Product Complexity, Investor Experience, and Returns*

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Abstract

The retail market for structured financial products has experienced substantial growth, accumulating trillions of dollars in assets worldwide since the 1990s. The concerns raised by regulatory bodies highlight the need for better investor protection in these markets that promote complex financial products. Using unique micro-data from the Brazilian Securities and Exchange Commission, this article investigates the relationship between product complexity, investor sophistication, and investor returns. We show that, on average, complex products yield lower returns. Sophisticated investors with greater experience in financial markets exhibit greater returns than unsophisticated investors, both on average and when investing in more complex products. Notably, independent brokers play a role in certifying complex products by mitigating rent-seeking behavior associated with lower-quality issuers. The study contributes to the ongoing discourse on regulating complex financial products.

Keywords: Financial Innovation, Financial Literacy, Structured Products, Product Design, Shrouding, Monitoring, Complexity

JEL classification: D18, D47, G10, G12, G21, G24, G28, G51, G53

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1 Introduction

The market for complex financial products sold to households, known as retail structured products, has grown significantly since its inception in the 1990s, with over one trillion dollars of assets outstanding in Asia, Europe, and the U.S. Several financial regulators, including the Securities and Exchange Commission (SEC), the European Securities and Markets Authority (ESMA), and the Financial Conduct Authority (FCA), have raised concerns that the complexity of these financial products requires a closer examination of the market from the perspective of investor protection.[1]

Structured products are securities that combine multiple financial assets and derivatives with an ex-ante payoff function that varies non-linearly with the performance of the underlying financial assets, frequently including capital protection. These financial products are buy-and-hold investments with the full extent of returns from complex performance features often not being realized until maturity. The underlying financial assets include equity indices, individual stocks, commodities, fixed income, and currencies. Product payoff functions are often complex and difficult to value.[2] The financial products are designed by banks for sale to retail investors and distributed over-the-counter (OTC) directly to the bank's retail investors or through non-bank-affiliated, i.e., independent distributors. The regulatory environment for structured products is challenging as structured notes are illiquid and only traded OTC. In contrast, exchange-traded notes (ETNs) are listed on stock exchanges and provide investors with a more liquid option.

Financial innovation that targets new payoff structures, including complex structured products, promises to improve risk sharing by allocating risk in incomplete markets (Ross (1976); Allen and Gale (1994); Duffie and Rahi (1995)). Financial intermediaries create profits by designing complex financial products that address investor demand for a payoff function,

[1] For example, in the U.S. see FINRA's Regulatory Notice 22-08 (Complex Products and Options) at https://www.finra.org/sites/default/files/2022-03/Regulatory-Notice-22-08.pdf. In the European Union, see Regulation (EU) No 1286/2014 of the European Parliament on packaged retail and insurance-based investment products (PRIIPs), available at https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=celex%3A32014R1286.

[2] Issuers acknowledge the complexity makes the products challenging to value, even for their own staff. "Talent shortfall limits funds' ability to sell wealthy clients on 'alts"', Financial Times, January 2, 2024

thus increasing social welfare (Lerner and Tufano (2011)). Complexity in financial innovation, however, can be associated with greater risk for investors. Financial intermediaries may introduce complex product features that shroud risk to seek rents by exploiting uninformed consumers (Gabaix and Laibson (2006)), cater to yield-seeking households (Bordalo et al. (2016)), and strategically create complexity to reduce the proportion of informed investors (Carlin (2009)).

In this paper, we examine the role of complexity in the market for structured products using unique data from the Brazilian Securities and Exchange Commission (CVM) on products, issuers, distributors, and investors for the universe of Brazilian structured products. We show complexity is associated with lower average realized returns consistent with the results in Celerier and Vallée (2017)—however, investment experience matters.

Sophisticated investors with greater experience in financial markets obtain greater returns than unsophisticated investors, both on average and when investing in more complex structured products. We rule out the possibility that our results on complexity and returns are explained by selection into risk characteristics, including the underlying asset class and product structure, issuer, and investor characteristics, including wealth, age, and location. The superior returns from investing in complex products are partly explained by sophisticated investors selecting better-quality complex products distributed by independent brokerages, who screen products for investors, especially when the issuers are of lower quality. This implies that reputational effects also affect product selection (Griffin et al. (2014).

This is the first paper to examine how the quality of complex financial products varies by investor sophistication and issuer characteristics. The results highlight that while financial innovation can improve risk sharing, financial complexity is used to generate rents by exploiting unsophisticated investors. More sophisticated investors mitigate this by selecting complex products from independent brokers, who act as intermediaries by screening products on quality. This has broader policy implications for investor protection and the debate on regulating complex financial products.

Our study uses novel data containing comprehensive information on all retail structured products sold in Brazil between 2016 and 2019, totaling more than five billion dollars in issuance.

The data includes term sheet data for 43,223 unique products issued by 17 institutions with 85 different underlying assets and distributed by 89 banks/brokers to 150,942 unique investors.[3] The term sheet includes detailed product characteristics, such as information on initial and settlement prices, issuer, distributor, underlying assets, maturity, capital guarantee, and the payoff formula used to measure complexity.

For many reasons, the Brazilian market for structured products is ideal for studying the relationship between complexity and returns. First, unlike countries where the market is opaque and obtaining data is complex, the CVM regulates the market and collects regulatory information on each product and distributor. Second, the CVM collects investors' unique IDs for each product sold, which can be linked to other regulatory data to capture investor characteristics, including financial market experience. Third, the regulator reports the initial and settlement prices, from which we can measure ex-post gross returns for each product. Fourth, the market is economically significant. By the end of 2023, structured product issuance in Brazil equals about 45% of retail investors' direct investments in government bonds.

The CVM regulatory microdata allows us to overcome several challenges in identifying the relationship between financial product complexity and returns. First, we observe the detailed payoff formulas, special features, and underlying assets – including security baskets – from which we can build a measure of complexity that captures how difficult it is for a retail investor to evaluate the product. Second, the data uniquely allows us to capture ex-post returns to investors, unlike other studies focusing on the headline rate marketed to investors ex-ante (Celerier and Vallée (2017)). Third, the detailed term sheet allows us to control for the underlying asset, features such as loss protection and early termination, and maturity that capture product risk associated with different levels of complexity.[4] Fourth, we can include issuer and distributor fixed effects to address selection on issuer quality (Griffin et al. (2014)). Finally, our analysis is not subject to reporting bias because we observe the complete market.

[3]The number of products in our sample is an order of magnitude larger than the samples used by Henderson et al. (2020) to study pre-issuance hedging in the U.S. and Celerier and Vallée (2017) to study complex products in Europe

[4]Vokata (2021) examine a specific type of structured products that can be replicated using traded options to estimate the embedded fees in yield enhancement products sold in the U.S.

Our primary measure of complexity combines the number of potential payoff scenarios and special features typically found in exotic options to measure each product's total number of features.[5] Intuitively, a product with more features offers greater scope to risk share but is more complex for an investor to value. Our main analysis presents evidence using a continuous and discrete measure of complexity. The discrete complex measure is an indicator variable equal to one if the total features are more than two and the underlying asset is a basket of securities.

We measure investor sophistication using regulatory data on whether the investor has experience in equities or derivatives when she starts investing in structured products. We also observe an investor's characteristics, including gender, age, education, household ZIP code, reported profession, and all investments in a structured note and other securities (e.g., equities, futures, and single-name options), from which we estimate investor wealth. On average, sophisticated investors comprise 57% of our sample. Sophisticated investors are younger, have lower wealth, and are less likely to have a bachelor's degree.

We start by presenting stylized facts in our data. First, complex products with more than two features comprise approximately 72% of the structured products market. Second, sophisticated investors hold a greater share of complex products and are more likely to invest in products from better-quality issuer banks and through independent brokerages than unsophisticated investors. This is consistent with sophisticated investors selecting better-quality issuers and products.

Examining excess returns, complex and non-complex products exhibit similar unconditional ex-post returns. However, complex products earn negative returns relative to non-complex products depending on the time of issue, implying that product complexity is correlated with aggregate economic factors. Focusing on sophistication, unsophisticated investors earn a negative return of -2.6% p.a. on complex products vis-a-vis non-complex products, consistent with banks introducing complex product features to shroud risk to exploit uninformed consumers

[5] For example, a simple call or put option has two payoff scenarios and, therefore, two features. In contrast, a butterfly has five payoff scenarios and features. A call KO option has three payoff scenarios and one special feature (i.e., the knockout), so four features in total.

(Gabaix and Laibson (2006)).[6] Finally, sophisticated investors earn an additional return of 5.86% p.a. on complex products relative to non-complex products vis-a-vis unsophisticated investors.

Our first set of tests examines the structure of returns. We estimate ex-post returns on our complexity measure in a saturated fixed effects framework that addresses selection concerns that complexity can be a function of product risk characteristics, issuer, and time-varying economic factors. Specifically, we include month-, distributor-, issuer-, and underlying fixed effects in our main tests to absorb factors that can explain complexity and risk. In later tests, we include investor fixed effects to mitigate selection on investor characteristics that might bias our results on sophistication. Complex products exhibit excess returns that are, on average, 3.5% lower than non-complex products. The negative returns associated with complexity could be understood through the lens of both risk-sharing and rent-seeking. On the one hand, more complex products have more features that offer risk-sharing opportunities that are not offered by standard financial products. On the other hand, complexity can shroud risk and allow issuers to capture rents.

We introduce investor sophistication to examine the role of rent-seeking in complex financial markets. If banks issue complex products to extract rents by exploiting unsophisticated investors, we expect the negative returns associated with complexity to be concentrated in products marketed to unsophisticated investors. We show that, on average, sophisticated investors realize positive excess returns relative to unsophisticated investors. The negative return associated with complexity is concentrated in products held by unsophisticated investors. The results hold when we include investor-fixed effects that absorb unobserved heterogeneity between investors. Further, results are similar for discrete and continuous complexity measures and are robust to alternate investor characteristics, including wealth and education.

Next, we study the channel through which sophisticated investors screen good issuers and products and realize larger relative returns from complexity. We start by focusing on the distribution model for complex products. Bank issuers sell products directly through

[6] Excess returns are calculated as the difference in a product's return relative to the Brazilian interbank deposit rate (CDI).

their retail network or an independent intermediary. Intermediaries, such as brokerages, act as delegating screeners of product quality on behalf of investors and, therefore, use their reputation to certify the products they distribute (Chemmanur and Fulghieri (1994); Boot and Thakor (1997); Duarte-Silva (2010); Inderst and Ottaviani (2012)).

We present two stylized facts consistent with sophisticated investors recognizing the certification role of independent brokers. Complex products are more likely to be distributed by independent brokers than directly by banks, and sophisticated investors are more likely to invest in structured products from independent brokerages than unsophisticated investors.

Examining returns in a saturated fixed-effects model, we show that returns on products retailed by independent brokers are greater than those sold directly by banks. Additionally, the negative return associated with complexity is concentrated in products sold by banks. Finally, only sophisticated investors earn a return premium on complex products issued by independent brokers. The results are consistent with independent brokers acting as delegated screeners of more complex products and sophisticated investors who recognize the certification role and select to invest with brokers.

Finally, we turn our attention to issuer quality to better understand the motive for banks to issue complex products to exploit unsophisticated investors. We show that banks prone to risk-taking, including those with a lower capital ratio or greater customer complaints, issue worse-quality structured products on average. Furthermore, the negative returns associated with complexity are concentrated in products issued directly by these lower-quality banks without an independent broker. The results imply that the risk-taking motives of banks can explain their rent-seeking behavior. Independent brokers play a crucial role by screening products from lower-quality banks on behalf of investors, but this does not mitigate the concern that unsophisticated investors are exploited when they invest in complex products directly from banks.

