. (CFTC, 2022c)

Also according to CFTC (2022c), the industry organizations are divided in 2 categories: Clearing Organizations and Trading Organizations. The Clearing Organizations are composed by derivatives clearing organizations (DCOs). DCOs are entities that enables each party to an agreement, contract, or novation, providing settlement or netting of obligations and clearing services that mutualize or transfer credit risk among participants. A DCO must register with the CFTC before providing clearing services of swaps, futures, and options on futures contracts. On Table 2, we present the currently registered DCOs overseen by CFTC in the United States.

As an outcome of the Dodd-Frank Act adopting the new Section 5h of the Commodity Exchange Act (CEA), two types of Trading Organizations were stablished on the basis that to operate a facility trading or processing of swaps, the facility needs to be registered as a Swap Execution Facility (SEF) or as a Designated Contract Market (DCM). To be registered and maintain registration, a swap execution facility (SEF) must comply with core principles and any requirement that the CFTC may impose by rule or regulation.

The Designated Contract Markets (DCMs) are exchanges allowed to trade futures or option contracts of different types of commodities and allow access to all types of traders, including retail customers. While some DCMs have been operating on the market as traditional futures

exchanges, recently CFTC designated others as new contract markets. In Table 1, we present the currently Trading Organizations with Designated Contract Markets (DCMs). (CFTC, 2022d)

The National Securities Clearing Corporation (NSCC), which is a subsidiary of the Depositary Trust Clearing Corporation (DTCC), is an important market participant regulated by the U.S. Securities and Exchange Commission (SEC). NSCC provides several services to the exchange traded market. Among other services, we can highlight clearing, settlement, risk management, central counterparty services and exchange-traded funds as the main relevant ones on the post crisis scenario discussed on this study. However, NSCC most important achievement is the netting efficiency of trades and payments between the market participants, reaching an average of 98% reduction on the value of the payments. (CFA Institute, 2022)

One of the mainly DCOs is Options Clearing Corporation (OCC) which is a clearing house based in Chicago specialized in equity derivatives clearing providing central counterparty clearing and settlement services to 15 exchanges. OCC acts to ensure counterparties are complying with obligations when clearing a contract. The instruments cleared by OCC include options, financial and commodity futures, security futures and securities lending transactions. (CFA Institute, 2022)

Electronic trading has also become more prevalent. Since the mandatory execution requirements for swap trades came into effect in October 2013 as part of the Dodd-Frank Act, the swap execution facilities (SEFs) have served to move a large share of OTC swap trading to electronic platforms playing an important part in the derivatives market scenario.

Table 1. CFTC Designated Trading Organizations - Designated Contract Markets (DCM)

Organization	Date (as of)	Organization	Date (as of)
Small Exchange, Inc.	03/10/2020	ICE Futures U.S., Inc.	06/10/2004
North American Derivatives Exchange, Inc.	02/18/2004	Board of Trade of the City of Chicago, Inc.	12/21/2000
Nodal Exchange, LLC	09/27/2013	Commodity Exchange, Inc.	12/21/2000
New York Mercantile Exchange, Inc.	12/21/2000	Chicago Mercantile Exchange, Inc.	12/21/2000
Minneapolis Grain Exchange, Inc.	12/21/2000	Eris Exchange, LLC	10/28/2011
LMX Labs, LLC	11/23/2020	Cboe Futures Exchange, LLC	08/07/2003
LedgerX LLC	06/24/2019	Cantor Futures Exchange, L.P.	04/20/2010
Kalshi	11/03/2020	Bitnomial Exchange, LLC	04/17/2020

*Source:*https://sirt.cftc.gov/SIRT/SIRT.aspx?Topic=TradingOrganizations&implicit=true&type=DCM&CustomColumnDisplay=TTTTTTTT

Table 2. CFTC Registered Derivatives Clearing Organizations (DCO)

Organization	Date of Registration		Type of derivatives permitted to clear
Chicago Mercantile Exchange, Inc.	as of	12/21/2000	All Interest Rate Swaps All FX Non-Deliverable Forwards and Cash-Settled Forwards; Metal Forwards and various commodity and energy swaps
ICE Clear Credit LLC	as of	07/16/2011	Credit Derivatives
ICE Clear US, Inc.	as of	12/21/2000	Equity, Digital Assets, FX and Commodities
ICE NGX Canada Inc.	as of	12/12/2008	Physically delivered or financially settled contracts (futures or swaps) based on energy products;
ICE Clear Europe Limited	as of	01/22/2010	Futures and options on futures, traded on or subject to the rules of a designated contract market, and swaps
Minneapolis Grain Exchange, LLC	as of	12/21/2000	Commodity Futures
LCH Ltd.	as of	10/29/2001	Futures and options on futures, traded on or subject to the rules of a designated contract market, and swaps
LCH SA	as of	12/17/2013	Swaps
LedgerX LLC	as of	07/24/2017	Fully collateralized futures, options on futures, and swaps
Nodal Clear, LLC	as of	09/24/2015	Futures and options on futures
North American Derivatives Exchange, Inc.	as of	02/18/2004	Fully collateralized, cash-settled, futures, options on futures, and swaps, listed for trading on its affiliated designated contract market.
Options Clearing Corporation	as of	12/10/2001	Futures, options on futures, and commodity options executed on designated contract markets
CX Clearinghouse, L.P.	as of	04/20/2010	Fully collateralized futures, options on futures, and swaps for which there is an underlying commodity
Eris Clearing, LLC	as of	07/01/2019	Fully collateralized futures and swaps
Eurex Clearing AG	as of	02/01/2016	Swaps

Source: https://sirt.cftc.gov/sirt/sirt.aspx?Topic=ClearingOrganizations

2.2.1.2. CCPS IN THE EUROPEAN UNION [1]

In the European Union (EU), the European Securities and Markets Authority (ESMA) is an independent authority accountable to the European Institutions seeking to enhance investor protection and promote stable and orderly financial markets. In addition, ESMA supervise financial entities such as Credit Rating Agencies (CRAs), Securitisation repositories (SRs) and

1 See all information on ESMA website: https://www.esma.europa.eu/

Trade Repositories (TRs), which are essential parts of the current European market infrastructure.

In 2012, the European Commission adopted without modifications the regulatory technical standards developed by ESMA on OTC derivatives, central counterparties, and trade repositories ("EMIR"). ESMA has developed detailed rules and guidance on reporting, registering, and accessing data, therefore mandating the report of all traded derivatives to Trade Repositories (TRs).

