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The Failure of a Clearinghouse: Empirical Evidence

by Vincent Bignon and Guillaume Vuillemey

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This paper provides the first detailed empirical analysis of the failure of a derivatives clearinghouse: the Caisse de Liquidation, which defaulted in Paris in 1974. Using archival data, we find three main causes of the failure: i) a weak pool of investors, ii) the inability to contain the growth of a large member position and iii) risk-shifting decisions by the clearinghouse. Risk-shifting incentives aligned the clearinghouse's interests with those of the defaulting member, induced delays in the liquidation of the defaulted position and led attempts at private renegotiation to fail. Our results have implications for current policy debates on the design and resolution of clearing institutions.

Keywords: CCP, Central clearing, Collateral, Derivatives, Failure, Resolution

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1 Introduction

The smooth functioning of financial markets requires an orderly settlement of transactions. Clearinghouses, or central clearing counterparties (CCPs), play a critical role in this process, both in over-the-counter and in exchange-based markets. After two parties agree on a transaction, a CCP interposes itself between them and becomes a buyer to the seller and a seller to the buyer. The two parties are therefore no longer exposed to each other, but only to the CCP. As such, a CCP insulates its members from bilateral default risk (Biais, Heider, and Hoerova, 2016). Central clearing is now mandatory for standardized derivatives in most countries, as regulators expect it to prevent market breakdowns or financial contagion (Duffie, Scheicher, and Vuillemey, 2015). However, a new risk arises: the CCP itself could fail, with dramatic effects for financial stability (Duffie, 2015). The risks posed by potential CCP failures is currently at the top of policymakers' agenda worldwide (BIS, 2017; Financial Stability Board, 2017).

In this paper, we provide the first detailed empirical analysis of the failure of a CCP. We hand-collect rich archival data to study the failure of the *Caisse de Liquidation des Affaires en Marchandises* (*CLAM*) in Paris in 1974. The CLAM was the only clearinghouse operating in the Paris Commodity Exchange, a market most active for sugar futures. Between 1973 and 1974, a six-fold increase in global sugar prices spurred trading activities. Starting in November 1974, margins calls due to the collapse of prices induced the largest clearing member, and ultimately the CCP, to fail. We collect comprehensive data on the exposures of the CLAM, of all clearing members, and of all ultimate investors. We also collect ten years of daily stock price data for the CLAM, together with information on equity ownership and governance. Finally, we build a dataset of events specifically related to the CLAM, including all changes in initial margin requirements before the crisis, and all main events pertaining to the resolution process.

Our first contribution is to highlight two fundamental causes of CCP fragility. First of all, we show that the composition of the pool of investors was a key driver of the CLAM's default. Indeed, a large part of the long open position (i.e., positions gaining value with increases in sugar prices) was held by retail investors, who were both unsophisticated

and non-diversified. In contrast, investors in similar sugar markets in London and New York were well-diversified financial institutions. Therefore, the same fluctuations in sugar prices across all three markets induced massive investor defaults only in Paris. Retail investors defaulted on margin calls from their brokers, and the largest broker ultimately defaulted on its own margin calls from the CLAM.

The second fundamental cause of the CLAM's failure was a misuse of instruments to manage risk. To be precise, the CLAM almost exclusively managed risk through initial and variation margins. Empirically, we show that initial margin requirements increased proportionally with the level and volatility of sugar prices. Therefore, average margin requirements were well-managed. However, this margining system did not prevent the growth of a single large position, which precipitated the CLAM's failure: in a few weeks, the position of the largest member increased from about 30% to 56% of the total open exposure. This finding implies that position limits or member-specific margin surcharges would have been needed. While the CLAM could implement such measures, it never did. In this context, we show that equity holders were perceiving the risk of default of the CCP as being non-zero. Using event studies, we find on average a 2.3% cumulative abnormal stock return on the CLAM's stock price five days after increases in initial margin requirements. This return would not be observed if equity holders were perceiving default risk as being constantly equal to zero.

Our second contribution is to show that agency conflicts within CCPs can make CCP defaults more likely and, upon occurrence, more costly. Theoretically, there is a trade-off for a CCP when a member is close to distress. On the one hand, the CCP wants to preserve its charter value, i.e., cash flows associated with the continuation of operations. Therefore, it should be tough with the member in distress in order to preserve surviving members ("*charter value effect*"). On the other hand, the CCP has incentives that resemble risk-shifting (Jensen and Meckling, 1976). Indeed, being tough with the defaulting member and liquidating its position may create a loss for the CCP, whose equity is bounded below by zero. Instead, risky decisions — e.g., delaying margin calls and betting on a price reversal — can avoid any equity loss with some probability. If the CCP is close enough

to the region where its equity value function is convex, due to limited liability, this *risk shifting effect* can be large. In this case, the CCP has incentives to be lenient with the member in distress, at the expense of surviving members.