The results are consistent with informational frictions increasing with product complexity in the market for structured financial products. Sophisticated investors use their experience to overcome information problems and better match the quality of issuers and products, realizing positive returns. Independent brokers are vital to mitigating informational frictions. However,

issuers, especially weaker ones, take advantage of the information environment by using complexity to shroud risk to exploit unsophisticated investors. The results highlight two sides of financial innovation. Product development can improve risk sharing, but we show that a dark side of innovation that increases complexity is that investors are exploited.

Our findings are important for understanding the role of regulation that provides investor protection in financial markets paper and help regulators understand how financial innovation that increases product complexity might lead to worse average returns for investors, especially unsophisticated ones.

2 Institutional Setting

Structured products, or notes, are hybrid securities that include several financial products, typically a stock or bond plus a derivative, and offer different investments to clients seeking a mix between fixed income and variable income within a single instrument. They are a relatively new product on Brazilian financial markets, where they are known as "Certificados de Operações Estruturadas" (COEs) and are similar to structured notes sold in the United States and Europe. The COE is a certificate issued against an initial investment, representative of a single and indivisible set of rights and obligations, with a payoff structure and characteristics of derivative financial instruments. A more detailed description of the Brazilian regulatory framework for COEs can be found in Appendix Table. A.1.

Regulators authorized the issuing of these securities in 2013, with only commercial, investment, and savings banks allowed to issue them. However, the market began to grow only in 2015 after the Brazilian Securities and Exchange Commission (CVM) authorized the public distribution of COEs to retail investors either directly by the issuing bank or through registered brokers unaffiliated with the issuer. Before 2015, COEs were only distributed privately, without advertising, to banks' High-Net-Worth clients.

Retail banks use their branch networks to distribute COEs to clients. In contrast, non-retail banks rely on online financial service platforms owned and operated by independent brokers to reach retail investors. An important feature of these non-bank affiliated investment platforms

is that COEs issued by multiple banks are available, and investors can choose the one that best matches their demands for risk and return. Furthermore, the platform distribution model also includes financial advisors who make investment recommendations for retail investors.

Brazilian law requires banks and other financial organizations to register all issued financial instruments, including COEs, with a trade depository (e.g., B3 S.A. is Brazil's largest service provider). In turn, B3, based on the CVM's regulatory requirements, defines the set of standardized information banks must provide when issuing a structured note. For example, issuers must disclose a COE's payoff, underlying assets, and maturity date. Furthermore, B3 lists standardized payoff functions and underlying assets (e.g., exchange rate) that issuers can use. If an issuer wants to use a different payoff function or underlying assets not present in the approved list, it must formally request B3's approval.

The top panel of Figure 1 uses CVM data, showing the cumulative issued value of COEs between 2014 and 2022 and its magnitude relative to the total volume traded on "Tesouro Direto", a government trading platform where domestic retail investors can make direct purchases of Brazilian government bonds (similar to Treasury Direct in the U.S.). The market for structured notes started to pick up after 2015, following regulatory changes that reduced the costs of selling the notes through distributors. The outstanding amount reached approximately BRL **35** billion by the end of 2020, equal to 45% of retail investors' direct investments in government bonds.

3 Data

Our data come from the Brazilian Securities and Exchange Commission (CVM). It contains detailed information on (i) products, (ii) issuers, (iii) distributors, and (iv) investors. The sample includes all notes issued and matured between January 2016 and December 2019, with data on 245,299 unique investor-product pairs sold by an issuer to a retail investor, sometimes through a distributor. Each market participant — issuer, distributor, and investor — has an associated unique ID that can be used for identification.

3.1 Products

For each product, the CVM provides information on the issue date, price, maturity date, settlement price, and whether a product can be redeemed before maturity. We also have data on the characteristics of the embedded derivatives, including the payoff diagram, and underlying asset. Of 64,310 unique products issued during our sample period, 43,223 matured and have settlement price data. These products are divided across 28 different product types assigned by the B3 exchange for a total issued amount equal to US$4.87 billion.[7]

Table 1 lists the 28 standardized product types (COE codes) approved by B3, with information on their regulatory features, our complexity measure, the total number of issued products, and issued amount. The largest products are digital and standard calls, with the largest five products comprising 75% of the total amount.

Each product is categorized by a payoff function that varies with the different embedded derivatives, resulting in wide variation in terms of product complexity. For example, the COE001001 standardized product type combines a time deposit with a plain vanilla call option. In contrast, the COE001009 combines a time deposit and a straddle put option strategy with a knockout feature.

Products are written with payoff functions on an underlying asset. Figure 1b presents the main underlying assets we observe in the markets. These include Brazilian equities, U.S. equities, EU equities, Asia equities, Brazilian interest rates, Brazilian inflation, FX, and gold.

In Panel A of Table 2, we present additional characteristics of unique products. The average product has a maturity date of 395 days, and more than 90% have an early termination clause.

3.2 Returns

We measure returns with the reported ex-post gross return after product expiration, calculated using the initial price and final settlement price obtained from the CVM. The settlement price is the one that investors receive either at maturity or at the early termination date. In

[7] To convert values, we used the official exchange rate throughout our sample, a 3.57 Brazilian Real = US$1.

Brazil, COEs are marketed as alternatives to overnight time deposits.[8] Therefore, we define the excess ex-post return as the difference in a note's gross return relative to the equivalent Brazilian interbank deposit rate (CDI), the benchmark for Brazilian interest-rate products:

$$R_{j,t,s} = R^{gross}_{j,t,s} - CDI_{t,s} \tag{1}$$

where $R^{gross}_{j,t,s}$ is the gross return for the j-*th* note, issued at time t and matured at time $t+s$. In turn, $CDI_{t,s}$ is the cumulative overnight interest rate from the issue date t to the maturity date t+s. Once we obtain the holding period return, we convert it to annualized returns.[9]

In Panel A of Table 2, we present excess returns for the 43,223 structured products. The mean (median) excess return is -0.37% (0.76%) p.a. Excess returns vary significantly by the underlying asset, reflecting the risk-return trade-off. For example, structured products with Brazilian equities as the underlying have a mean excess return of -1.6%, while structured products with U.S. equities as the underlying have a mean excess return of 2.0%.

3.3 Product Complexity

Our main objective is to examine how product complexity affects realized returns. We consider seven features of the embedded derivatives of a note to measure product complexity: (i) path dependency; (ii) barrier option; (iii) "digital" payoffs; (iv) number of scenarios; (v) if the embedded derivatives are only traded over-the-counter; (vi) if previous attributes can be modified before maturity; and (vii) if the underlying is a basket of assets. This definition is similar to the one in Celerier and Vallée (2017), which uses a continuous complexity measure based on counting the number of "features" (e.g., digital, worst of option) along seven different product dimensions (e.g., upside modulation, early redemption, and path dependence). We observe these features directly from the dataset, while Celerier and Vallée (2017) measure

[8] See *Best of both worlds: COE combines stocks and fixed income* https://canalmynews.com.br/economia/melhor-dos-dois-mundos-coe-mescla-renda-fixa-e-renda-variavel/

[9] Note that we do not use ex-ante expected returns as it would require estimating the value of the derivative component of each product, which often does not have a closed-form solution.

product complexity and risk through an algorithm that scans the textual description of each payoff formula.

In our analysis, we use two definitions of complexity. First, an indicator variable (*D(Complexity)*) that is equal to one if the number of features is greater than two or if the underlying asset is a basket of securities, zero otherwise. Second, we create a continuous measure that adds the number of features of each product to capture the dimension of complexity. For example, a vanilla call option on a single underlying asset would have a complexity measure equal to two, stemming from its two alternative payoff scenarios depending on whether the underlying is above or below the strike price.

Table 1 also has the scores on each feature used to determine the complexity for each product type. There are six features, plus whether the underlying asset is a basket of securities that uniquely classifies each standardized product type as complex or not.[10] Our sample comprises 18,586 complex products (43% of the total) that are roughly equally split between complex and non-complex products in terms of issued amounts. [11]

3.4 Investors

Retail investors that acquire structured notes are uniquely identified in our sample by an anonymized identification variable provided by the CVM, comprising 150,910 unique investors. We observe characteristics examined in the household finance and asset pricing literature for each investor, including gender, age, wealth, and reported profession.[12] We measure investor wealth as the total amount invested in COEs. We create the variable *D(College Degree)*, which measures an investor's educational level based on their profession, defined as equal to one for occupations that require a bachelor's degree, zero otherwise.

[10] In Appendix Table A.4, we delve into the impact of each feature on excess returns individually (columns (1)-(6)) and jointly (column (7)). Notably, the number of scenarios, singular payoffs, path-dependent options, and the inclusion of a product in a basket all significantly influence returns. We combine these features to construct a comprehensive measure of complexity.

[11] Almost all COEs with calls, call spreads, and put spreads are classified as simple products. Only 13 of them (i.e., 0.03% of the sample) have a basket of underlying assets and are categorized as complex.

[12] We observe age, gender, and reported profession for a subset of investors only.

We introduce a novel measure of investor experience to capture the degree to which they should be able to evaluate structured products. The micro-data on investors allows us to identify all investments made in structured products and other securities (e.g., equities, futures, and single-name options). We use this data to create a time-varying measure of investor experience, (*D(Experience)*), based on their experience of investing in equities and equity derivatives, equal to one if an investor has prior experience with investing at the point she invests in a COE, zero otherwise.

Our measure of experience captures investor sophistication by directly measuring knowledge learned through investing in financial markets. In contrast, wealth indirectly proxies financial experience, and education uses formal education as a proxy for an investor's financial literacy.

We report descriptive statistics for our investors in Panel B of Table 2. The typical investor is 48 years old and buys 1.64 products in our sample, with an average wealth of 77,310 BRL. About 53% of investors have prior investing experience, and a similar fraction report a profession that requires a college degree.[13]

Investors hold 1.64 structured products, on average, in our sample period. The mean (median) return that an investor realizes on their structured products is 1.31% (1.73%), with a standard deviation of 5.94%. In contrast to the product-level returns presented in Panel A, investors realize higher excess returns, but the variation in realized returns is still considerable. This implies that investors select into better products, on average.

3.5 Issuers and Distributors

Structured products are issued by 17 issuers and distributed through 89 institutions, including issuers and brokerages. The banking sector in Brazil is very concentrated, with a small number of large and medium-sized banks operating branches throughout the country. There are smaller regional banks, but there are very few of them. According to a 2018 Banking Report by the Central Bank of Brazil (BCB), the five largest banks had a market share of 84.4% of total

[13] In Appendix Table A.4 we report descriptive statistics of our main variables for experienced and non-experienced investors and the means difference tests between these two sets of investors.

deposits at the end of 2018 (see, e.g., Joaquim et al. (2023)). We find a similar pattern in the COE market. The top five of 17 issuers account for 62% of the number of issues and 81% by issued amount. Domestic and international banks are equally important: international banks and domestic ones each have 50% of the market. The issuing institutions are likely diversified, such that COEs are not being used for hedging risk exposures elsewhere in the bank.

In Panel C of Table 2, we present descriptive statistics for issuers at the issuer-year level. Issuers sell 4,541 structured product contracts, on average. We measure the number of unique distributors used to sell products for each issuer. This measure captures the degree of certification an issuer's products receive from third-party brokerages. The mean (median) number of distributors used to market products is 10.9 (5) with a standard deviation of 9.6, implying both that issuers use multiple distribution channels and that issuers differ in how they distribute products. We create the indicator variable *D(Independent Distributor)*, equal to one if the distributor is wholly independent of the issuer and zero otherwise.