Trade Repositories (TRs) centrally collect and maintain the records of all derivative contracts, which enhance the transparency on derivative markets and mitigate risks maintaining financial stability. To report according to EMIR regime, counterparties must follow the validation rules applied by the TRs.

Also in 2012, supplementing regulation took place regarding regulatory technical standards on indirect clearing arrangements, the clearing obligation, the public register, access to a trading venue, non-financial counterparties, and techniques to dimmish risk to for the non-cleared OTC derivatives contracts, its subsequent reviews have also continuously enhanced the regulatory and supervisory arrangements for CCPs to mitigate the negative systemic effects. The soundness and robustness of CCPs is therefore at the heart of ESMA's mission to safeguard financial stability in the European Union and promoting stable and orderly financial markets.

The current CCPs and TRs registered and authorized by ESMA are presented on below Tables 3 and 4. Table 4 also provides information regarding which CCPs covers interest rate derivatives instruments.

Table 3. ESMA Registered Trade Repositories (TRs)

Country of residence	Name of the trade repository
United Kingdom	Bloomberg Trade Repository Limited
	CME Trade Repository Ltd. (CME TR)
	DTCC Derivatives Repository Plc (DDRL)
	ICE Trade Vault Europe Ltd. (ICE TVEL)
	UNAVISTA LIMITED
Ireland	DTCC Data Repository (Ireland) Plc
Luxembourg	Regis-TR
Netherlands	UnaVista TRADEcho B.V. (The Netherlands)
Poland	Krajowy Depozyt Papierów Wartosciowych S.A. (KDPW)

Source: https://www.esma.europa.eu/supervision/trade-repositories

Table 4. List of CCPs with authorisation covering derivatives financial instruments

Name of the CCP	Country of establishment	Interest Rate Derivatives covered
Nasdaq OMX Clearing AB	Sweden	x
European Central Counterparty N.V.	Netherlands	
KDPW_CC P	Poland	x
Eurex Clearing AG	Germany	x
CCG	Italy	
LCH SA	France	
European Commodity Clearing	Germany	
Keler CCP	Hungary	x
BME Clearing	Spain	x
ICE Clear Netherlands B.V.[32]	Netherlands	
Athex Clear	Greece	

Source: https://www.esma.europa.eu/sites/default/files/library/ccps_authorised_under_emir.pdf

2.2.2. LIQUIDITY

Liquidity is a crucial characteristic for investment decisions that is relevant both for market participants and regulators. As mentioned before, this was one of the topics analysed by the regulators when creating the reforms adopted after the global financial crisis, and one of the goals of the compulsory clearing for standardized OTC derivatives deals, and consequently, the participation of CCPs in the process.

However, as analysed in the study of Menkveld et al. (2015), it is not still obvious that central clearing indeed improves market liquidity. They highlight that while requirements of collateral/margin and funding costs could negatively affect liquidity, the multilateral netting efficiency of a CCP mitigates the counterparty risk across those market participants, resulting in less settlements and an increase of their participation, and therefore, more liquidity on this market.

In contradiction of this idea that the netting efficiency would neutralize the lack of liquidity caused by settlement costs, Koeppl et al. (2011) consider that higher settlement costs result in a lower volume of transaction, decreasing the settlement frequency. Thus, while liquidity is decreasing, the overall costs of liquidity in the CCP is increasing. In order to balance this risk, the CCP must ensure that participants have the incentive to settle, and therefore, the study

focuses on how to optimally balance such costs against the higher default exposure associated with less frequent settlement.

In addition, when equalizing counterparty risk across market participants, smaller dealer banks are able to compete with larger dealer banks, which increases competition, reduces bid-ask spreads and, as consequence, improves liquidity (Loon and Zhong, 2016).

While bid–ask spreads are often used as measure of liquidity, Jankowitsch et al. (2011) consider that it cannot be simply captured in order understand real price dispersion effects. Thus, a new liquidity measure was developed by quantifying the price dispersion and deviation was interpreted as liquidity effect. As a result, the proposed liquidity measure showed a strong relation with characteristics of the analysed asset class, suggesting that the price deviations from expected market valuations are significantly higher and more volatile than it was previously assumed.

Alongside with liquidity enhancement, mitigation of systemic risk was another goal to be achieved by regulators on the aftermath of the global financial crisis. One of the overlooked adverse effects was analysed by Bakoush et al. (2020) as the increasing systemic liquidity shortages. On their study, they developed a model to analyse the distress impact on the interbank market due to central clearing and margin requirements on the OTC interest rate swaps (IRS) market. They consider that banks could be taken into distress if they lack available of liquid assets to lack fund margin requirements.

2.3. INTEREST RATE DERIVATIVES.

In accordance with the development of the derivatives market after the global financial crisis, interest-rate derivatives markets have also been adapting to several regulatory changes. The BIS conducted the 2016 Triennial Survey, using data from the Depository Trust & Clearing Corporation (DTCC). This study was the first time data had been collected on the share of centrally cleared contracts. DTCC pioneered derivatives services in 2006 when it established the Trade Information Warehouse (TIW), an infrastructure for record retention and asset servicing of cleared and bilateral credit derivatives. TIW's robust infrastructure provides automated operational capabilities across three services: the Warehouse, Lifecycle Event Processing, and Central Settlement. (DTCC, 2022)

In line with the necessity of short-term borrowings by banks, countries, and financial institutions, in their study, Zhao and Moser (2009), model alternative methods of interest rate

risk management. Their results support that the usage of interest rate derivative has risk reducing effects, since usage of derivatives can manage residual interest rate exposures. This is discussed in the most recent literature as hedging theories (balance sheet risk management).

In times of interest-rate uncertainty, in order to fund its loan growth, a bank is less likely to use fund sources that are more sensitive to the interest rate changes. Instead, banks tend to rely on less interest-rate-sensitive sources. Although, the possibility of using interest-rate derivatives allows them to use different sources of funds, reducing their reliance on less interest-rate-sensitive sources. (Brewer, 2014)

2.3.1. BANK OF INTERNATIONAL SETTLEMENTS DATABASE

Starting in 1930, The Bank for International Settlements (BIS) is the oldest international financial institution. Alongside with central banks and other national authorities, BIS provide statistics designed to inform about financial stability, international monetary spill overs and global liquidity. (BIS, 2022)

In BIS statistics, information is available for activity measurement of derivatives traded on organized exchanges, for the full history of the statistics (from 1993) and compiled from commercial data sources on over 50 organised exchanges. However, OTC derivatives statistics information are only collected in the Triennial Central Bank Survey.