Empirically, four pieces of evidence show that risk-shifting incentives were dominant in our case. First, the CLAM delayed the declaration of the largest member's default, and therefore the liquidation of its open position. This can be seen as a bet on a price reversal. Second, the CLAM also continued to register new transactions from the member in default. Third, the CLAM attempted to manipulate settlement prices: it called for the temporarily closure of the sugar market. Indeed, due to a specific rule of the exchange, the resulting settlement price would then have been significantly higher than market prices. The economic effect would have been a shift in margin calls from the defaulted member to solvent members. This decision was a risky bet, as it was based on a debatable interpretation of the market's rulebook; indeed, it was later overruled by the highest administrative court. Fourth, the CLAM refused a proposal by sugar professionals to buy the entire position of the defaulted member, which would have allowed the market to reopen immediately. In all these cases, the CLAM took high-risk decisions in an attempt to avoid impairments of its equity. Consistent with risk-shifting theories, we show that distortions arose precisely in the region where the CLAM's equity value function was convex, due to limited liability. Overall, we find that the interests of the CLAM and of the defaulted member became closely aligned near distress, at the expense of solvent members.

Our findings are relevant for current policy discussions. First of all, our results show that risk-shifting problems can be large in CCPs. The distortions we document may still arise today, since CCPs remain thinly capitalized relative to their largest potential clearing liabilities (Duffie, 2015). While the structure of CCP default waterfalls (i.e., loss allocation schemes) now enables sharing losses with surviving members, which mitigates risk-shifting, other factors currently amplify the potential for risk-shifting. In particular, CCPs have arguably become too-big-to-fail (Tucker, 2013), which creates additional convexity in their equity value function. Distortions arising from risk-shifting can be

mitigated either by higher capitalization and by better governance. Specifically, a governance structure that gives more weight to hedgers, for whom the continuation of clearing services is more valuable, seems desirable. Additionally, near distress, a management of CCPs based on rules, rather than discretion, can also reduce expected default costs. Relatedly, our findings give ground to the idea that, if private attempts to negotiate a recovery are inefficiently distorted by risk-shifting incentives, the early intervention of a resolution authority is desirable.

Lastly, our results highlight the need to design risk-management systems that appropriately account for the size and concentration of members' positions. While concentration margins exist in modern CCPs, risk arising from crowded exposures across members are still not accounted for (see Cruz Lopez, Hurlin, Harris, and Pérignon, 2016; Menkveld, 2017). Moreover, our findings imply that the composition of the population of ultimate investors is relevant for CCP stability. While retail investors are less prevalent today than in our context, the opacity of members remains an important challenge for CCPs. This is even more the case since CCP membership is quickly expanding and client clearing (i.e., clearing by a large member on behalf of ultimate investors) is gaining popularity. Given the difficulty for CCPs to monitor opaque ultimate investors, margins may play a useful screening role, by excluding more financially constrained investors from the market.

Related literature

Our paper is the first to empirically study the failure of a CCP by relying on detailed data.[1] The failure of the CLAM had not been studied before, except through a brief account by Simon (1981, Chap. 16). Throughout history, we know of only two other examples of CCP failures, that of the Kuala Lumpur Commodity Clearing House in 1983 and that of the Hong Kong Futures Guarantee Corporation in 1987. Cox (2015) and Norman (2011,

[1] A related literature studies how central clearing affects market prices and financial stability. Theoretically, Duffie and Zhu (2011) study conditions under which a CCP can reduce counterparty risk, while Acharya and Bisin (2014) show that CCPs decrease counterparty risk in the presence of externalities. Empirically, Bernstein, Hughson, and Weidenmier (2014) show that the introduction of the New York Stock Exchange Clearinghouse in 1892 significantly lowered counterparty risk, contagion risk, and the volatility of returns. Loon and Zhong (2014) also find a reduction of counterparty risk after CDS contracts are cleared.

Chap. 9.4) give narrative accounts of the 1987 events in Hong Kong, but do not have access to internal CCP data to document the economic mechanisms leading up to the failure.[2] In October 1987, following the crash in the stock market, clearing institutions in the US went under severe stress, but did not fail. Bernanke (1990) discusses policy interventions by the Federal Reserve that preserved their integrity. More recently, Boissel, Derrien, Örs, and Thesmar (2016) show that lenders in the repo market behaved as if the probability of CCP default was large during the European sovereign debt crisis.