We also employ two variables reported by the central bank that measure issuer quality: (i) the *Complaints Index* and (ii) the *Basel Index*. The *Complaints Index* is based on public complaints about financial institutions' practices made to the BCB. It was designed by the central bank to raise consumer awareness and promote fair behavior towards banks' consumers. The index also identifies the nature of the complaints, helping consumers choose the institution that best meets their needs. For each bank, the central bank computes the quarterly number of "well-founded" complaints, defined as those for which there is evidence of non-compliance by the institution with a law or regulation whose supervisory competence lies with the Central Bank of Brazil.[14] The index for a bank is defined as the total number of complaints per 1,000,000 customers. For each COE purchased on date t, the complaint index information associated with the issuer will be reported by the BCB for the previous quarter.

The second measure is the *Basel Index*, determined by the Basel III regulatory total capital ratio requirements. This ratio dictates that banks and credit unions maintain capital levels that exceed the minimum regulatory thresholds, with those incorporated in Brazil requiring a

[14]The complaint index is available here https://www3.bcb.gov.br/ranking/idLegado.do

minimum capital adequacy ratio of 10.5%. The central bank publishes data at the bank level quarterly.[15]

4 Empirical Analysis

We examine how product complexity affects structured product returns, controlling for the product characteristics, including the underlying asset class and the supply and demand effects described in Section 3.

4.1 Methodology

Consider the following general characterization of structured product ex-post excess returns, $R_p = R(j,k,l)$, where the product is structured on asset class j, issued by bank k, distributed by broker l, at time t:

$$R_{j,k,l,t} = R\left(R_j, R_k, R_l, R_t, \phi_{j,k,l,t}\right) \tag{2}$$

Product returns are determined by an underlying asset component, R_j, which reflects the risk-return trade-off for the asset; an issuer component, R_k and R_l, which reflect the issuer or distributor style, including expertise in developing or selecting products; and a time component R_t that reflects the ex-post risk premium; and a product specific component, $\phi_{j,k,l,t}$.

The product-specific component, $\phi_{j,k,l,t}$, captures product excess returns not explained by the underlying assets included in the product, the issuer and distributor, or the time of the issue. We expect a large degree of complexity to be determined by the underlying asset class or the issuer.[16] We focus on how excess returns are explained by product complexity not specific to an asset class, issuer, distributor, or holding period, which is reflected in $\phi_{j,k,l,t}$.

[15] The Capital Adequacy Ratio and others Pillar 3 information disclosed by Brazilian banks can be found here: https://www3.bcb.gov.br/ifdata/

[16] For example, the complexity variable has a standard deviation of 0.5 in the full sample but is reduced by approximately 70% within-issuer, distributor, or asset class.

Our empirical specification estimates excess returns as a function of product complexity in the panel of structured products, absorbing underlying asset class, issuer, distributor, and time-fixed effects. We estimate:

$$R_p = \alpha_j + \alpha_k + \alpha_l + \alpha_t + \beta_1 Complexity_p + \gamma' Product\ Characteristics_p + \epsilon_p, \quad (3)$$

where *Complexity* measures product complexity and *Product Characteristics* denotes products' maturity in days and an indicator variable, *Early Termination*, equal to one if the COE allows for early redemption and zero otherwise.

The coefficient β_1 in Equation 3 identifies the effect of complexity on ex-post returns. We predict that β_1 should be negative if product complexity improves risk sharing or shrouds risk (Gabaix and Laibson (2006); Henderson and Pearson (2011); Vokata (2021). The counterfactual $\beta_1 = 0$ is that product complexity affects returns only through the underlying asset class or issuer style.

Next, we examine sophisticated investors' ability to select complex products. In the panel of structured products p held by investors i, we estimate excess returns as a function of product complexity and investor sophistication:

$$\begin{aligned} R_{i,p} = {} & \alpha_j + \alpha_k + \alpha_l + \alpha_t + \beta_1 Complexity_p + \beta_2 Sophistication_i \\ & + \beta_3 Complexity_p \times Sophistication_i + \gamma' Product\ Characteristics_p + \epsilon_{i,p}, \end{aligned} \quad (4)$$

where $Sophistication_i$ includes an investor's wealth, age, education, and investment experience.

Equations 3 and 5 are central to our paper's results. Identifying the role of complexity on returns by investor sophistication provides evidence on whether complexity shrouds risk and creates rent for issuers. If sophisticated investors select better products, we expect β_2 to be positive. If issuers use complexity to increase rents by catering to risk-seeking (unsophisticated) investors, we expect β_1 to be negative and β_3 to be positive in equation 5. If, in contrast, risk-sharing explains the negative premium on complexity, we expect no differential effect on

complexity across sophistication. Therefore, estimating equation 5 allows us to disentangle risk-sharing from rent-seeking behavior.

In further tests, we explore how issuer characteristics and distribution models affect the relation between realized returns and complexity and how investors select products. In particular, we examine if sophisticated investors select better complex products by contracting with independent brokerages that can provide reputation to issues. We estimate excess returns as a function of product complexity, and investor sophistication, and distribution model:

$$\begin{aligned} R_{i,p} \quad = \quad & \alpha_j + \alpha_k + \alpha_l + \alpha_t + \beta_1 Complexity_p + \beta_2 Sophistication_i \\ & + \beta_3 IndependentDistributor_{k,l,t} + \beta_4 Complexity_p \times Sophistication_i \\ & + \beta_5 Complexity_p \times IndependentDistributor_{k,l,t} \\ & + \beta_6 Sophistication_i \times IndependentDistributor_{k,l,t} \\ & + \beta_7 Complexity_p \times Sophistication_i \times IndependentDistributor_{k,l,t} \\ & + \gamma' Product\ Characteristics_p + \epsilon_{i,p}, \end{aligned} \tag{5}$$

If independent brokerages create value by screening products, we expect β_3 and β_5 to be positive. If sophisticated investors use their experience to select better products through independent brokerages, we expect β_7 to be positive.

In summary, our empirical strategy identifies the effect of complexity on product return by exploiting the microdata on structured products in a saturated fixed effect estimation that absorbs asset class, issuer, investor, and time effects.

4.2 Complexity & Product Characteristics

We begin the analysis by examining the relationship between ex-post excess returns and product complexity in the Brazilian structured products market described by Equation 3.

Our results are presented in Table 3 using the complexity indicator variable (*D(Complexity)*) for the sample of 43,223 products issued and matured.

In column (1), we present unconditional evidence that complexity is associated with negative excess returns. Complex products realize excess returns that are, on average 2.4% lower than returns on non-complex products. Selection may explain the difference in realized returns. For example, the timing of complex products might be correlated with negative market returns, issuer preferences in product design, or underlying asset risk. In columns (2) - (4), we introduce year-month, issuer, and underlying fixed effects to mitigate these selection concerns. The negative excess return associated with complexity is dampened by approximately one-third but remains significant.

It is also possible that complexity is associated with other dimensions of product design that impact product risk. In column (5), we include product characteristics. Products with longer maturity exhibit greater excess returns, consistent with a term premium, Products with an early termination clause offer lower excess returns, consistent with the option value reducing risk. The negative return premium on complexity is again dampened at 1.4% but remains significant.

In column (6), we introduce underlying asset-time and issuer-time fixed effects to address the selection concern that complexity might be associated with time-varying product selection, which also explains returns. Complex products earn a realized excess return that is 1.7% p.a. lower than for non-complex products.

Finally, in column (7), we present results using the continuous complexity measure. The negative and significant coefficient on $Ln(Complexity)$ implies that doubling the number of complex features in a structured product is associated with an excess return premium of -1.25%, all else equal.

The product level results provide evidence of a strong negative relationship between realized excess returns and complexity, confirming the main results in the analysis for a sample of European structured products by Celerier and Vallée (2017). The negative return premium could be consistent with a premium for risk-sharing or rent-seeking motives by issuers that design complex securities to generate profits at the expense of retail investors' informational asymmetry (e.g., Entrop et al. (2016); Vokata (2021); Ammann et al. (2023)).

4.3 Complexity & Investor Sophistication

While product complexity is an expected driver of negative returns, it paints an incomplete picture since investors observe product and issuer characteristics before acquiring a structured product. Therefore, differences across investors may also explain ex-post performance. For example, more experienced investors might be more capable of analyzing products and avoiding potential losses due to shrouding and rent-seeking. Our unique micro data on investor characteristics allow us to present new analyses on the interaction between investor experience and product design and how it affects structured product returns.

We present evidence on how investor sophistication explains returns from investing in structured products. If sophisticated investors can better evaluate and select products, we expect sophistication to be associated with positive returns.

In Table 4, we examine how measures of investor sophistication, including our measure of investment experience. Using the investor-product sample, we estimate specification 5. In column (1), we present evidence that experienced investors realize positive excess returns of 0.27%, including year-month, issuer, distributor, and underlying asset fixed effects and product characteristics to mitigate selection effects that can explain returns.

Investor experience intuitively captures the level of financial literacy that an investor might have in evaluating financial assets. In columns (2)–(5), we compare investor experience with proxies for investor sophistication used in the literature. Calvet, Campbell, and Soldini (2007, 2009) and Betermier et al. (2013) present evidence that investor age, wealth, the interaction of age and wealth, occupation, and education level capture investor sophistication and can explain trading behavior and performance.[17]

Investor experience explains excess returns in structured products. There is weak evidence that wealthy, educated investors perform better, consistent with the evidence on portfolio rebalancing for Swedish investors in equity markets in Calvet, Campbell, and Soldini (2009). However, we show that the experience of investing in equities and derivatives better captures investor sophistication in terms of transferable expertise to the structured product market.

[17] See Badarinza, Campbell, and Ramadorai (2016) for a more recent review of the literature.

If experienced investors exhibit skill in selecting structured products, they should be better able to evaluate and select complex structured products. Section 4.1 highlights that conditioning on investor sophistication allows us to disentangle rent-seeking from risk-sharing.

We examine the relation between investor sophistication, product complexity, and returns by estimating specification in Equation (5). Section 4.1 highlights that conditioning on investor sophistication allows us to disentangle rent-seeking from risk-sharing. Our unique micro data on investor characteristics allow us to present new analyses on the interaction between investor experience and product design and how it affects structured product returns.

In column (1) of Table 5, we present estimation results showing that the negative excess returns associated with complexity are concentrated in products marketed to unsophisticated investors. The positive and significant coefficients on $D(Experience)$ and $D(Complex) \times D(Experience)$ imply that investment experience is important in selecting structured products on average and especially for complex products. The coefficient estimated in column (1) implies that a one standard deviation increase in experience increases returns by 0.8%($= 0.5 \times [0.462 + 1.168]$) for complex COE investments on average. Inexperienced investors earn a negative excess return on complexity, consistent with complexity shrouding risk and facilitating rent-seeking by informed issuers.

In column (2)-(4), we examine how complexity interacts with alternate measures of sophistication. Controlling for investor experience, wealthier, more educated, and older investors realize negative excess returns on complex products. Throughout, the result is that experienced investors select better complex products. The results suggest that investor characteristics used to proxy for sophistication may be a proxy for traits that make them more vulnerable to being exploited by shrouding.

In summary, we present robust evidence that experience in equity financial markets provides expertise in more complex financial markets, such as the market for structured products. Our results complement studies that examine the importance of investor experience and skill, including Korniotis and Kumar (2011), Campbell, Ramadorai, and Ranish (2014), and Feng and Seasholes (2005).