In terms of coverage, data are disaggregated by 24 currencies (including many emerging market currencies) as well as the maturity of the underlying interest rate (short-term, long-term), disaggregation by instrument (futures and options) and location of the exchange (North America, Europe, Asia-Pacific, other markets).

The statistics on exchange-traded derivatives cover the turnover and open interest (outstanding positions) of foreign exchange and interest rate futures and options. The statistics are presented as the conversion of data on the number of contracts into notional amounts using information about contract sizes. This type of information is useful to perform consistent comparisons of activity across these different markets. Turnover is also a useful measure, and it can be taken as an indicator of liquidity, although a rough one.

Derivatives statistics provided by the BIS also help to monitor the progress of efforts by policymakers to reduce systemic risks in derivatives markets by shifting OTC instruments' clearing and trading to central counterparties (CCPs) and organised exchanges.

2.3.2. MARKET OUTLOOK

For a better understanding of current and past derivatives trading activity scenarios, the BIS Statistics Warehouse provides useful information about exchange-traded interest rate derivatives in a few different categories. Considering the categories and information available, the ones selected for this study are exchange location, risk category and instrument category. Those three main categories allow us to understand and analyse the characteristics of the market in question and the economic background of the different market locations.

Interest rate derivative products have been traded over the years in several different countries and are present in exchange locations all over the world. According to information available in the BIS Statistics Warehouse and illustrated on Table 5, there is a clear difference in turnover notional amount of interest rate derivatives instruments traded among the different exchange locations.

Despite the wide presence in all continents, the largest markets for this product are still in well-developed countries such as in Europe and North America. The European market is much larger than other exchange locations representing 35% of the global notional amounts traded between 2000 and 2019, while other exchange locations all combined (Australia/New Zealand, Asian and Other Exchanges) represent only 5% in the overall market.

The European market has always been significantly big and crucial in the global derivatives scenario. A great part of its size and importance could be explained by the presence of great dealers located in the United Kingdom. Until 2019, the UK had historically been the main trading location for euro-denominated contracts of derivatives. Although, since the withdrawal of the United Kingdom from the European Union (Brexit), CCPs such as LCH Limited, LME Clear Ltd and ICE Clear Europe Limited ceased being an authorized as an European Central Counterparty starting from Brexit day.

For a better understanding of the exchange-traded interest rate derivatives market, the information breakdown of CCPs by countries could possibly provide important detailed information. However, the BIS does not publish a country breakdown, grouping instead the data by regions. According to the BIS, their contractual arrangements with commercial data providers do not allow them to share other exchange-level data with external parties.

In this sense, considering (1) the importance of the North American market representing 61% of total turnover in notional amounts (daily average) from 2000 to 2019; (2) that the United States was the initial centre and location of the 2008 financial crisis; and (3) the pioneer role

regulating the derivatives markets, the sample to be further analysed in this study are the interest rate derivatives instruments traded in organized exchange market in the United States.

Table 5. Derivatives Exchanges locations
Turnover - notional amounts (daily average) in millions of USD

Year	North American	European	Australia/New Zealand	Asian	Other exchanges
2000	670 524	465 633	23 396	177 889	10 569
2001	1 290 179	692 175	24 583	141 169	15 481
2002	1 477 382	832 179	24 148	125 939	11 551
2003	1 608 035	1 343 268	37 980	127 209	12 685
2004	2 290 769	1 618 675	57 407	107 982	21 119
2005	3 009 685	1 785 706	75 844	97 343	27 672
2006	3 950 601	2 127 962	95 606	187 794	35 775
2007	4 590 146	2 799 832	134 399	214 903	54 573
2008	4 163 015	3 083 816	116 777	153 085	49 245
2009	2 902 048	2 573 100	81 771	104 622	45 868
2010	3 498 188	2 857 159	142 700	109 118	99 701
2011	3 808 292	2 959 001	197 221	95 698	114 972
2012	2 747 481	2 084 376	171 999	96 365	104 558
2013	3 152 284	2 725 951	199 388	82 804	95 131
2014	4 039 743	1 918 221	148 719	58 588	70 607
2015	4 048 553	1 411 273	151 867	57 816	58 386
2016	4 807 507	1 461 574	151 427	60 188	54 611
2017	5 275 844	1 892 563	143 221	59 660	72 478
2018	6 271 898	2 216 919	147 774	67 352	70 811
2019	6 774 928	1 865 851	186 224	66 648	90 140
2000-2019	**70 377 102**	**38 715 234**	**2 312 451**	**2 192 172**	**1 115 933**
%	**61%**	**34%**	**2%**	**2%**	**1%**