We study how incentives for a CCP to engage in risk management can be distorted when a large clearing member is in distress. As such, our paper relates to the literature on the design of a CCP's capital structure and of its loss-allocation mechanisms in default (Elliott, 2013; Duffie, 2015; France and Kahn, 2016). Relatedly, Biais, Heider, and Hoerova (2012, 2016) show that CCPs can efficiently mutualize counterparty risk by appropriately setting margins.[3] Koeppl et al. (2012) study the design of clearing systems.

2 Theoretical discussion

We inform our empirical work with theory. The main characteristic of the capital structure of a CCP is that it operates with a *matched book* (Duffie, 2015). For any long position with a counterparty, there is an offsetting short position with another counterparty. The operation of a matched book implies that, absent the default of clearing members, the CCP is indifferent about the level of settlement prices and about the distribution of margin calls across members. Indeed, any variation margin that is collected from a member is simultaneously paid to another member.

When a CCP is not subject to moral hazard, central clearing can be more efficient than

[2] Official reports were produced following both defaults in Kuala Lumpur and Hong Kong, respectively by the Task Force on the Kuala Lumpur Commodity Exchange, and by Davison (1988). The main goal of these reports is not to analyze CCP failures, but to propose reforms of the organization of commodity exchanges. See also Budding, Cox, and Murphy (2016) for the description of a stress episode in the New Zealand Futures and Options Exchange in 1989, and Gregory (2014) for a brief description of a few other near-failures.

[3] A separate literature studies the amount of margins necessary to safely clear derivatives. See, for example, Duffie, Scheicher, and Vuillemey (2015), Cruz Lopez, Hurlin, Harris, and Pérignon (2016), Huang and Menkveld (2016) and Menkveld (2017).

bilateral clearing due to the mutualization of idiosyncratic default risk (Biais, Heider, and Hoerova, 2012). This is true regardless of whether there is moral hazard on the investors' side. Indeed, in this case, the CCP can achieve efficient risk management by appropriately setting margins (Biais, Heider, and Hoerova, 2016). The socially efficient level of margins trades off their opportunity cost (since funds have to be kept in the form of risk-free assets rather than invested) and their incentive benefits, i.e., margins incentivize investors to screen their counterparties before central clearing takes place. The main prediction is that a CCP which is not subject to moral hazard should have no incentives to engage in poor risk management when it operates a matched book, i.e., is far away from distress.

In contrast, when a clearing member is close to default, the incentives of a CCP can be distorted. Specifically, there is a tension between two forces. First, there is a *charter value effect*: the CCP wants to preserve the cash flows associated with the continuation of clearing services.[4] To this end, it should properly manage the collection of margins and eventually the liquidation of the position of the distressed member. Therefore, the charter value effect gives incentives for the CCP to be tough with the distressed member, in order to preserve surviving members.

Second, there is also a *risk-shifting effect* (Jensen and Meckling, 1976; Leland, 1998). If strict risk management is implemented and the defaulting member's position is liquidated, the CCP's equity may be impaired. This is the case if the initial margin and default fund contribution paid by the member in distress are insufficient to cover the costs associated with the liquidation of its position. However, the equity value of the CCP is bounded below by zero, due to limited liability. Instead, if the defaulting member's position is not liquidated, the member can survive with some probability, e.g., if a price reversal occurs or if a government intervenes to bail out the member. In this case, the CCP's equity is not impaired. Therefore, if the CCP is close enough from the region where its equity value function is convex, its interests can become closely aligned with those of a defaulting member. The CCP may increase its expected equity value at the expense

[4]Theoretically, the charter value equals the present value of future rents (i.e., cash flows above the level that would ensure zero profit in a perfectly competitive market, see Keeley, 1990). In CCPs, rents can arguably be large: due to network externalities arising from multilateral netting (Duffie and Zhu, 2011), the market for clearing is typically characterized by monopolistic competition.

of surviving members. Distortions can take several forms, such as delaying margin calls or liquidation, or manipulating settlement prices in order to tilt margin calls away from the distressed member. The risk-shifting effect is more likely to dominate when a CCP is poorly capitalized, or when its governance gives low weight to members deriving the largest value from the continuation of clearing services.

3 Institutional background

We start with a description of the Paris sugar futures market, of its clearinghouse, and of the circumstances leading up to its failure in 1974. Additional institutional details are in Appendix A.

3.1 The Paris sugar futures market

Before the 1974 crisis, the Paris sugar futures market was a global and fast-growing marketplace, due to three main factors. First, Paris was the only international market for futures on white sugar. Instead, London and New York offered contracts on brown sugar (see Simon, 1981, for a comparison). Second, the Paris market was open to foreign investors and particularly attractive for arbitrage trading in times of high price volatility. Indeed, daily limits on price fluctuations were wider and more flexible than in New York and London. Third, the liquidity of the market improved significantly over time for hedgers (e.g., sugar producers), due to the increased participation of retail investors acting as liquidity providers. In 1974, less than 1% of traded contracts ended up with physical delivery, most contracts being unwound before maturity.