4.4 Complexity & The Role of Independent Distributors

Independent distributors, such as brokerages, can mitigate the effects of complexity by screening products on behalf of retail investors. The issuers pay these distributors and receive a fraction of the total value sold. Due to dynamic reputational concerns, we expect these intermediaries to have incentives to certify the quality of products sold to retail investors, improving the realized returns. In Appendix Table A.2, we show that complex products are more likely to be distributed by independent brokers than directly by banks (58% versus 14% for non-complex products) and that sophisticated investors are more likely to invest in structured products from independent brokerages than unsophisticated investors (77% versus 6%).

We first examine how excess returns vary by distribution model. In Table 6, we show the impact of the distribution model on the realized returns. We estimate Equation 4, focusing on whether a product is distributed by an independent broker, measured by *D(Independent Distributor)*.

In column (1), we find that excess returns are, on average, 4.2% higher for products distributed independently. In columns (2) and (3), we show that the return premium from independent distribution is even greater for complex products. This aligns with our expectations of how independent distributors can mitigate risk shrouding that negatively affects retail investors. Finally, in column (4), we introduce investor fixed effects to mitigate the concern that independence captures investor expertise. The results hold.

Table 7 examines the joint impact of complexity, experience, and distribution channel on returns. We find that the higher relative returns achieved by sophisticated investors on complex products relative to unsophisticated investors are even higher when these products are also independently distributed. For example, the triple interaction reported in column (2) is statistically significant and equal to 2.42% p.a. Further, experience alone does not affect complexity (the coefficient on $D(Complexity) \times D(Experience) = 0$). This implies that the advantage of experience is selecting products from independent brokers.

These findings suggest that independent distributors can choose and offer better complex products for sale. An alternative channel for why products sold by independent distributors have better returns is that these distributors can also screen the quality of issuing banks. We expect that products issued by banks with a worse reputation will deliver lower returns to investors.

Table 8 tests this channel by considering two independent quality measures of the issuing bank. In Panel A, we use the *Complaints Index*, which measures public complaints about financial institutions' practices made to the BCB. For each issuer, the central bank computes the quarterly number of "well-founded" complaints, defined as those for which there is evidence of non-compliance by the institution with a law or regulation whose supervisory competence lies with the Central Bank of Brazil. The index for a bank is defined as the total number of complaints divided by the number of customers. For each COE purchased on date t, the complaint index information associated with the issuer will be reported by the BCB for the previous quarter. In Panel B, we measure quality using the *Capital Adequacy Ratio*, determined by the Basel III regulatory capital ratio requirements. This ratio is computed quarterly and dictates that banks and credit unions maintain capital levels that exceed the minimum regulatory thresholds, with those incorporated in Brazil requiring a minimum capital adequacy ratio (CAR) of 10.5%.

The advantage of using the *Complaints Index* and *Capital Adequacy Ratio* is that both provide time-varying measures of issuer quality that can explain rent-seeking incentives but are arguably exogenous to the performance of the issuer's structured product portfolio, which is typically a very small part of the issuer's portfolio. Our analysis absorbs alternative explanations for rent-seeking, including the private ownership structure of banks that impacts risk-taking (Saunders et al. (1990)) that are time-invariant. Further, the *Complaints Index* cannot be manipulated by the issuer, unlike the *Capital Adequacy Ratio*.

Using the public complaints measure, Panel A shows that structured notes issued by banks with more complaints per customer have, on average, worse realized returns. In columns 2 and 3, these returns are even lower for complex products. However, column 4 shows that these negative results are reversed if the product is independently distributed. The triple interaction

is positive and significant at the 1% level. In Panel B, we find a similar story. Products offered by banks with lower capital adequacy ratios exhibit worse returns, but this negative relation seems to stem from complex products.

In Table 9, we use our data to understand better how sophisticated investors benefit from selecting products from independent distributors. We using three measures to capture distributor skill. *D(Large Independent Distributor)* is an indicator variable that takes a value of one if that independent distributor's amount in BRL of COE products is above the median; zero otherwise. The Market Share of COEs is an indicator variable that takes a value of one if the market share of each COE across the independent distributors is above the median and zero otherwise. Finally, an independent distributor is classified as *Specialized* if it sells more than 30% of one COE product. Our results show that large independent distributors, the market share of COEs, and being a specialized distributor are all associated with larger realized returns for complex products. Our results show that independent distributors can benefit retail investors by screening for higher-quality products and issuers.

5 Conclusion

The retail market for structured financial products experienced substantial growth in the 1990s. We use unique micro data from the Brazilian Securities and Exchange Commission to examine the relationship between product complexity, investor sophistication, and investor returns. On average, complex products yield lower returns. Sophisticated investors, typically more experienced and knowledgeable about financial markets, tend to fare better with complex products. Moreover, these sophisticated investors prefer products distributed by independent brokerages rather than directly from issuers, especially when issuer quality is low.

These findings show that distributors' screening efforts and issuers' reputations are crucial in product selection and investment outcomes. We contribute to the ongoing discourse on

regulating complex financial products and to concerns raised by regulatory bodies that retail investors might be exploited when buying complex financial products.[18]

Our findings may also contribute to an ongoing policy debate over approaches to consumer financial protection (Campbell 2016, Jackson and Rothstein 2019). While structured products can improve risk-sharing and potentially generate higher returns, they pose significant risks, particularly for less-informed investors, warranting robust regulatory frameworks to protect investor interests. It also supports the requirements in many countries that some securities can only be sold to "accredited" investors who meet a certain threshold of income or wealth and have previous financial experience to be allowed to invest in complex products.[19]

[18]For example, the European Commission has completed an impact assessment of regulation on retail financial products: https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52023SC0278

[19]For example, in the U.S.: https://www.sec.gov/education/smallbusiness/exemptofferings/faq#faq2.

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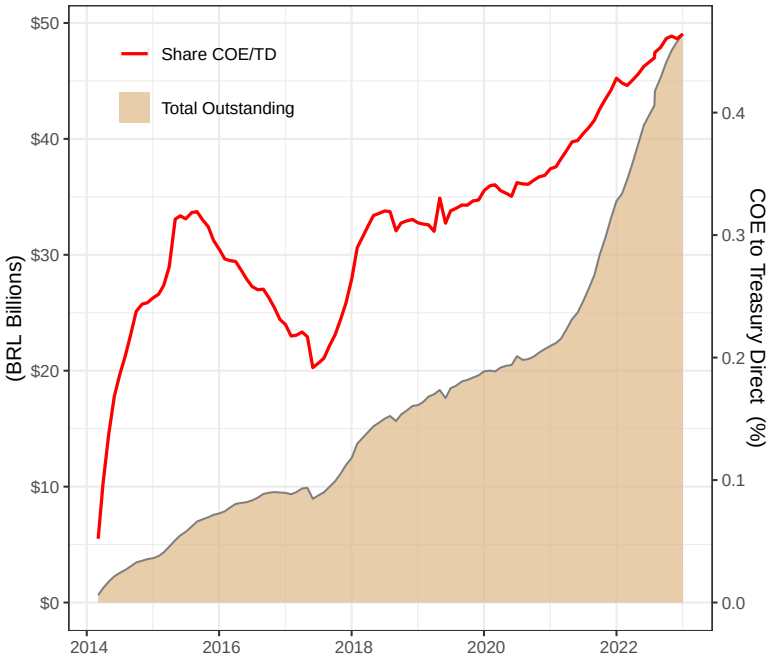
Figure 1: **Size of the Market. Issuance of COE and Underlying Assets**

These graphs show the market size in absolute and relative terms of Structured Transaction Certificates (COEs). Figure (a) reports the monthly issuance activity of COEs between January 2014 and June 2022. The beige area represents the cumulative value measured in billions of Brazilian Reals (BRL). The red solid line in Figure (a) represents the percentage share of the COE market relative to the total volume traded on Treasury Direct. Treasure Direct is a government trading platform where domestic retail investors can purchase Brazilian government bonds directly. By June 2022, issuance in COEs represented roughly 45% of retail investors' direct investments in Brazilian government bonds. Figure (b) plots COE contracts issued in Figure (a) that matured by type of underlying asset during our sample period. Our sample periods include all contracts issued on January 4, 2016, which have matured. Our sample period's latest issued date and matured contract is September 30, 2019. COEs are written on the following underlying assets: FX, Local Public Equities, Local Interest Rates, US Public Equities, EU Public Equities, Asia Public Equities, Local Inflation, and Gold.

(a) Issuance of COEs: Market Size (Absolute and Relative Terms)



(b) Matured Structured Notes By Underlying Asset

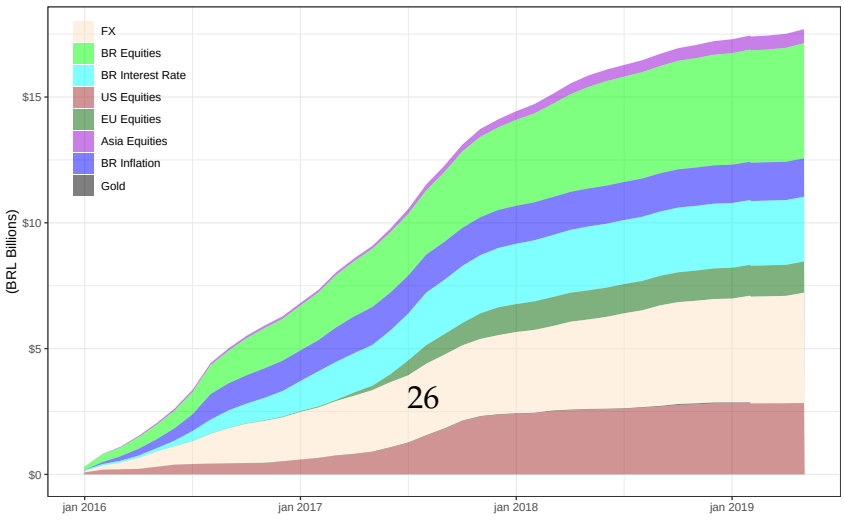
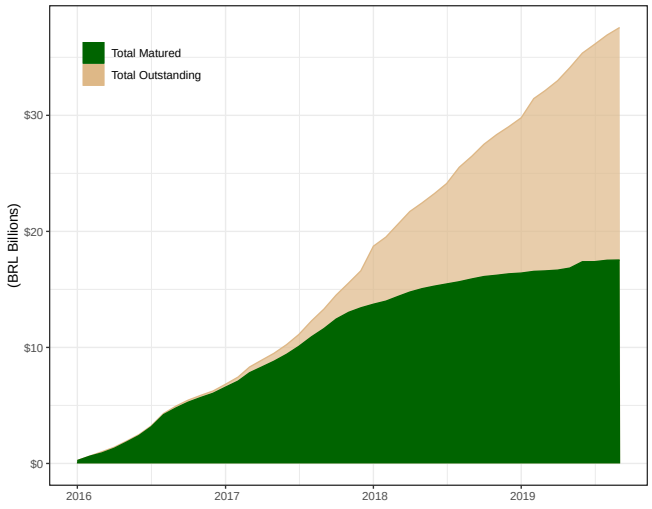