Source: BIS Statistics Warehouse

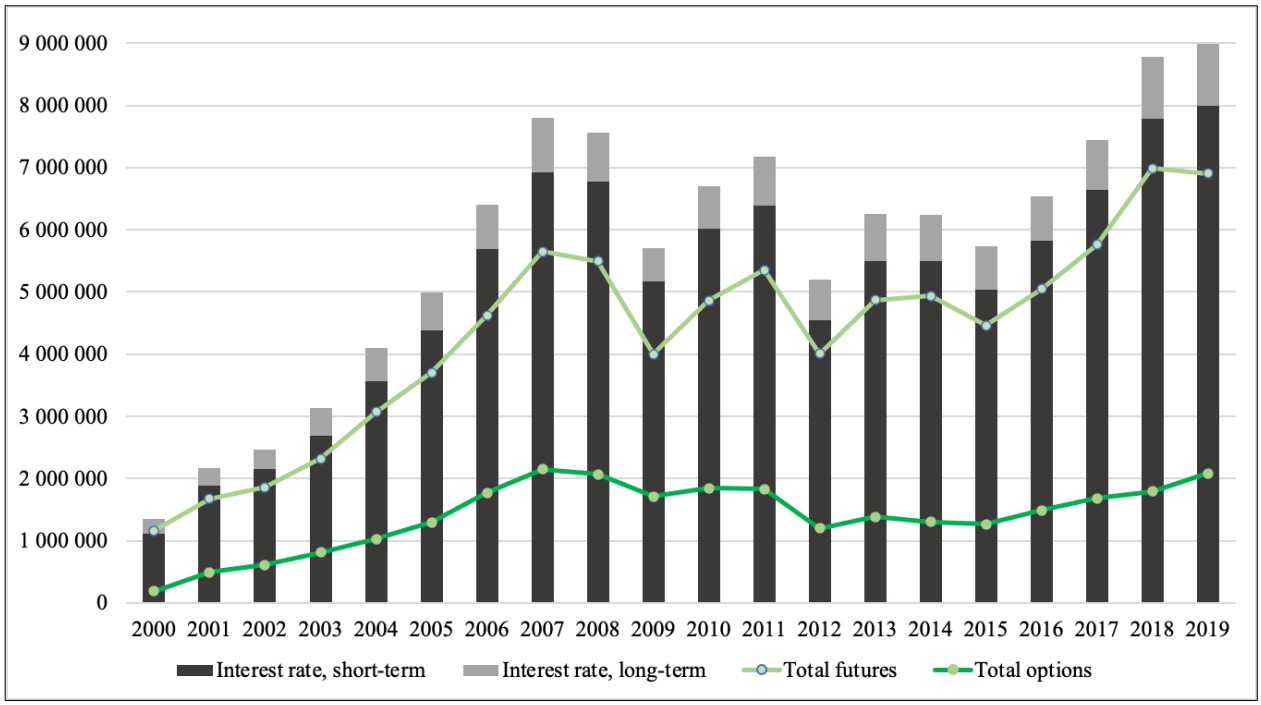
Another important analysis to better understand the interest rate derivatives market is to examine what are the instruments and risk category that are driving the market over the last 20 years. As illustrated in Fig 1, the trading of short-term interest rate, rather than log-term is clearly high. One of the arguments for this discrepancy is that shorter-maturity instruments tend to boost turnover, since these contracts are replaced more often.

In addition, when analysing by instrument types, futures are also increasingly more traded than options. The Interest Rate derivatives usage allow market participants to manage risk efficiently across the entire U.S. dollar-denominated yield curve. Therefore, changes in monetary police related to interest rate by the FED, could also impact the market of interest rate derivatives,

considering the usage of derivatives contracts, either options or futures, in order to guarantee the matching interest rate to current assets or liabilities.

The possibility mentioned above will be properly tested in this study by including changes in U.S. federal funds along the years as an independent variable in the regressions models created in section 3.2.

Fig 1. Interest rate derivatives by risk and instrument categories for all Exchanges – Turnover - notional amounts (daily average) by risk category and type of instrument in millions of USD



Source: BIS Statistics Warehouse

2.4. GDP

Gross domestic product (GDP) is the most powerful statistical figure in human history and has become the comparative benchmark for the wealth and growth rates of nations. GDP expresses as a number the value of all goods and services produced in a specific period in a specific country. Although GDP could be considered only a measure of a country's economic output, it is far more than a simple statistic. GDP is a key indicator of development and progress, and its growth rate also describes its rate of change. (Lepenies, 2016)

It is frequently claimed that the years 2008 and 2009 constitute America's worst macroeconomic performance since the Great Depression. However, The Great *Contraction* lasted almost four years (1929-1933), therefore longer and incomparably deeper than the most

recent financial crisis. On the other hand, after the U.S. economy hit bottom, from 1933 to 1937 the average annual real GDP growth rate reached a robust expansion of 9.5 percent. (Blinder, 2013)

The period chosen to be analysed in this study is from the years 2000 to 2019. During this long period, the US economy faced several important bumps and events that severely affected the national economy and different markets. One of the biggest distress events in that period, was the dot-com bubble. At the end of the 1990s, the entrance of many internet-based young firms, which had never generated profit, caused great excitement, leading to speculation, and ultimately, causing a bubble in internet and other technology stocks. That oversized excitement resulted in the NASDAQ index reaching a peak in March 2000. However, by the end of that year, it had lost more than half of its value. (Quinn and Turner, 2020)

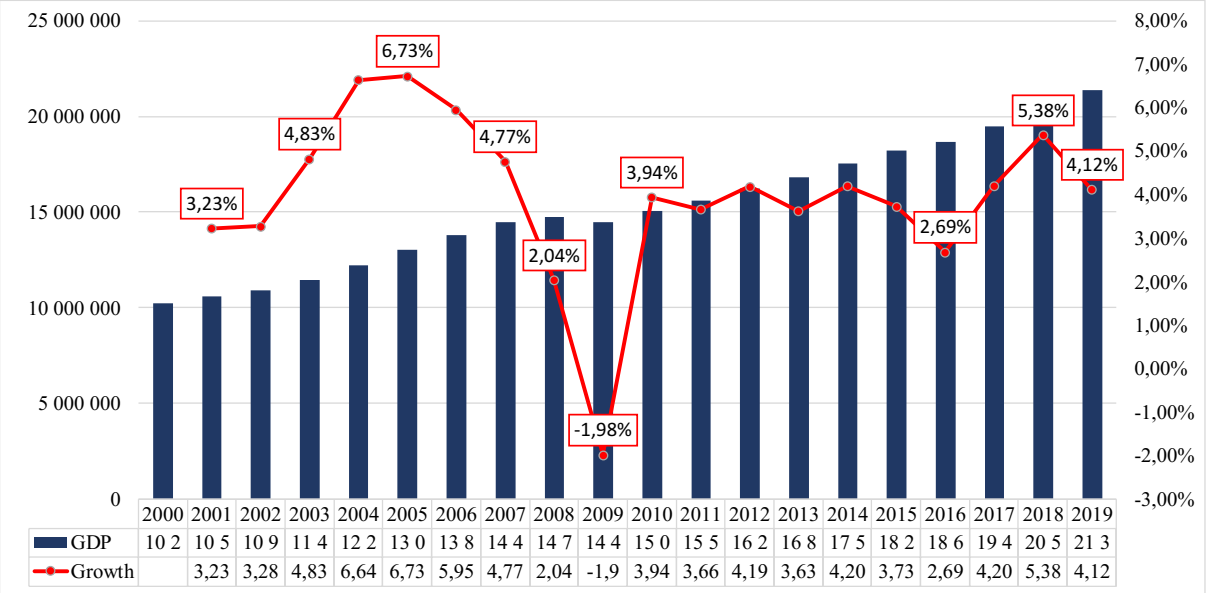
According to Blinder (2013), after the tech stock (dotcom) bubble burst in 2000 and the stock market crashed, many Americans decided to invest in real estate, considering it to be a safer type of investment. From 2003 to 2006, fundamentals for housing such as income growth and interest rate were appealing to investors.