At the center of the trading process are 35 registered commodity brokers (*commissionnaires agréés*), akin to Futures Commission Merchants in the US. They are the only agents allowed to submit orders and therefore act as intermediaries for other market participants. In 1974, there were about 1,500 clients, including retail investors. Once a trade is completed, registered brokers are required to transmit the terms of the transaction to the clearinghouse. Brokers are liable for their clients in case of client default. Until the

collapse of the market at the end of 1974, sugar futures represented the largest segment of the Paris Commodity Exchange, in which cocoa and coffee futures were also traded.

3.2 The clearinghouse

All trades in the Paris Commodity Exchange must be novated to a single CCP, the *Caisse de Liquidation des Affaires en Marchandises* (CLAM). Its functioning, depicted in Figure 1, closely resembles that of modern CCPs. The CLAM is a publicly listed company, whose only function is to clear and settle trades in the Paris commodity exchange. Its clearing members are all registered commodity brokers. Any new transaction by an individual investor is registered at the CLAM in the name of its broker. The novation of a new transaction is complete once it is declared in identical terms by two brokers who are counterparties. After that, the clearinghouse bears all counterparty risk.

Counterparty risk is managed by the CLAM primarily through initial and variation margins. Upon registration of a new transaction, both the buyer and the seller are subject to an initial margin requirement. Additionally, each party commits to pay variation margins when exposures move out of the money. Margin calls are computed based on end-of-day settlement prices set by the market's technical committee. Variation margins must be received by the clearinghouse before the market re-opens on the second trading day after the call. Practically, the clearinghouse was legally registered as a bank, and each margin account opened for a broker was a standard deposit account. A broker deposits funds, which receive an interest, and can also benefit from external bank guarantees, such as letters of credit. Out of these funds, each broker pays initial and variation margins. Therefore, each clearing member's balance with the CCP is defined as

$$\begin{aligned} \text{Balance on CCP account} \;=\; & \text{Deposited capital} + \text{External bank guarantees} \\ & - \text{Initial margins} - \text{Variation margins}, \end{aligned} \tag{1}$$

and a clearing member is considered in default as soon as its account balance becomes negative. However, in practice, the CLAM has often tolerated short-lived negative bal-

ances, due to operational delays associated with the payment of variation margins.[5] In this case, initial margins temporarily cover a shortfall of variation margins.

To pay margins to the clearinghouse, registered brokers collect margin payments from their clients. In a typical arrangement, a client possesses a margin account with his broker, where deposited funds exceed the initial margin to be paid by the broker to the CCP. For example, if the initial margin required by the CCP is 10% of the contract value, the broker requires a deposit of about 15% from its clients. The 5% buffer provides additional protection against client default risk and allows reducing the frequency of margin calls to investors.

If a member fails on margin calls, the CLAM takes the position of the defaulting clearing member in its own name and liquidates it, in order to return to a matched book. Any loss made by the CLAM when trying to liquidate the position is imputed to its equity. As such, the CLAM did not have the possibility to call additional resources from surviving members, as modern CCPs typically do (Duffie, 2015).

3.3 The 1974 sugar crisis

We proceed with a description of the main features of the 1974 sugar crisis. A more detailed timeline of events is contained in Appendix Table A1.

Between November 1973 and November 1974, sugar prices have been multiplied by six, from 1,300 to 8,100 French francs (FRF) per ton, as illustrated in Figure 2.[6] The increase in sugar prices is global and due to a combination of structural and exceptional factors. In the Fall 1974, several countries experienced shortages of sugar in grocery stores, and expectations of long-lasting shortages were widespread.[7]

[5]The collection of margins relied on the use of phone and mail services.

[6]Throughout the paper, we report monetary amounts in 1974 FRF. 1 FRF in 1974 represents 0.76 EUR in 2015, i.e., approximately 0.85 USD in 2015.

[7]Structurally, highly volatile sugar prices in the 1970s can be explained by the limited share of the free sugar market (about 10% of global production), due to a large number of international agreements. In 1973 and 1974, prices of many commodities rose, following the oil shock. In the case of sugar, poor meteorological conditions and limits to exports by some countries (embargo in Poland) also contributed to the fear of a long-lasting sugar shortage. See Appendix Figure A2 for sugar future prices in Paris, London and New York. For an illustration of physical sugar shortages, see Appendix C that reproduces an article published in the New York Times in November 1974.