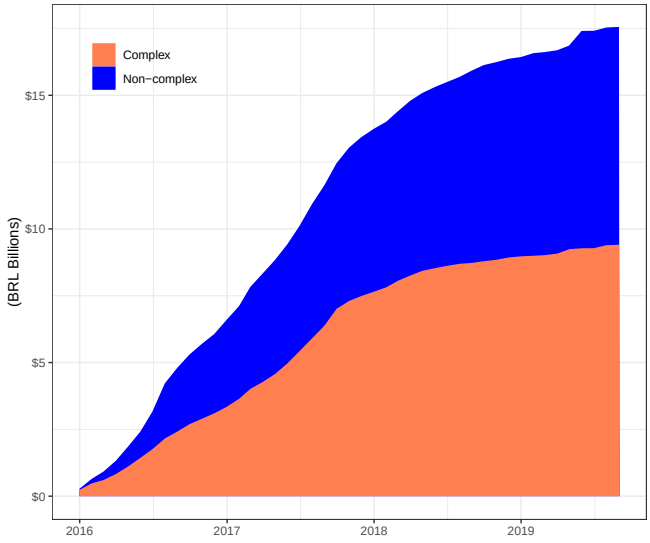
Figure 2: **Structured Notes. Times-Series Dynamics By Contract-Issuance Date**

These graphs explore the time-series dynamics of the structured notes contracts. The data in our empirical analysis comprises issued products that have already matured. Our unit of analysis in the empirical analysis of the figures is at the contract-issued date. In our empirical analysis, we only observe contracts that have matured. The date in the x-axis of figures (a) to (d) is when the contract was issued. Our data starts with products issued on January 4, 2016. Figure (a) reports all total issued contracts (in beige) and matured contracts (in blue). For example, all contracts issued on January 4, 2016, have matured in the data. We do not include some products since they have not matured at the end of our sample period. Our sample period's latest issued date and matured contract is September 30, 2019. The number of issued products was 36,897 on January 4, 2016 and 567,913 on September 30, 2019. The y-axis of Figures (a), (b), and (c) is BRL billions. Our data contains 53.5% of the contracts outstanding and matured on September 30, 2019. Figures (b) and (c) split the Matured contracts in Figure (a) by Complex and Non-complex products and by the type of distribution channel (i.e., products are sold by a broker affiliated with a bank or by an independent distributor), respectively. Figure (d) reports the share of matured contracts with complex products over time.

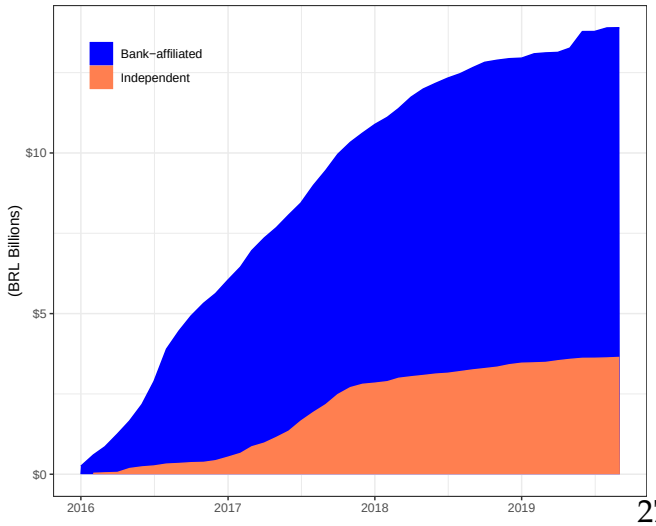
(a) Total Issued and Matured by Issuance Month



(b) Split by Product Complexity



(c) Split by Distribution Channel



(d) Fraction of Complex Products over Time

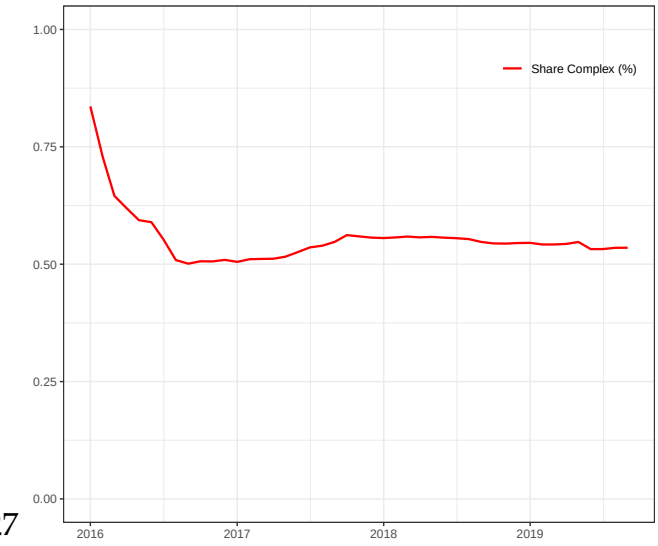


Table 1: **Complex Products – Building the Complexity Measure**

This table builds the steps of our complexity measure. We consider seven dimensions of the products given by the main regulatory framework of COEs. These seven dimensions contribute to classifying a product as complex or not: Path Dependency, Barrier, Singular Payoffs, Number of Scenarios, OTC Only, Feature Change, and Basket Inclusion. Path Dependency refers to whether the option exhibits path dependence (dummy = Yes). The derivative feature Barrier refers to whether the product includes barrier options (dummy = Yes). The Singular Payoffs feature shows a singularity jumping from zero to a positive value (dummy = Yes). This option has a fixed singular payoff that depends on a specific condition being met. The Number of Scenarios counts the number of outcomes that are possible from the structured product. This is a continuous measure. The Number of Scenarios is taken from the Caderno de Formulas - COE published by [B]3 BRASIL BOLSA BALCAO updated 12.12.2023. OTC Only denotes COEs whose embedded derivatives are not traded on exchanges (dummy = Yes). Feature Change represents whether any previous attributes may be modified before maturity. Total Features is the sum of the previous six dimensions. A structured product is classified as *Non-complex* if the total features are equal to or less than three and the structured product is not included in a basket of underlying assets. A *Complex* product is either part of a basket of underlying assets (independent of the total number of features) or the number of features is three or more. Of the 245,299 contracts, 148,594 are not part of a basket. The data has three baskets: spread, standard, or worst-of-type. We treat the three baskets similarly and indistinguishable from each other for our definition of complexity.

COE Code	**Type of Structured Product**	**Regulatory Features to Determine Complexity**							**Number of Complex Products**			**Complex Products Value (Amount in BRL R$)**	
		Path Dependency	*Barrier*	*Singular Payoffs*	*Number of Scenarios*	*OTC only*	*Feature Change*	**Total Features**	**No**	**Yes**	**Total**	**No**	**Yes**
COE001001	Call	0	0	0	2	0	0	2	16,325	7	16,332	3,433,425,255	22,052,782
COE001002	Put	0	0	0	2	0	0	2	1,000	0	1,000	238,179,235	
COE001003	Call KO	1	1	0	3	1	0	6	0	4,177	4,177		1,637,155,739
COE001004	Put KO	1	1	0	3	1	0	6	0	24	24		13,182,717
COE001005	Call Spread	0	0	0	3	0	0	3	5,524	4	5,528	2,937,547,738	10,995,100
COE001006	Put Spread	0	0	0	3	0	0	3	1,641	2	1,643	868,255,827	10,977,000
COE001009	Straddle Put KO	1	1	0	4	1	0	7	0	1	1		3,555,000
COE001010	Straddle KO Call Put	0	1	0	4	1	0	6	0	8,717	8,717		1,118,602,159
COE001011	Digital Call	0	0	1	2	1	0	4	0	2,546	2,546		3,843,097,815
COE001012	Digital Put	0	0	1	2	1	0	4	0	1,338	1,338		1,212,014,123
COE001013	Double Digital	0	0	1	3	1	0	5	0	35	35		181,458,000
COE001015	Range Accrual	1	0	0	2	1	0	4	0	122	122		550,944,970
COE001022	Put KI	1	1	1	3	1	0	7	0	47	47		116,466,131
COE001025	Double No Touch	1	0	0	2	1	0	4	0	229	229		69,610,500
COE001026	One Touch	1	0	0	2	1	0	4	0	186	186		107,034,093
COE001027	Condor	0	0	0	5	0	0	5	0	3	3		2,445,000
COE001028	Butterfly	0	0	0	5	0	0	5	0	70	70		60,048,048
COE001030	Put Spread com KI + Call com	0	1	1	6	1	0	9	0	1	1		4,900,000
COE001031	Forward	0	0	0	2	0	0	2	147	0	147	674,014,526	
COE001033	Participation Forward Limitadores	0	0	0	4	1	0	5	0	24	24		57,257,000
COE001034	Participation Forward Flex II	0	0	0	4	1	1	6	0	338	338		17,879,170
COE001040	PutSpread + PutSpread	0	0	0	9	0	0	9	0	361	361		18,850,178
COE001041	Wedding Cake	0	0	0	4	1	0	5	0	39	39		18,104,004
COE001042	Call KO 1 + Call KO 2	0	1	1	9	1	0	12	0	274	274		277,224,229
COE001043	Edge Accrual	1	0	0	4	1	0	6	0	2	2		10,680,000
COE001044	Podium	0	0	0	6	1	0	7	0	34	34		8,494,500
COE001045	Troca de Indexadores	1	0	0	1	1	1	4	0	2	2		7,000,000
COE001049	Call KO + Put	1	1	1	6	1	1	11	0	3	3		1,000,000
	Total								24,637	18,586	43,223	8,151,422,581	9,381,028,258

Table 2: **Descriptive Statistics**

This table reports the descriptive statistics of the key variables used in the analysis. The data comes from the Brazilian Securities and Exchange Commission. Our contracts correspond to a Structured Transaction Certificate (COE). Each COE is an investment product inaugurated on the Brazilian market in mid-2014. They were created by Law 12,249/10. The rule was drawn by Brazil's National Monetary Council (CMN). These Structures Notes are an innovative and flexible instrument combining fixed income and equity elements. It also has the differential of being structured based on risk-return scenarios attracting different investor profiles. COEs are the Brazilian version of structured notes prevalent in the United States and Europe. Our sample data on issued and matured COE contracts starts on January 4, 2016. Panel A reports the product-level descriptive statistics for 43,223 unique products. Panel B reports the investor-level descriptive statistics for 150,910 unique investors. Panel C reports the issuer-year descriptive statistics for the 17 issuers across the four sample years. For a detailed definition of each variable used in the analysis, see Appendix Table A.3.

Panel A: Product Level

	Mean	*Median*	*Std. Dev*	*No. Obs*
Excess Return	-0.37%	0.76%	5.68%	43,223
D(Complexity)	0.43	0.00	0.50	43,223
Early Termination	0.90	1.00	0.30	43,223
Maturity (Days)	394.96	253.00	226.93	43,223
Capital Guarantee (%)	89.4	100.0	45.9	43,223

Panel B: Investor Level

	Mean	*Median*	*Std. Dev*	*No. Obs*
D(Experience)	0.53	1.00	0.50	150,942
Wealth (in BRL)	77,310	35,000	99,765	150,942
D(College Degree)	0.55	1.00	0.50	77,636
Age	47.17	45.00	15.86	132,280
Female	0.72	0	0.45	112,179
No. of Structured Products	1.64	1.00	1.27	150,942
Excess Return	1.31%	1.73%	5.94%	150,942

Panel C: Issuer-year Level

	Mean	*Median*	*Std. Dev*	*No. Obs*
No. Product contracts sold	4,541	1,172	7,614	54
No. Distributors	10.9	5	9.6	54
Complaint Index	1,024	20	3,479	54
Basel Index (%)	17.66	16.85	3.69	54

Table 3: **Ex-post Excess Returns and Product Complexity**

This table reports the results of regressions that examine the relation between a COE's complexity and its realized excess returns. The dependent variable *Excess Returns* is the difference in a matured note's realized return relative to the Brazilian interbank deposit rate (CDI). The realized returns are calculated using the initial price and final settlement price. Both prices are obtained from the CVM. The settlement price is the one the investor will redeem its investment either at maturity or at the date of early termination. For each COE, the ex-post excess return is measured as $R_j = R_j^{Gross} - CDI_j$ where R_j^{Gross} is the gross return of COE j and CDI_j is the compounded return of the CDI between the issuance and maturity of COE j. The main variable of interest is *D(Complexity)*. This indicator variable takes a value of 1 if the COE is either part of a basket of underlying assets (irrespective of the total number of features) or has three or more total features, as defined in Table 1. All specifications control for Maturity (in days) and Early Termination. Standard errors are reported in brackets and clustered at the underlying asset-time level. ***, **, and * denote statistical significance at the 1%, 5% and 10% levels, respectively.