From 2000 to 2005, U.S. economy was recovering, and U.S. GDP growth reached its peak in 2005 with 6,73% (Fig 2), also the highest for the whole studied period. By that time, while house prices were increasing, buyers were able to refinance their mortgage, often to a higher amount and lower interest rate. As U.S. householders kept levering up their mortgages, in 2008, according to Blinder (2013), the total household debt (mortgage plus personal) rose from about 100% of GDP to 140% since 2000. The outcome of that excessive leveraged scenario in the US economy resulted in severe mortgage ineptness.

Mortgage ineptness was one of the drivers to the collapse on the U.S. economy at that time. Although several other important factors not analysed in this study led the biggest banks in the U.S., and consequently the U.S. economy, to collapse. In this sense, on September 15, 2008, the notorious investment bank Lehman Brothers collapsed and symbolizes now the beginning for the 2008 financial crisis.

As presented below in Fig 2, the U.S. GDP growth dropped from +6.73% in 2005 to -1.98% in 2009, as an outcome of the great financial crisis started in the country. Although, GDP growth was already going down since its peak in 2005, due to the total collapse of the U.S. economy in late 2008, the great impact aftermath was clearly presented in the year of 2009, reaching negative growth rate.

Fig 2. Gross Domestic Product in billions of dollars



	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
GDP	10 2	10 5	10 9	11 4	12 2	13 0	13 8	14 4	14 7	14 4	15 0	15 5	16 2	16 8	17 5	18 2	18 6	19 4	20 5	21 3
Growth		3,23	3,28	4,83	6,64	6,73	5,95	4,77	2,04	-1,9	3,94	3,66	4,19	3,63	4,20	3,73	2,69	4,20	5,38	4,12

Source:https://apps.bea.gov/iTable/iTable.cfm?reqid=19&step=2#reqid=19&step=2&isuri=1&1921=survey

From 2010 until 2019, GDP kept growing, although in different rhythms along the time. The most notorious year after 2008 is the year of 2018. According to IMF World Economic Outlook of April 2015, the unexpected weakness in the United States was likely to prove a temporary setback, since underlying drivers for acceleration in consumption and investment remained intact. Those drivers were wage growth, labor market conditions, easy financial conditions, lower fuel prices, and a strengthening housing market.

By 2019, according to Badkar (2019), consumer spending had been the main engine of economic growth up to that point in time. In Fig 2, it is possible to see that U.S. GDP reached 21.3 billions of dollars that year and positive growth rate of 4.12%.

2.5. INTEREST RATE IN THE USA

According to Blinder (2013), in order to manage the state of country´s aggregate demand conventional monetary policy is used and it consists of raising or lowering the federal funds rate. In the U.S., this is done by the Federal Reserve (FED) when selling or buying riskless securities, such as Treasury securities, in the open market. Aside from that, any other measure taken by central banks is considered unconventional monetary policy. When conventional monetary policy is exhausted or nearly exhausted, central banks resort to unconventional monetary policy.

When compared to the 1970s, the U.S. economy has experienced low inflation and small variation in real activity. These results can be attributed to a shift in the way the Federal Reserve conducts monetary policy. (Cajueiro and Tabak, 2010)

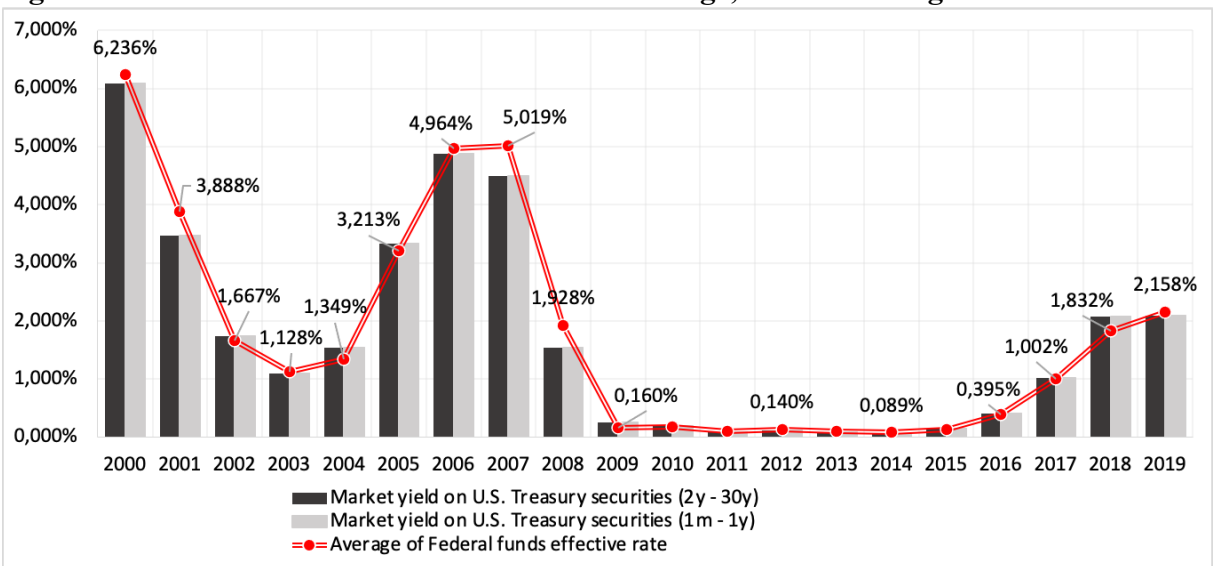
Analysing federal funds rate data from FED's website since 2000, the only period prior to the financial crisis with low rates was from 2002-2004. Aside from that period, the federal funds rates have always been at least 3 percent or higher.

However, since 2008, FED's monetary policies have been holding the federal funds rate down, getting really close to zero until 2016. One of the main reasons for such policies approach by FED was the extremely low inflation, which led even to discussions of possible deflation in the U.S. economy at that time.

In line with Thomsen (2019), the inflation target of 2 per cent adopted by FED was kept successfully, in a scenario where actual inflation was below that target. The low-inflation environment in many mature countries led to economic growth by allowing real wages to rise and personal consumption to increase.