In the Paris Commodity Exchange, sugar price increases were accompanied by an inflow of funds from retail investors. Panel A of Figure 3 shows a boom in the volume of transactions registered by the CLAM between end-1971 and end-1974, from 54,000 tons to 1.9 million tons traded per month. While sellers of sugar futures were mostly sugar producers and brokers, retail investors were taking long positions to an overwhelming extent. Using a breakdown of all brokers' accounts at the CLAM into client sub-accounts, Table 1 shows that 96.9% of retail investors with an open position in December 1974 were holding a long position.

Starting on November 21st 1974, sugar prices started to fall. Two main factors led to major troubles at the CLAM and to the closure of the market on December 3rd. First, one registered broker, Nataf, was holding a large long position, representing 56% of the total open position by the CLAM. This position was held on behalf of about 600 retail investors, not on Nataf's own account. As prices dropped, Nataf received large variation margin calls, which it passed through to ultimate investors. Second, sugar prices hit the price fluctuation limit (called "limit down", see Appendix A) several days in a row. Therefore, the market could not clear. While many investors sent orders to unwind long positions and limit losses, their brokers could not find counterparties. Among others, Nataf could not execute orders from clients, which would have reduced its open position. Subsequently, a number of investors stopped responding to margin calls from Nataf or other brokers. Similarly, once it appeared that Nataf would fail on its variation margin calls, it was clear that the CLAM would not be able to find counterparties to liquidate defaulted exposures and return to a matched book.[8]

Under the pressure of brokers with a long position, and with the support of the CLAM, the quotation of prices was suspended by government decision on December 3rd. After that, attempts to re-open the market did not succeed, in part due to the refusal of the CLAM to register new transactions before the settlement of outstanding positions was complete. During this period, the main contentious issue concerned the price at which

[8]Price fluctuation limits have subsequently been accused of amplifying the crisis by preventing the liquidation of defaulted positions. However, the main theoretical effect of price limits is to introduce delays (see Brennan, 1986, for a theory). Absent the limit, investors may have liquidated positions at much lower equilibrium prices, and may thus have defaulted on their cash payments anyways.

existing positions should be settled. The market re-opened only in January 1976, after the liquidation of the CLAM and the creation of a new CCP.

These events can be seen through the lens of the CLAM's stock price, plotted in Figure 4 over the 1966-1975 period (Panel A). After several years of stability, the large increase in the CLAM's stock price coincides with the increase in trading volume that starts in 1972 and continues in 1973 (see Figure 3). During this period, the CLAM generates increasing income from clearing fees. During the main phase of the sugar price boom (i.e., the year 1974 until end-November), the stock price of the CLAM did not increase. However, since the market performed poorly in 1974 (see Figure A4), large excess returns were still earned by the CLAM. Finally, the CLAM's stock price did not start to collapse when sugar prices dropped, but only when Nataf was declared in default and the sugar market closed (Panel B).

3.4 Data

To study the CLAM's failure, we hand-collect data from two main archive centers: the Archives of the French Department of Commerce and the Archives of the Paris Chamber of Commerce (see Appendix B for details). Both institutions were involved in the supervision of the Paris Commodity Exchange. Their archives contain a large number of documents related to the exchange, including legal documents and statistical records about the activity of the market. We also obtain relevant documents from the Archives of the Bank of France and of the Ministry of Finance. These documents allow us to reconstruct the history of the sugar crisis in great details. One of the most useful data sources is a set of documents related to Nataf, the defaulting member. We have detailed data on its account at the CLAM, on all initial and variation margin payments in the last three months of activity, and on all its transactions on behalf of retail investors in the last trading days. We also find a hand-written accounting book containing information on the financial position of all of Nataf's clients.

Furthermore, we exploit the fact that the CLAM was a publicly listed firm, and collect daily data on its stock price, on dividend distributions and on the number of shares

outstanding, for the 1966-1975 period. Data are obtained from the *Cours authentique et officiel*, the daily newspaper published by the professional association managing the Paris Stock Exchange. Data on the CLAM's stock price are complemented with daily data on two stock market indices — one composite and one for financial firms only — computed by the Paris Stock Exchange. Relatedly, we also collect data on the ownership structure and governance of the CLAM from documents produced by the Bank of France.

Finally, we reconstruct time series of spot and future sugar prices (by maturity) at a daily frequency. Data are obtained from the economic newspaper *Les Echos* for the 1973-1975 period. We obtain data on prices in the Paris market and in the other two global sugar markets, London and New York.

4 Incomplete risk management and CCP losses

We use our data to show two direct causes of the CLAM's failure. First, the pool of investors with long positions was composed of non-diversified retail investors, who defaulted massively when sugar prices dropped. Second, while the average level of initial margins increased with the level and volatility of sugar prices, flat margin requirements across members were not sufficient to ensure stable clearing. Specifically, the CLAM failed to protect itself against the growing position of a member.