	Dep. Var.: Ex-post Excess Returns						
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
D(Complexity)	-2.435***	-2.454***	-2.949***	-1.755***	-1.392***	-1.705***	
	[0.704]	[0.890]	[0.777]	[0.475]	[0.442]	[0.594]	
Ln(Complexity)							-1.802*
							[1.003]
Maturity					0.007***	0.005***	0.006***
					[0.001]	[0.001]	[0.001]
Early Termination					-0.884*	-0.049	0.367
					[0.491]	[0.572]	[0.572]
Time FE	No	Yes	Yes	Yes	Yes	No	No
Issuer FE	No	No	Yes	Yes	Yes	No	No
Underlying FE	No	No	No	Yes	Yes	No	No
Issuer-Time FE	No	No	No	No	No	Yes	Yes
Underlying-Time FE	No	No	No	No	No	Yes	Yes
Observations	43,223	43,223	43,223	43,223	43,223	43,105	43,105
R-squared	0.045	0.177	0.073	0.226	0.244	0.492	0.490

Table 4: **Ex-post Excess Returns and Investor Characteristics**

This table reports the results of regressions that examine the relation between a COE's investor characteristics and its realized excess returns. The dependent variable *Excess Returns* is the difference in a matured note's realized return relative to the Brazilian interbank deposit rate (CDI). The realized returns are calculated using the initial price and final settlement price. Both prices are obtained from the CVM. The settlement price is the one the investor will redeem its investment either at maturity or at the date of early termination. For each COE, the ex-post excess return is measured as $R_j = R_j^{Gross} - CDI_j$ where R_j^{Gross} is the gross return of COE j and CDI_j is the compounded return of the CDI between the issuance and maturity of COE j. The main variable of interest is *D(Complexity)*. This indicator variable takes a value of 1 if the COE is either part of a basket of underlying assets (irrespective of the total number of features) or has three or more total features, as defined in Table 1. All specifications control for Maturity (in days) and Early Termination. Standard errors are reported in brackets and clustered at the underlying asset-time level. ***, **, and * denote statistical significance at the 1%, 5% and 10% levels, respectively.

	Dep. Var.: Ex-post Excess Returns						
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
D(Experience)	0.266*		0.238*		0.295**		0.293**
	[0.140]		[0.141]		[0.145]		[0.129]
Ln(Wealth)		0.115*	0.107				
		[0.069]	[0.070]				
Ln(Age)				0.091	0.074		
				[0.077]	[0.077]		
D(College Degree)						0.074	0.066
						[0.048]	[0.046]
Maturity	-0.009***	-0.009***	-0.009***	-0.009***	-0.009***	-0.007***	-0.007***
	[0.002]	[0.002]	[0.002]	[0.002]	[0.002]	[0.002]	[0.002]
Early Termination	0.467	0.435	0.423	0.407	0.396	0.263	0.248
	[0.800]	[0.805]	[0.803]	[0.822]	[0.820]	[0.785]	[0.782]
Time FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Issuer FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Underlying FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Distributor FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	245,229	245,229	245,229	209,049	209,049	124,775	124,775
R-squared	0.384	0.384	0.384	0.388	0.388	0.337	0.338

Table 5: **Ex-post Excess Returns, Product Complexity, and Investor Characteristics**

This table reports the results of regressions that examine the relation between a COE's investor characteristics and its realized excess returns. The dependent variable *Excess Returns* is the difference in a matured note's realized return relative to the Brazilian interbank deposit rate (CDI). For each COE, the ex-post excess return is measured as $R_j = R_j^{Gross} - CDI_j$ where R_j^{Gross} is the gross return of COE j and CDI_j is the compounded return of the CDI between the issuance and maturity of COE j. The main variable of interest is *D(Complexity)*. This indicator variable takes a value of 1 if the COE is either part of a basket of underlying assets (irrespective of the total number of features) or has three or more total features, as defined in Table 1. All specifications control for Maturity (in days) and Early Termination. Standard errors are reported in brackets and clustered at the underlying asset-time level. ***, **, and * denote statistical significance at the 1%, 5% and 10% levels, respectively.

	Dep. Var.: Ex-post Excess Returns			
	(1)	(2)	(3)	(4)
D(Complexity)	-3.681***	-3.359***	-3.464***	-3.292***
	[0.490]	[0.480]	[0.480]	[0.457]
D(Experience)	0.462***	0.542***	0.434***	0.432***
	[0.166]	[0.173]	[0.165]	[0.159]
D(Complexity) × D(Experience)	1.168***	1.295***	1.240***	0.951**
	[0.443]	[0.480]	[0.450]	[0.409]
Ln(Age)		0.066		
		[0.072]		
D(Complexity) × Ln(Age)		-0.469*		
		[0.275]		
Ln(Wealth)			0.059	
			[0.072]	
D(Complexity) × Ln(Wealth)			-0.364**	
			[0.177]	
D(College Degree)				0.018
				[0.048]
D(Complexity) × D(College Degree)				-0.500***
				[0.108]
Maturity	-0.013***	-0.013***	-0.013***	-0.010***
	[0.003]	[0.003]	[0.003]	[0.003]
Early Termination	-0.124	-0.188	-0.076	-0.320
	[0.723]	[0.753]	[0.725]	[0.677]
Time FE	Yes	Yes	Yes	Yes
Issuer FE	Yes	Yes	Yes	Yes
Underlying FE	Yes	Yes	Yes	Yes
Distributor FE	Yes	Yes	Yes	Yes
Observations	245,229	209,049	245,229	124,775
R-squared	0.409	0.411	0.410	0.365

Table 6: **Ex-post Excess Returns, Product Complexity, and the Role of Independent Distributors**

This table shows the differential impact of the role of the independent distributor on the returns of complex and non-complex products. The dependent variable is Excess Returns. *D(Independent Distributor)* is a time-invariant indicator variable that takes a value of one if an independent distributor sells the COE product and zero if an affiliated bank sells it. The dependent variable *Excess Returns* is the difference in a matured note's realized return relative to the Brazilian interbank deposit rate (CDI). For each COE, the ex-post excess return is measured as $R_j = R_j^{Gross} - CDI_j$ where R_j^{Gross} is the gross return of COE j and CDI_j is the compounded return of the CDI between the issuance and maturity of COE j. The main variable of interest is *D(Complexity)*. This indicator variable takes a value of 1 if the COE is either part of a basket of underlying assets (irrespective of the total number of features) or has three or more total features, as defined in Table 1. All specifications control for Maturity (in days) and Early Termination. Standard errors are reported in brackets and clustered at the underlying asset-time level. ***, **, and * denote statistical significance at the 1%, 5% and 10% levels, respectively.

	Dep. Var.: Ex-post Excess Returns			
	(1)	(2)	(3)	(4)
D(Complexity)		-3.312***	-3.735***	-4.222***
		[0.468]	[0.485]	[0.531]
D(Independent Distributor)	4.21***	5.079***	5.508***	4.075***
	[1.76]	[1.839]	[1.801]	[1.236]
D(Complexity) × D(Independent Distributor)			4.399**	5.160***
			[1.917]	[1.537]
Maturity	-0.009***	-0.013***	-0.013***	-0.017***
	[0.002]	[0.003]	[0.003]	[0.003]
Early Termination	0.481	-0.081	-0.140	0.339
	[0.803]	[0.728]	[0.722]	[0.585]
Time FE	Yes	Yes	Yes	Yes
Issuer FE	Yes	Yes	Yes	Yes
Underlying FE	Yes	Yes	Yes	Yes
Distributor FE	Yes	Yes	Yes	Yes
Investor FE	No	No	No	Yes
Observations	245,229	245,229	245,229	145,740
R-squared	0.384	0.409	0.413	0.612

Table 7: **The Role of Independent Distributors and Experienced Investors**

This table shows the differential impact of the role of experienced investors and products sold by independent distributors on the returns of complex and non-complex products in an OLS framework. *D(Experience)* is a time-varying indicator variable that takes a value of one if the investor has previous experience up to the issuance month, since 2015, trading stocks, futures, or options before investing in COEs, zero otherwise. *D(Independent Distributor)* is a time-invariant indicator variable that takes a value of one if an independent distributor sells the COE product and zero if an affiliated bank sells it. The dependent variable *Excess Returns* is the difference in a matured note's realized return relative to the Brazilian interbank deposit rate (CDI). For each COE, the ex-post excess return is measured as $R_j = R_j^{Gross} - CDI_j$ where R_j^{Gross} is the gross return of COE j and CDI_j is the compounded return of the CDI between the issuance and maturity of COE j. The main variable of interest is *D(Complexity)*. This indicator variable takes a value of 1 if the COE is either part of a basket of underlying assets (irrespective of the total number of features) or has three or more total features, as defined in Table 1. All specifications control for Maturity (in days) and Early Termination. Standard errors are reported in brackets and clustered at the underlying asset-time level. ***, **, and * denote statistical significance at the 1%, 5% and 10% levels, respectively.

	Dep. Var.: Ex-post Excess Returns		
	(1)	(2)	(3)
D(Complexity)	-3.846***	-3.780***	-4.430***
	[0.505]	[0.506]	[0.549]
D(Experience)	0.312**	0.353***	0.907***
	[0.153]	[0.130]	[0.219]
D(Complexity) × D(Experience)	0.441	0.207	0.625**
	[0.294]	[0.269]	[0.286]
D(Independent Distributor)	5.444***	5.948***	5.161***
	[1.801]	[1.839]	[1.351]
D(Complexity) × D(Independent Distributor)	4.141**	2.250	2.945
	[1.927]	[2.209]	[1.983]
D(Experience) × D(Independent Distributor)		-0.581	-1.261*
		[0.507]	[0.682]
D(Complexity) × D(Experience) × D(Independent Distributor)		2.422**	2.175*
		[1.199]	[1.302]
Maturity	-0.013***	-0.013***	-0.017***
	[0.003]	[0.003]	[0.003]
Early Termination	-0.163	-0.158	0.335
	[0.720]	[0.717]	[0.580]
Time FE	Yes	Yes	Yes
Issuer FE	Yes	Yes	Yes
Underlying FE	Yes	Yes	Yes
Distributor FE	Yes	Yes	Yes
Investor FE	No	No	Yes
Observations	245,229	245,229	145,740
R-squared	0.414	0.414	0.612

Table 8: **Exploring The Quality of All Distributors**

This table explores the quality of the distributors selling COE products on the returns of complex and non-complex products in an OLS framework. The dependent variable *Excess Returns* is the difference in a matured note's realized return relative to the Brazilian interbank deposit rate (CDI). For each COE, the ex-post excess return is measured as $R_j = R_j^{Gross} - CDI_j$ where R_j^{Gross} is the gross return of COE j and CDI_j is the compounded return of the CDI between the issuance and maturity of COE j. In Panel A, *Complaint Index* is an external measure of quality based on the lagged number of complaints filed against a bank over the total number of clients. In Panel B, *Capital Adequacy Ratios (CAR)* is an internal measure of quality and measures the amount of a bank's core capital expressed as a percentage of its risk-weighted asset. In our specifications, *CAR* is an indicator variable that takes a value of one if *CAR* is below the median for that period and zero otherwise. Both quality measures are time-variant and demeaned. For simplicity, we report the interaction terms of interest only. The main variable of interest is *D(Complexity)*, a demeaned indicator variable that takes a value of 1 if the COE is either part of a basket of underlying assets (irrespective of the total number of features) or has three or more total features, as defined in Table 1. *D(Experience)* is a time-varying indicator variable that takes a value of one if the investor has previous experience up to the issuance month, since 2015, trading stocks, futures, or options before investing in COEs, zero otherwise. *D(Independent Distributor)* is a time-invariant indicator variable that takes a value of one if an independent distributor sells the COE product and zero if an affiliated bank sells it. All specifications control for Maturity (in days) and Early Termination. Standard errors are reported in brackets and clustered at the underlying asset-time level. ***, **, and * denote statistical significance at the 1%, 5% and 10% levels, respectively.