From 2017 to 2019, as the US economy recovered, monetary policies followed its growth, although still keeping the 2 per cent inflation target. All federal funds rate fluctuation from 2000 to 2019 are illustrated in Fig 3 below.

Fig 3. US interest rates from 2000 to 2019 for average, short and long maturities



Source: https://www.federalreserve.gov/

3. METHODOLOGY

The research methodology is based on statistical analysis, which in this paper is the multivariate regression analysis. This type of analysis is used to forecast time series and estimate parameters by modelling and analysing several variables. In multivariate regression modelling, it is possible to describe the relationship between a dependent variable and several others independent variables.

This paper studies the relationship between the U.S. market exchange-traded interest rate derivatives from 2000 to 2019 with three independent variables that could possibly have influenced the market outcome of such type of product in that period.

The main purpose of this analysis is to understand the impact of post 2008 financial crisis regulations on organized exchange markets of interest rate derivatives products in the United States and to understand to what extent the U.S. economy (measured by GDP) and monetary policy (measured by interest rates) could have also impacted the market in question.

Through the multivariate regression equations developed on topic 3.2, we will be able to calculate and interpret predicted values for the dependent variables and assumed values for the independent variables. Therefore, the following steps will be followed to present the analysis results: (1) explain the assumptions of the multivariate regression models; (2) how much of the total variance is explained by the independent variables according to adjusted R Square; (3) interpret the overall significance of the regression according to an *F*-test in an ANOVA table; and (4) determine the statistical significance of each independent variable (p-values).

3.1.VARIABLES

Considering the fact that the United States is the worldwide largest exchange market of interest-rate derivative products, was also the centre of the 2008 financial crisis and, in addition, the first location to develop and implement regulations to the derivatives market, all variables on this study are linked to the U.S. market or economy.

As dependent variables to be analysed in the multivariate regression models, the interest-rate derivative products were divided in four dependent variables according to risk category (short-term or long-term) or type of instrument (futures or options), as follows:

- Y_1 = *Exchange-traded Interest Rate Derivatives of Short-term*

- Y_2 = *Exchange-traded Interest Rate Derivatives of Long-term*
- Y_3 = *Exchange-traded Futures Interest Rate Derivatives*
- Y_4 = *Exchange-traded Options Interest Rate Derivatives*

The first dependent variable Y_1 is measured by the logarithm of quarterly turnover notional amount of interest rate derivatives instruments (both futures and options) traded in the U.S. exchange market from 2000 to 2019, but only for short-term interest rates, in millions of dollars.

The second dependent variable Y_2, very similar to Y1, is measured by the logarithm of quarterly turnover notional amount of interest rate derivatives instruments (both futures and options) traded in the U.S. exchange market from 2000 to 2019, although now only for long-term interest rates, also measured in millions of dollars.

The third dependent variable Y_3, differently from the previous ones, is now measured by the logarithm of interest rate derivatives Futures quarterly turnover notional amount traded in the U.S. exchange market from 2000 to 2019, for both short-term and long-term interest rates, also measured in millions of dollars.

The fourth and last dependent variable Y_4, similar to the last one, is measured by the logarithm of interest rate derivatives Options quarterly turnover notional amount traded in the U.S. exchange market from 2000 to 2019, for both short-term and long-term interest rates, also measured in millions of dollars.

All dependent variables were extracted from the Bank for International Settlements (BIS) website, specifically through BIS Statistics Warehouse tool, for the period of 2000 to 2019 on quarterly basis, according to risk type for Y_1 and Y_2, and according to instrument type for Y_3 and Y_4.

Along with the four previously described dependent variables, five independent variables were collected aiming to shed light on the possible influence/relationship between them and the dependent variables mentioned above.

The first independent variable X_1, and common to all models/analysis, is the quarterly reported U.S. GDP extracted from the *BEA* (U.S. Bureau of Economic Analysis) website for the period of 2000 to 2019 on quarterly basis. In this study, it is included in the regression model to understand what the relationship between the country's economic condition and the exchange-traded Interest Rate Derivatives market was.

- X_1= GDP

The second, third and fourth independent variables (X_2, X_3 and X_4) were all extracted from the U.S. Federal Reserve Board website (FED) from the year of 2000 to 2019 on a quarterly basis. X_2 represents the market yield average of U.S. treasury securities of short-term maturities (1, 3, 6 months and 1-year). X_3 represents the market yield average of U.S. treasury securities of long-term maturities (2, 3, 5, 7, 10, 20 and 30 years). For the purpose of studying the short-term interest-rate derivatives instruments, X_2 will be used, considering that it refers to securities with short-term maturities between one month and one year. As for the study of long-term interest-rate derivatives instruments, X_3 will be used since it refers to long-term securities with different maturities varying from two years to thirty years. And at last, X_4, which is the average effective rate of all Federal funds, will be used to study both instrument types of interest-rate derivatives, Futures and Options.

- X_2 = Market yield on U.S. Treasury securities (1m - 1y)
- X_3 = Market yield on U.S. Treasury securities (2y - 30y)
- X_4 = Average of Federal funds effective rate

The last independent variable X_5 is a dummy variable. X_5 represents the scenarios prior and post regulations. In this sense, X_5 is equal to 0 for the period prior to regulations (2000 to 2009) and 1 for the period after regulations took place (2010 to 2019).

- X_5= Regulations

Table 6 and 7 below present summary statistics of all dependent and independent variables mentioned above, which will be used to create the regression models in section 3.2.

Table 6. Dependent Variables Summary Statistics

Variable	Count	Mean	Std. Dev	Minimum	Maximum
Y_1: IR Derivatives Short-term	80	3 218 447	1 535 317	510 682	7 662 624
Y_2: IR Derivatives Long-term	80	300 408	148 647	56 001	659 101
Y_3: IR Derivatives Fut	80	2 603 297	1 250 193	459 283	5 974 577
Y_4: IR Derivatives Opt	80	915 558	452 731	107 399	2 326 901

Table 7. Independent Variables Summary Statistics

Variable	Count	Mean	Std. Dev	Minimum	Maximum
X_1: GDP	80	15 279 481	3 268 321	10 002 179	21 694 458
X_2: Market yield on U.S. Treasury securities (1m - 1y)	80	0,01736	0,01821	0,00046	0,06207
X_3: Market yield on U.S. Treasury securities (2y - 30y)	80	0,03123	0,01323	0,01302	0,06527
X_4: Average of Federal funds effective rate	80	0,01784	0,01921	0,00073	0,06520
X5: Regulations	80	0,5	0,05625	0	1

3.2. MULTIVARIATE REGRESSION MODELS

In accordance with the dependent and independent variables presented in section 3.1, four multivariate regression equations were formulated to describe the relation between the four dependent variables and the five independent variables.