4.1 Pool of investors and failures on margin calls

Between November 21st and December 2nd, sugar prices fell by 21% and the limit-down (set at 300 FRF per day, see Appendix A) was hit seven times. In this context, the first fundamental cause of the default of the CLAM is the composition of the pool of ultimate investors in the sugar market. Specifically, unsophisticated retail investors were holding a large part of the long open position, and defaulted massively when prices started to drop.[9] Ultimately, these defaults induced Nataf to default on its own margin calls from

[9]During the boom, no clearing member had major difficulties to pay variation margins. Indeed, most sellers of sugar futures were sugar producers or dealers, who were simultaneously benefiting from high spot prices. The fact the sellers remained far from default can also explain why there were no additional

the CLAM. Other brokers were also close to default.

We start by documenting the extent of defaults by retail investors.[10] Across all clearing members, Panel B of Table 1 shows that 93.1% of the 683 retail investors with open positions on December 2nd were realizing mark-to-market losses. However, mark-to-market losses by clients do not create immediate losses for brokers, even if clients stop answering to margin calls. Indeed, investors were often depositing excess balances on their brokerage account.

To analyze the transmission of investor losses to brokers, we focus on Nataf, for reasons of data availability. Since Nataf is the largest and only failing clearing member, its case is the most relevant. Panel A of Table 3 shows, for all investors with positions on the day of default, the average price at which they bought sugar futures. The main finding is that more than 90% of investors bought futures in October and November, i.e., in the few weeks preceding the price collapse. Therefore, they were highly exposed. Then, Panel B shows the percentage of retail investors with negative balances on their account with Nataf, after taking into account excess balances and external guarantees. At the settlement price on December 2nd (6,217 FRF/ton), 49.6% of investors had a negative balance vis-à-vis Nataf. Furthermore, Panel C shows that the magnitude of investors' losses can be large. At the 25th percentile of the profit-and-loss distribution, the loss equals 62,900 FRF per investor. Finally, the fact that investor losses induced Nataf to fail on its own margin calls can be seen from studying its account balance at the CLAM, computed as in Equation (1). Panel B of Figure 8 shows that Nataf's balance turned negative on November 25th, and subsequently became more negative every single day but one.

What were the main causes driving retail investors' defaults? Using judicial documents from a series of procedures that started after the closure of the market, we find that: (i) some investors did not have enough liquid financial resources, (ii) some investors did not

distortions of CCP risk management during the boom.

[10]The participation of retail investors in futures markets was encouraged by public authorities on a number of grounds: the need to provide counterparties for hedgers, and the need to build an active futures market for the countries of the European Economic Community (Menu, 1980). For example, retail investors benefited from a tax abatement on gains in futures markets.

know they could be called for margins and did not respond to margin calls, and (iii) some investors stopped paying margins after sending sell orders, even though these orders were not executed due to limit downs. Points (ii) and (iii) are particularly interesting, since they highlight that retail investors were unsophisticated and, to a large extent, uninformed about basic features of the market.[11]

Furthermore, the impact of investor defaults on brokers was aggravated due to the tendency of brokers, including Nataf, to specialize in the collect of orders either from sugar professionals or from retail investors. Therefore, they were de facto specializing in the collect of long or short positions and benefited from very limited offsets across clients. Their positions were therefore "crowded", in the sense of Menkveld (2017).

Finally, from the point of view of the CCP, the fact that margins were ultimately paid by retail investors and not by the brokers themselves was problematic. Indeed, the CCP had little or no information about retail investors themselves. In this respect, the situation of the CLAM was similar to that of many modern CCPs in the presence of client clearing (i.e., the fact that many traders are not direct clearing members, but clear their exposures through a dealer, see Duffie et al. (2015)).

To put these findings into perspective, we stress that, in the London sugar market, retail investors did not play a significant role. Clearing through the International Commodities Clearing House (ICCH) was broadly opened to about 280 members (Rees and Jones, 1975), and diversified financial institutions played an important role.[12] Diversified financial institutions were also playing a major role in the New York sugar market (Simon, 1981). Therefore, the same price dynamics (see Figure A2) had very different effects on investor defaults in Paris and in these other two markets.

[11] Relatedly, we find 44 records of judicial procedures opposing investors to their brokers in 1974 and 1975. These trials involve 7 brokers, suggesting that debatable practices to attract uninformed investors were common. A novel by Georges Conchon and a movie by Jacques Rouffio, *Le sucre* (1977 and 1978, respectively), describe these practices.

[12] Furthermore, ICCH was a wholly-owned subsidiary of United Dominions Trust Ltd. As such, it benefited from large borrowing facilities from its parent company (Rees and Jones, 1975).