Panel A: External Measure of Quality – Capital Adequacy Ratio (CAR)

	Dep. Variable: Ex-post Excess Returns			
	(1)	(2)	(3)	(4)
D(Complexity)	-3.300***	-2.953***	-3.188***	-3.595***
	[0.473]	[0.532]	[0.674]	[0.590]
D(CAR)	0.251	-0.379	-0.729	-1.035
	[0.889]	[1.019]	[1.600]	[0.979]
D(Complexity) × D(CAR)		-2.301	-2.984	-3.255**
		[1.514]	[2.358]	[1.614]
D(Independent Distributor)			5.539***	3.864***
			[1.858]	[1.334]
D(Complexity) × D(Independent Distributor)			4.542**	5.389***
			[1.796]	[1.531]
D(CAR) × D(Independent Distributor)			-0.394	-0.114
			[2.102]	[1.516]
D(Complexity) × D(CAR) × D(Independent Distributor)			5.232	6.792**
			[3.593]	[2.770]
Maturity	-0.013***	-0.012***	-0.013***	-0.017***
	[0.003]	[0.003]	[0.003]	[0.003]
Early Termination	-0.077	-0.200	-0.325	0.168
	[0.728]	[0.749]	[0.750]	[0.601]
Time FE	Yes	Yes	Yes	Yes
Issuer FE	Yes	Yes	Yes	Yes
Underlying FE	Yes	Yes	Yes	Yes
Distributor FE	Yes	Yes	Yes	Yes
Investor FE	No	No	No	Yes
Observations	245,229	245,229	245,229	145,740
R-squared	0.408	0.410	0.416	0.613

Panel B: Internal Measure of Quality – Complaints Index

	Dep. Variable: Ex-post Excess Returns			
	(1)	(2)	(3)	(4)
D(Complexity)	-3.337***	-2.344*	-0.503	-0.073
	[0.473]	[1.329]	[1.224]	[0.985]
D(Complaint Index)	-1.032	-1.223	-4.650***	-4.152***
	[0.989]	[1.060]	[1.255]	[0.981]
D(Complexity) × D(Complaint Index)		-1.119	-3.610***	-4.463***
		[1.441]	[1.362]	[1.106]
D(Independent Distributor)			3.272	2.241
			[2.258]	[1.548]
D(Complexity) × D(Independent Distributor)			-0.139	-0.914
			[2.251]	[1.822]
D(Complaint Index) × D(Independent Distributor)			5.500***	4.765***
			[1.635]	[1.355]
D(Complexity) × D(Complaint Index) × D(Independent Distributor)			7.472***	9.534***
			[2.362]	[1.967]
Maturity	-0.013***	-0.013***	-0.013***	-0.017***
	[0.003]	[0.003]	[0.003]	[0.003]
Early Termination	-0.032	-0.034	-0.190	0.344
	[0.729]	[0.727]	[0.710]	[0.573]
Time FE	Yes	Yes	Yes	Yes
Issuer FE	Yes	Yes	Yes	Yes
Underlying FE	Yes	Yes	Yes	Yes
Distributor FE	Yes	Yes	Yes	Yes
Investor FE	No	No	No	Yes
Observations	245,229	245,229	245,229	145,740
R-squared	0.409	0.409	0.420	0.616

Table 9: **Who Are The Independent Distributors?**

This table shows the differential impact of the role of experienced investors and products sold by independent distributors on the returns of complex and non-complex products in an OLS framework. The dependent variable *Excess Returns* is the difference in a matured note's realized return relative to the Brazilian interbank deposit rate (CDI). For each COE, the ex-post excess return is measured as $R_j = R_j^{Gross} - CDI_j$ where R_j^{Gross} is the gross return of COE j and CDI_j is the compounded return of the CDI between the issuance and maturity of COE j. The main variable of interest is *D(Complexity)*. This indicator variable takes a value of 1 if the COE is either part of a basket of underlying assets (irrespective of the total number of features) or has three or more total features, as defined in Table 1. We construct three measures. *D(Large Independent Distributor)* is a time-invariant indicator variable that takes a value of one if that independent distributor's value of sold COE products is above the median and zero otherwise. *D(High Market Share)* is a time-varying indicator variable that takes a value of one if an independent distributor has a market share above the median for a COE product's underlying asset, and zero otherwise. *D(Specialized Distributor)* is a time-varying indicator variable that takes a value of one if more than 50% of products sold by an independent distributor in a year have the same underlying asset. All specifications control for Maturity (in days) and Early Termination. Standard errors are reported in brackets and clustered at the underlying asset-time level. ***, **, and * denote statistical significance at the 1%, 5% and 10% levels, respectively.

	Dep. Var.: Ex-post Excess Returns					
	(1)	(2)	(3)	(4)	(5)	(6)
D(Complexity)	2.581*	1.358	2.505*	1.533	2.109	2.009
	[1.340]	[1.551]	[1.352]	[1.743]	[1.365]	[1.412]
D(Large Independent Distributor)	1.606	0.817				
	[0.979]	[0.910]				
D(Complexity) × D(Large Independent Distributor)		3.464**				
		[1.663]				
D(High Market Share)			1.626*	1.297		
			[0.888]	[0.831]		
D(Complexity) × D(High Market Share)				1.618		
				[1.686]		
D(Specialized Distributor)					2.446**	2.306*
					[1.182]	[1.366]
D(Complexity) × D(Specialized Distributor)						0.553
						[3.598]
Maturity	-4.621***	-4.644***	-4.617***	-4.616***	-4.583***	-4.582***
	[0.744]	[0.746]	[0.746]	[0.746]	[0.730]	[0.729]
Early Termination	1.334	1.269	1.314	1.233	1.480	1.471
	[1.631]	[1.624]	[1.650]	[1.665]	[1.658]	[1.665]
Time FE	Yes	Yes	Yes	Yes	Yes	Yes
Issuer FE	Yes	Yes	Yes	Yes	Yes	Yes
Underlying FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	112,118	112,118	112,118	112,118	112,118	112,118
R-squared	0.507	0.509	0.508	0.509	0.513	0.513

Appendix

Appendix A.1: Regulatory Framework Provided By Brazilian Authorities

This is a description of the main regulatory framework around the legislation of COEs. The source is B3 S.A., the Brazil Stock Exchange, and Over-the-Counter Market, located in São Paulo. B3 S.A. – Brasil, Bolsa, Balcão is one of the world's largest financial market infrastructure companies, providing trading services in an exchange and OTC environment. B3 is a public company traded under the ticker symbol B3SA3 on the Novo Mercado premium listing segment, and its stock is tracked by the Ibovespa, IBrX-50, IBrX, and Itag indices, among others. https://www.b3.com.br/en_us.

General Features

On September 5, 2013, the Brazilian Monetary Council (Conselho Monetário Nacional – CMN) approved CMN Resolution No. 4623 (CMN Res. 4623/2013), which amended regulations on the conditions for issuing Structured Operations Certificates (Certificados de Operações Estruturadas – COEs), created by Law No. 12249 of June 11, 2010.

The COE is a certificate issued against an initial investment, representative of a single and indivisible set of rights and obligations, with a profitability structure characteristic of derivative financial instruments.

The COE is similar to the structured note adopted in the international market, such as in the United States and Europe. These structured products are hybrid securities that include several financial products, typically a stock or bond plus a derivative. They offer various investment opportunities to clients who seek a mix of fixed-income and variable-income within a single instrument.

Authorized Issuers

Only multiple banks, commercial, investment, and savings banks, are authorized to issue COEs. These institutions must designate a Director responsible for the issuance, distribution, or negotiation of COE trading. This appointed Director may assume other roles within the institution except those

related to administering third-party resources and risk management, which must be entirely segregated from the director's role.

Underlying Assets

COEs can be underpinned by various assets such as price indices, bond indexes, securities indexes, interest rates, exchange rates, securities, and other underlying assets, albeit with certain restrictions. Price indices, bond indexes, securities indexes, interest rates, and exchange rates used as benchmarks must be regularly calculated and subject to public disclosure. Securities and other underlying assets need to have quotes regularly disclosed by stock exchanges, commodities and futures exchanges, organized over-the-counter (OTC) markets, or by managing entities of clearing, settlement, and registry of assets system authorized by the Central Bank of Brazil.

Underlying assets can be calculated using a methodology that combines the benchmarks referred to in (a) and/or (b), provided that it is consistent and verifiable. The use of this methodology is the exclusive responsibility of the issuing institution. Finally, the underlying asset can be disclosed in Brazil or traded abroad, with due observance of the same requirements for assets in Brazil, including regarding exchanges and OTC markets, which the competent foreign authorities must regulate.

The issuance of COE referenced in credit operations, credit instruments, and securitization and derivatives instruments of credit is expressly prohibited.

Types of COEs

There are two types of COEs, classified according to their profitability structure:

- Protected par-valued investment: Investment whose total value of minimum payments due to the investor is equal to or greater than the initial investment.
- Investment with par value at risk: Investment whose total value of minimum payments due to the investor is equal to or greater than a previously defined portion of the initial investment.

In both cases, the certificate's par value on the issued date must equal the initial investment.

Responsibilities and Controls: Accredited Entities

The issuing institution and the institutions that participate in the process of distribution, placement, or negotiation of the COE are accredited entities that must implement policies and procedures to ensure the adequacy of the certificates to the investor profile, observing the investors' needs, interests, and goals. These policies and procedures must be based on consistent and verifiable criteria.

Policies must consider the following three dimensions:

- The type, level of risk, and complexity of the COE;
- The amount to be invested;
- The assets and liabilities, and financial situation of the investor;
- The investor's experience and her ability to understand the risks of the investment;
- Declared preferences of the investor regarding the assumption of risk;
- The procedures used in the negotiation of the COE.

The accredited entities must ensure that the information concerning the COE is provided using documents made available to the investors. These documents must be written in clear, objective, and appropriate language according to their nature and complexity. The document should be clear enough to allow the investor to understand the trading conditions, payment flows, and incurred risks of the investment. This information shall clarify that the receipt of payments is subject to the credit risk of the certificate's issuer.

Responsibilities and Controls: Issuing Entities

The issuing institutions must ensure that their operational controls and risk management processes are appropriate to the complexity and the volume of circulating certificates. The operational controls must at least comply with the following requirements:

- Allow for the calculation of the marked market value of the certificates individually daily;
- Based on clearly defined criteria and procedures, and well documented;

- Allow the continuous control of verification of the operational limits established by the institution;
- Ensure consistency of the information contained in the record of the Authorized System;
- Contain systematic prevention controls against operational failures and issuances incompatible with market prices.