The first regression equation (1) aims to comprehend the relation between the dependent variable turnover amount of short-term exchange-traded interest rate instruments (Y_1), the U.S. GDP (X_1), the short-term market yield on U.S. Treasury securities (X_2) and the introduction of regulations on OTC market (X_5). The expected value of the error term (ε) is 0, uncorrelated across observations and normally distributed.

$$Y_1 = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_5 X_5 + \varepsilon \quad (1)$$

The second regression equation (2) aims to comprehend the relation between the dependent variable turnover amount of long-term exchange-traded interest rate instruments (Y_2), the U.S. GDP (X_1), the long-term market yield on U.S. Treasury securities (X_3) and the introduction of regulations on OTC market (X_5). The expected value of the error term (ε) is 0, uncorrelated across observations and normally distributed.

$$Y_2 = \beta_0 + \beta_1 X_1 + \beta_3 X_3 + \beta_5 X_5 + \varepsilon \quad (2)$$

The third regression equation (3) aims to comprehend the relation between the dependent variable turnover amount of exchange-traded interest rate Futures (Y_3), the U.S. GDP (X_1), the average of Federal funds effective rate (X_4) and the introduction of regulations on OTC market

(X_5). The expected value of the error term (ε) is 0, uncorrelated across observations and normally distributed.

$$Y_3 = \beta_0 + \beta_1 X_1 + \beta_4 X_4 + \beta_5 X_5 + \varepsilon \quad (3)$$

The fourth regression equation (4) aims to comprehend the relation between the dependent variable turnover amount of exchange-traded interest rate Options (Y_4), the U.S. GDP (X_1), the average of Federal funds effective rate (X_4) and the introduction of regulations on OTC market (X_5). The expected value of the error term (ε) is 0, uncorrelated across observations and normally distributed

$$Y_4 = \beta_0 + \beta_1 X_1 + \beta_4 X_4 + \beta_5 X_5 + \varepsilon \quad (4)$$

4. RESULTS

This study was conducted to determine if the regulations implemented in the United States on the OTC derivatives market starting in 2010 influenced the outcome of exchange-traded interest rate derivatives, considering the U.S. economy and monetary policy framework.

It was generally hypothesized that the U.S. economic situation (measured by GDP), the U.S. monetary policy (measured by federal funds rates) and the start of stricter regulations aiming to disincentivize trading through OTC derivatives market could be related with the increase in turnover notional amount of exchange-traded interest rate derivatives. To test this hypothesis, multivariate regression analyses were used.

Given the distinctive difference between the two types of instruments and two types of risk categories of exchange-traded interest rate derivatives turnover notional amount (Fig 1), four hypotheses were created in order to better comprehend the outcome of each type of product and the specific variables that are related to each one of them. The models crated to test these hypotheses were presented in the previous section 3.2.

The results of the four models tested Y_1, Y_2, Y_3 and Y_4 are presented below on tables 8 and 9.

Table 8. Regressions Statistics

Model	Multivariate R	R^2	Adjusted R^2	Standard Error	Obs.
Y_1: IR Derivatives Short-term	0,89572	0,80232	0,79452	0,26199	80
Y_2: IR Derivatives Long-term	0,93536	0,87489	0,86995	0,21788	80
Y_3: IR Derivatives Fut	0,91821	0,84310	0,83691	0,23172	80
Y_4: IR Derivatives Opt	0,83508	0,69736	0,68541	0,34909	80

In table 8, we present the regressions statistics for the four models created. We calculated the coefficient of determination adjusted R^2, which indicates the percentage of how much of the total variance is explained by the independent variables.

In this sense, results show that 79% of the variance in short-term exchange-traded interest rate derivatives turnover amount (Y_1) can be accounted by the three predictors collectively (GDP, short-term federal funds rates and the start of regulation). ($F(3,80) = 102{,}82041$, $p<0.05$)

In accordance with previous result, 87% of the variance in long-term exchange-traded interest rate derivatives turnover amount (Y_2) can be accounted by the three predictors collectively (GDP, long-term federal funds rates and the start of regulation). ($F(3,80) = 177{,}15707$, $p<0.05$)

In addition, for both types of instruments, 84% (F (3,80) = 136,13146, p<0.05) and 68% (F (3,80) = 58,37371, p<0.05), respectively, of the variance in exchange-traded interest rate derivatives Futures (Y_3) and Options (Y_4) turnover amount can be accounted by the three predictors collectively (GDP, average of federal funds rates and the start of regulation).

According to Table 9 presented below, we can analyse and determine the statistical significance and unique individual contributions of each independent variables for each of the four models tested.

Table 9. ANOVA

Regression	***df***	***SS***	***MS***	***F***	***Significance F****
Y_1: IR Derivatives Short-term	3	21,17189	7,05730	102,82041	0,00000
Y_2: IR Derivatives Long-term	3	25,22893	8,40964	177,15707	0,00000
Y_3: IR Derivatives Fut	3	21,92859	7,30953	136,13146	0,00000
Y_4: IR Derivatives Opt	3	21,34131	7,11377	58,37371	0,00000

* *Represent the significance level at 5%.*

		β	***Standard Error***	***t Stat***	***P-value***
***Y_1**: IR Derivatives Short-term*	β_0	-39,7420	3,90368	-10,18063	0,00000
	***X_1*:** GDP	3,32501	0,23904	13,91009	0,00000
	***X_2*:** Market yield on U.S. Treasury securities (1m - 1y)	-2,05820	2,04914	-1,00442	0,31836
	***X_5**: Regulations*	-0,60429	0,11471	-5,26803	0,00000
***Y_2**: IR Derivatives Long-term*	β_0	36,68632	3,48033	-10,54104	0,00000
	***X_1*:** GDP	2,98529	0,20999	14,21609	0,00000
	***X_3*:** Market yield on U.S. Treasury securities (2y - 30y)	-1,34914	3,37936	-0,39923	0,69084
	***X_5**: Regulations*	-0,24894	0,09847	-2,52798	0,01355
***Y_3**: IR Derivatives Fut*	β_0	37,46359	3,45325	-10,84879	0,00000
	***X_1*:** GDP	3,16922	0,21146	14,98700	0,00000
	***X_4*:** Average of Federal funds effective rate	-1,37997	1,72070	-0,80198	0,42506
	***X_5**: Regulations*	-0,46088	0,10165	-4,53387	0,00002
***Y_4**: IR Derivatives Opt*	β_0	47,12161	5,20240	-9,05766	0,00000
	***X_1*:** GDP	3,70449	0,31858	11,62826	0,00000
	***X_4*:** Average of Federal funds effective rate	-2,85327	2,59227	-1,10069	0,27451
	***X_5**: Regulations*	-0,89710	0,15314	-5,85799	0,00000