4.2 Risk management via initial margins

In principle, defaults by ultimate investors should not push a CCP into distress, if margins have been appropriately collected. The CLAM relied almost exclusively on initial and variation margins to manage risk. Initial margins were set as a fixed FRF amount per ton of sugar traded, regardless of the maturity of the future contract, and were the same for buyers and sellers. In this section, we study whether, with a per-unit initial margin requirement, a rising sugar price translated into lower risk controls for the CCP.

To study this question, we collect information on all changes in initial margin requirements from end-1973 to end-1974. There are 12 such changes, plotted in Panel A of Figure 5. With the exception of a short-lived peak in January 1974, initial margins have been increasing over the period, from 140 FRF per ton of sugar in December 1973 to 800 FRF per ton in November 1974.[13] To assess whether this change is commensurate with changes in future prices over the period, we normalize initial margin requirements by the settlement price on the nearest-term future on every trading day. The results, plotted in Panel B of Figure 5, show that initial margin requirements have been remarkably stable during the sugar price boom, representing about 10% of the nearest-term future price. This is still true within the last few weeks of operations, when the CLAM was larger in size and could in theory have been more subject to moral hazard.

A related concern is whether initial margins did keep up with the volatility of sugar prices. To answer this question, we first compute daily returns on the nearest-term sugar future contract, and plot them in Panel A of Figure 6. The volatility of sugar prices was significantly lower in the second half of 1974, when prices were increasing rapidly, than in the first part of the year.[14] Next, to better assess the CLAM's response to volatility, we

[13] The January 1974 peak in margins follows a large increase in sugar prices. After that, many investors closed their long positions to cash in their gains and buy futures at the new price (so-called *achetés-vendus*). Therefore, the CLAM had to disburse cash to these investors. Since a sizable part of variation margins for investors with short positions were not paid in cash but with bank guarantees, the CLAM had a liquidity shortage. The increase in margins was decided to make it more costly for investors to open new positions and induce them to keep their existing positions until maturity. The increase in margin requirements reduced trading volume (see Panel A of Figure 3) and was reverted a few days later.

[14] We check that our measure of volatility is not biased downwards due to limit-up or limit-down pricing. This is not the case during the boom phase.

estimate its 98% Value-at-Risk (VaR) each day, using data on the 200 preceding trading days.[15] We normalize this VaR by the daily initial margin requirement per ton of sugar. This ratio, plotted in Panel B of Figure 6, is often far below one. Therefore, initial margins collected were sufficient to cover shortfalls due to large price changes at a one-day-horizon (at the 2nd percentile of the returns distribution). Second, the ratio of the VaR to initial margins has been decreasing for several months before the sugar crisis, when prices were quickly rising. Therefore, we cannot conclude that margin requirements were too low given the volatility of sugar prices.

As a next step, one may wonder whether a level of initial margins of 10% is itself too low on a permanent basis. Several elements suggest that this is unlikely. First, we stress that a 10% initial margin requirement is consistent with the daily price fluctuation limits imposed by the exchange, which were set at about 10% of sugar prices (see Appendix A). Therefore, as long as variation margins were paid, the initial margin collected by the CLAM was sufficient to cover shortfalls for one trading day under any scenario. Second, this level of margins is markedly higher than the one that prevailed in London (2% of the sugar price), even though sugar prices were following a similar dynamics (see Appendix Figure A2). Finally, another question is whether initial margins should have been higher given that the increase in sugar prices is akin to a bubble. However, while the rise and fall of sugar prices may *ex post* be considered as a bubble, it was not seen as such when it occurred.[16] A large number of newspaper articles show that high prices were interpreted as reflecting the sugar market's fundamentals, in particular the shortage of physical sugar in many countries (see Appendix C for an example).[17] Taken together, all these arguments cast doubt on the idea that the average level of initial margins required was structurally too low at the CLAM.

A last concern could be that, while the quantity of initial margins required increased with changes in the level and volatility of prices, the quality of margins deteriorated.

[15] Value-at-risk calculations were not common in the 1970s, and became widespread only in the 1990s.

[16] Even ex post, characterizing the dynamics of asset prices as a bubble is difficult (see for example Pastor and Veronesi, 2006).

[17] In the French economic newspaper *Les Echos*, a daily chronicle was devoted to commodity markets. In 1974, fundamental factors explaining rising sugar prices are discussed almost every day.