Table A.2: **Descriptive Statistics by Product Complexity, Investor Experience, and Type of Distribution**

This table reports the descriptive statistics of the key variables used in the analysis by different groups: the complexity of the COE contract (Product Type), whether the investor is experienced or not in trading options (Investor Type), and whether the distribution of the COE is done by an independent broker or an accredited an entity affiliated with a Bank (Distributor Type). The last column tests for the difference in means for each underlying characteristic of product, investor, and distributor types. ***, **, and * denote statistical significance at the 1%, 5% and 10% levels, respectively.

Variable	Average	Median	Std. Dev	Std Dev (Within Investor)	No. Obs	Average	Median	Std. Dev	Std Dev (Within Investor)	No. Obs	
Product Type	**Complex Product**					**Non-Complex Product**					Mean Difference
D(Experience)	0.64	1.00	0.48	0.29	176,232	0.35	0.00	0.48	0.39	68,997	0.29***
D(Independent Distributor)	0.58	1.00	0.49	0.08	176,232	0.14	0.00	0.35	0.04	68,997	0.44***
Wealth (in BRL)	97,251	45,000	119,411	111,283	176,232	151,795	100,000	135,034	120,221	68,997	-54544.37***
D(College Degree))	0.53	1.00	0.50	0.50	85,377	0.62	1.00	0.49	0.49	39,400	-0.09***
Age	46.22	43.00	15.88	14.29	150,883	52.35	53.00	15.68	15.36	58,166	-6.13***
COE Products Bought By Investors	2.71	2.00	2.80	2.78	176,232	2.48	2.00	2.73	2.53	68,997	0.23***
Maturity (Days)	252.33	250.00	132.42	146.92	176,232	430.63	446.00	190.73	148.51	68,997	-178.31***
Basel Index (%)	18.81	16.58	5.26	2.10	176,232	17.06	16.89	1.85	1.06	68,997	1.76***
Complaint Index (Quartiles)	1,165	36.83	2,995	484.21	176,232	354	36.83	1,447	148.39	68,997	811.64***
Investor Type	**Experienced Investor**					**Non-Experienced Investor**					Mean Difference
D(Complexity)	0.82	1.00	0.38	0.34	136,846	0.59	1.00	0.49	0.45	108,383	0.24***
D(Independent Distributor)	0.77	1.00	0.42	0.08	136,846	0.06	0.00	0.24	0.03	108,383	0.71***
Wealth (in BRL)	101,292	40,000	127,499	111,283	136,846	126,871	76,000	123,548	121,601	108,383	-25578.4***
D(College Degree))	0.54	1.00	0.50	0.50	60,024	0.57	1.00	0.49	0.49	64,753	-0.04***
Age	44.23	41.00	14.71	14.29	114,688	52.41	53.00	16.48	15.35	94,361	-8.18***
COE Products Bought By Investors	2.91	2.00	3.19	2.78	136,846	2.31	2.00	2.12	2.43	108,383	0.59***
Maturity (Days)	290.00	251.00	162.69	146.92	136,846	318.27	251.00	179.86	139.68	108,383	-28.27***
Basel Index (%)	19.50	16.88	5.78	2.10	136,846	16.83	16.49	1.56	0.89	108,383	2.67***
Complaint Index (Quartiles)	1,567	36.11	3,296	484.21	136,846	141	36.83	1,169	34.28	108,383	1426.81***
Distribution Type	**Independent Distributor**					**Distributor Affiliated to Bank**					**Mean Difference**
D(Experience)	0.94	1.00	0.24	0.25	112,086	0.24	0.00	0.42	0.46	133,143	0.71***
D(Complexity)	0.91	1.00	0.28	0.12	112,086	0.56	1.00	0.50	0.03	133,143	0.36***
Wealth (in BRL)	67,552	25,000	98,708	101,967	112,086	150,518	100,000	134,471	123,758	133,143	-82965.38***
D(College Degree))	0.50	0.00	0.50	0.50	45,806	0.59	1.00	0.49	0.49	78,971	-0.09***
Age	41.29	38.00	13.27	13.43	96,557	53.61	54.00	16.06	15.57	112,492	-12.32***
COE Products Bought By Investors	2.76	2.00	3.12	3.05	112,086	2.55	2.00	2.47	2.42	133,143	0.21***
Maturity (Days)	280.88	251.00	166.88	156.12	112,086	320.69	251.00	172.43	140.00	133,143	-39.82***
Basel Index (%)	20.21	16.91	6.21	3.02	112,086	16.72	16.44	1.19	0.79	133,143	3.49***
Complaint Index (Quartiles)	1,905	18.05	3,638	807.27	112,086	122	36.83	783	38.22	133,143	1782.34***

Table A.3: **Variables' Definition**

This table reports the definition of each variable used in the analysis. The definition and explanations of the variables include the names used throughout the paper, whether the variable is defined at the investor, product, distributor, or issuer level, the detailed description, the range, and whether the variable is a time-varying measure. The data is from the Brazilian Securities and Exchange Commission of Brazil (CVM). The CVM is tasked with maintaining a fair and equitable financial services industry through policy development and regulation.

Name	Defined By	Description	Range	Time-Varying Measure
D(Complexity)	Product	Indicator variable describing whether a product is complex or not. Each product has a set of mandatory features, such as the number of payoffs, barriers, path dependency, number of scenarios, and whether the product is part of a basket. We standardized all information to make comparisons compatible.	0 = Non-Complex, 1 = Complex. We also built a continuous complexity measure using the number of features of each product.	No
D(Experience)	Investor	Indicator variable describing whether an investor has previous experience trading stocks, futures, or options before investing in a COE. The previous experience window starts in 2015.	0 = No Experience, 1 = With Experience	Yes if non-experience investor becomes experienced.
D(Independent Distributor)	Distributor	Indicator variable describing whether a product is sold by an independent distributor (broker) or a bank-affiliated entity.	0 = Affiliated-Bank, 1 = Independent	No
Age	Investor	Number of years	0 to 100	Yes
Wealth (in BRL)	Investor	Amount invested in COE	Continuous	No
D(College Degree)	Investor	Indicator variable describing whether an investor has undergraduate studies (bachelor's degree).	0 = No Bachelor, 1 = With Bachelor	No
No. of COE Products Bought By Investors	Investor	Number of COEs the investor bought	1 to 60	No
Maturity (Days)	Product	Different in days between issuance and maturity dates, adjusted by early termination	1 month to 3 years measured in days	Yes
Early Termination	Product	Indicator variable describing whether a product can be redeemed before maturity	0 = Only at Maturity, 1 = Early Termination	No
Basel Index (%)	Issuer	Capital adequacy ratio. Capital adequacy ratios (CARs) measure the amount of a bank's core capital expressed as a percentage of its risk-weighted asset.	12% to 35%	Yes (quarterly)
Complaint Index	Issuer	The lagged measure of the number of complaints filed against a bank over the total number of clients. Number of complaints is lagged. For a product bought by an investor, we correlate it with the complaint index from the previous quarter.	Continuous	Yes (quarterly)
Total Volume Distributor (log)	Distributor	Log of total volume (in BRL) sold by an independent distributor		Yes
D(Large Independent Distributor)	Distributor	Indicator variable for large and independent distributors whose amount sold is above the median.	1= Amount Sold >Median, 0 = Otherwise	No

Table A.4: **Descriptive Statistics by Product Complexity, Investor Experience, and Type of Distribution**

This table reports results that examine the conditional correlations between the different features of the complexity measure defined in Table 1 on excess returns. The features that determine the complexity measure are, by nature, non-linear. The dependent variable is Excess Returns. Columns (1) to (6) include each COE feature defined in Table 1 separately. Column (7) adds all of these features in the same specification. All specifications control for Maturity (in days) and Early Termination. Standard errors are reported in brackets and clustered at the underlying asset-time level. ***, **, and * denote statistical significance at the 1%, 5% and 10% levels, respectively. Panel B reports the pairwise correlations of the individual features.

	Dep. Var.: Ex-post Excess Returns						
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Number of Scenarios	-0.799**						-0.032
	[0.329]						[0.325]
Barrier		-0.319					0.073
		[0.801]					[1.593]
Single Payoffs			-3.722***				0.201
			[0.644]				[1.742]
Path Dependency				4.617***			5.601***
				[0.932]			[1.287]
OTC Only					-1.355**		-3.472**
					[0.568]		[1.751]
Feature Change						3.541**	5.392***
						[1.469]	[1.988]
Maturity	0.008***	0.008***	0.007***	0.009***	0.007***	0.008***	0.007***
	[0.001]	[0.001]	[0.001]	[0.001]	[0.001]	[0.001]	[0.001]
D(Early Termination)	-0.112	-0.507	-1.798***	-0.406	-0.856	-0.564	-1.036*
	[0.513]	[0.533]	[0.562]	[0.528]	[0.521]	[0.515]	[0.572]
Constant	-1.181	-2.868***	-1.290**	-4.004***	-1.880***	-2.972***	-1.560
	[0.871]	[0.561]	[0.578]	[0.616]	[0.617]	[0.553]	[1.019]
Time Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Issuer Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Underlying Assets Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	43,223	43,223	43,223	43,223	43,223	43,223	43,223
R-squared	0.247	0.240	0.255	0.282	0.244	0.242	0.304

Table A.5: **Robustness Analysis Using a Continuous Measure of Complexity**

This table shows the results of the robustness test for Tables 6 and 7 when replacing the discrete complexity measure by its continuous version, *Ln(Complexity)*. This variable is defined as the sum of seven features: (i) path dependency; (ii) barrier option; (iii) "digital" payoffs; (iv) number of scenarios; (v) if the embedded derivatives are only traded over-the-counter; (vi) if previous attributes can be modified before maturity; and (vii) if the underlying is a basket of assets. Once the number of attributes has been calculated, the logarithm is applied. The other variables are exactly as previously defined. ***, **, and * denote statistical significance at the 1%, 5% and 10% levels, respectively.

	Dep. Var.: Ex-post Excess Returns					
	(1)	(2)	(3)	(4)	(5)	(6)
Ln(Complexity)	-3.107***	-3.899***	-4.714***	-3.104***	-4.306***	-5.023***
	[0.774]	[0.797]	[0.800]	[0.774]	[0.835]	[0.828]
D(Experience)	0.367***	0.513***	0.568**			
	[0.131]	[0.159]	[0.281]			
D(Experience) × Ln(Complexity)		1.612***	1.784***			
		[0.550]	[0.497]			
D(Independent Distributor)				4.894***	5.075***	3.714***
				[1.818]	[1.910]	[1.299]
D(Independent Distributor) × Ln(Complexity)					4.147**	4.595***
					[1.855]	[1.483]
Maturity	-0.012***	-0.012***	-0.017***	-0.012***	-0.012***	-0.016***
	[0.003]	[0.003]	[0.003]	[0.003]	[0.003]	[0.003]
Early Termination	0.714	0.747	0.758	0.734	0.789	0.841
	[0.755]	[0.752]	[0.587]	[0.759]	[0.742]	[0.578]
Constant	4.748***	4.593***	6.138***	2.712**	2.300*	4.441***
	[0.845]	[0.835]	[0.890]	[1.112]	[1.171]	[1.017]
Time FE	Yes	Yes	Yes	Yes	Yes	Yes
Issuer FE	Yes	Yes	Yes	Yes	Yes	Yes
Underlying Assets FE	Yes	Yes	Yes	Yes	Yes	Yes
Investor FE	No	No	Yes	No	No	Yes
Observations	245,229	245,229	145,740	245,229	245,229	145,740
R-squared	0.398	0.399	0.603	0.398	0.402	0.605