Even though, as previously presented, the turnover amount over the years for the four different types of exchange-traded interest rate derivatives was distinctly different, the results obtained

by the multivariate regression analysis presented on the Table 9. ANOVA table lead us to the same conclusions for all the models.

Looking at the contributions of GDP (X_1), the results show that for all models, the variable GDP (X_1) is statistically significant ($p < 0.05$) and is positively related with all the dependent variables. When analysing the estimated coefficients (β) of this explanatory variable, we find the following: for Y_1, β = 3,32501; for Y_2, β = 2,98529; for Y_3, β= 3,16922; and for Y_4, β = 3,70449. These findings allow us to assume that the outcome of the organized-exchange market of interest rate derivatives from 2000 to 2019 is positively related to the economy in the U.S measured by GDP. Therefore, the studied market followed the same rhythm of U.S. GDP and cold be predicted by this variable along time.

However, when analysing the results for the federal funds rates average and the average of short-term and long-term maturities (X_2, X_3 and X_4), we conclude that those variables are not statistically significant ($p > 0.05$) for all the four models developed. For the first model, we can conclude that there is not a statistically significant relationship between the short-term federal funds rates (X_2) and the short-term exchange-traded interest rate derivatives turnover amount (Y_1), considering the p-value = 0,31836. The same can be concluded for the long-term dependent and independent variables, where there is not a statistically significant relationship between the long-term federal funds rates (X_3) and long-term exchange-traded interest rate derivatives turnover amount (Y_2), considering p-value = 0,69084. In addition, there is not a statistically significant relationship between the variable Average of Federal funds effective rate (X_4) and both exchange-traded interest rate derivatives Futures and Options turnover amount (Y_3 and Y_4), considering a p-value = 0,42506 and a p-value = 0,27451, for each and respectively dependent variables. Thus, the U.S. monetary policy cannot be associated with any of those products' outcome from 2000 to 2019.

The results of the last and most important independent variable (X_5) allow us to answer the research question, and additionally bring another view to the effectiveness of the regulations taken place in 2010. The variable used to analyse the organized-exchange interest rate derivatives market considering the impact of the restricting regulations imposed to OTC derivatives market is the dummy variable (X_5). It represents the scenarios prior (2000-2009) and post regulations (2010-2019) on bilaterally trading (OTC). In this sense, results show that the beginning of regulations on OTC derivatives market is statistically significant ($p < 0.05$) related to all turnover amount of exchange-traded interest rate derivatives products. However,

it negatively affects those variables, considering the following p-values: for Y_1, p = -0,60429; for Y_2, p = -0,24894; for Y_3, p = -0,46088; and for Y_4, p = -0,89710.

Considering the idea that a global purpose for the regulation of OTC derivatives market would create an incentive for trading derivatives in organized-exchanges, the results presented above show that the actual effect on interest rate derivatives traded on organized-exchanges was actually the opposite. With a negative relationship between the start of regulation and the turnover notional amount of all risk and instrument categories of exchange-traded interest rate derivatives, we can conclude that the regulations not only did not boost the exchange market, but also had a negative effect on the performance of that market.

5. CONCLUSION

As a result of the 2008 global financial crisis, there was great recognition of the importance of derivatives markets, but also of the historical lack of regulation for this market worldwide. One of the most important results of the crisis for both the U.S. and the European Union (EU) was, in the 2009 G20 Summit in Pittsburgh, the agreement to reform to OTC derivatives markets.

Although regulations started in different times for the U.S. and the EU (2010 and 2012 respectively), both regulations aimed three main changes: (1) to require higher capital and collateral for non-centrally cleared OTC derivatives deal; (2) mandatory central clearing for all standardized OTC derivatives; and (3) reporting of trading activities of both of OTC and cleared deals to improve market transparency.

Considering the changes imposed to the derivatives markets, the bilateral OTC trading for standard derivatives started facing greater costs and reporting requirements, which aimed to incentivize players to move from bilateral trading to centrally and cleared trading in organized exchanges.

In this sense, this research aimed to understand the impact of the start of regulations in the U.S. on notional turnover amounts of interest-rate derivatives contracts traded in organized exchange markets. For this analysis, the periods considered were before regulations (2000-2009) and after regulations (2010-2019), in order to understand if the stricter regulations on OTC market really shifted the market trading to organized exchanges.

Other aspects to be considered in the research were the health of U.S. economy (GDP), which could have impacted the overall market, including derivatives market, and in addition, the interest-rate changes along the years.

Based on four different types of multivariate regression analysis, according to risk (short-term and long-term) and instrument (Futures and Options), it can be concluded that for all types of risks and instruments, the increasing size of national economy measured by GDP was statistically significant and is positively related to the notional turnover amount of interest-rate derivatives. Therefore, the exchange-traded derivatives market grew across time alongside with the U.S. economy measured by GDP.

However, it can also be concluded that the changes in interest-rates by the FED along the time were not statistically significant in relation to the notional turnover amount of exchange traded interest-rate derivatives. In addition, even though the impact of the start of the regulations was

statistically significant, an important negative relationship is identified. Therefore, the start of regulation did not increase the notional turnover amount of interest-rate derivatives in organized exchanges as would be expected, but actually had a negative effect on the market. The findings could be interpreted as a continuous market tendency to remain trading bilaterally or an impact in the overall derivatives markets, both OTC bilateral and through organized exchanges. Uncovering this would require data that is not publicly available.

In order to better understand the implications of these results, the OTC market should also be analysed, although available information of this market is still very limited, restraining possible studies about this specific market. Considering the increase shared information along time, future studies could address the same analysis to OTC market in order to evaluate the real impact of the regulations considering both markets.

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