Indeed, the use of bank guarantees was widespread to pay margins over that period. Since bank guarantees do not represent actual cash inflows for the CCP, but off-balance sheet assets, they were considered of lower quality. To assess whether the quality of margins posted decreased, we find daily data on the margin account held by Nataf at the CLAM in the three months preceding its default. The decomposition of assets on its margin account, and of its margin calls, is plotted in Panel A of Figure 8. While bank guarantees represented a large share (56.9%) of total margins in September 1974, subsequent margin calls were paid almost exclusively in cash. By the end of November, the ratio of bank guarantees to total margins had fallen to 32.2%. Therefore, there was no decrease, but an increase, in the quality of margins posted by the largest clearing member. Moreover, there is evidence that the CLAM was verifying the quality of bank guarantees provided. The CLAM refused letters of credit from banks that were not creditworthy enough (see Appendix A for an example in the fall 1974). This further challenges the idea that a poor fixation of initial margin levels is to blame for the failure of the CLAM.

4.3 The build-up of the Nataf position

Next, we show that flat initial margin requirements across all members proved unable to prevent the growth of a large member position. As discussed above, the CLAM relied almost exclusively on margins to manage risk, based on the idea that initial margins of 10% are enough to absorb any losses at a one-day horizon if the price fluctuation limits are themselves equal to 10%. Theoretically, margins should be a sufficient instrument in this context if any position can be liquidated by the CLAM at a price above or equal to the limit-down (or, below or equal to the limit-up). However, by definition, limit-up and limit-down prices are not market clearing prices. In this context, if a CCP inherits a large position, it may be unable to liquidate it. The larger the position, the more likely it is that frictions associated with its liquidation are large (e.g., time period needed and fire sale discounts). This form of illiquidity provides a rationale for using an additional instrument to contain the build-up of large positions.

We use our data to show that the CLAM was unable to contain the build-up of Nataf's

position, which ultimately represented 56% of the CCP's open position. While Nataf had been a major member for years, its position had remained limited. It represented 9% of the CLAM's open position in January 1974, and 20% in April. To precisely document the build-up, we approximate Nataf's exposure using data on initial margins paid. In Figure 7, we plot this exposure in tons of sugar (Panel A), as well as its share within the total open position of the CLAM (Panel B). As we see, Nataf's open position increased massively in the last weeks of operations, from about 55,000 tons to about 100,000 tons. Similarly, its share within the total exposure increased from 32% in October to about 60% in November.[18]

The CLAM did not react to this increasing position by taking additional risk management decisions. Specifically, the CLAM was allowed to vary initial margins for particular brokers, based on their risk characteristics or the size of their position. However, according to a confidential report produced by the Bank of France in 1975, this possibility was never used.[19] Other potential distortions were coming from the fact that, initial margins at the CLAM were paid based on the largest gross exposure. Instead, they were paid on net positions in other markets such as London. For example, an investor with a long position of 5 contracts and a short position of 3 contracts would pay margins based on 5 contracts in Paris, and based on $5 - 3 = 2$ contracts in London. The practice of gross margining reduced incentives to close positions, and may have played a role in sustaining large open positions.

To summarize, the focus of the CLAM on initial margins did not prevent the growth of a single large position. In the presence of potentially illiquid markets, there is a rationale for limiting the size of positions that cannot be liquidated. However, the CLAM did not take sufficient decisions.

[18]The large position of Nataf can partially be explained by its superior ability to use technology (phones) to reach individual investors.

[19]Position limits had been commonly used in US commodity exchanges for decades (Baer and Saxon, 1949) and in other French commodity exchanges (Le Havre, Roubaix) since the end of the 19th century.

4.4 Event study using margin changes

Did equity holders realize that risk controls were weak? Or did they encourage risky strategies, e.g., due to moral hazard? We proceed by conducting event studies around all increases in initial margin requirements during the boom.

Theoretically, equity holders' reaction to an increase in initial margins depends on how they view its impact on future cash flows to the CCP. There are two opposite effects. First, higher margins have a negative impact on trading volume, thus on clearing fees.[20] Second, higher margins also reduce the probability of default of the CCP, and therefore allow the CCP to earn clearing fees for a longer period of time. In an extreme case, if equity holders perceive the probability of default of the CCP as being always equal to zero, we expect negative excess returns after margin increases. Indeed, higher margins in this case would lower the trading volume without reducing the CCP's probability of default, equal to zero.

There are nine distinct increases in initial margins over our sample period, as shown in Panel A of Figure 5. In the baseline specification, we exclude the large increase in margins of end-January 1974, which was decided for reasons unrelated to standard risk management (see footnote 13). We center event studies around the implementation date of margin increases, denoted τ, and focus on an event window of five trading days before and after the event. A potential concern is that the implementation date is not the same as the announcement date, which we do not observe, and which should be more directly relevant for the stock price. However, this concern is minor in our case. First, according to the rule book of the CLAM (CLAM, 1971, Article 10), new margins requirements are effective at most two days after they have been announced, unless a government representative opposes the decision. There never was any such opposition during our sample period. Second, for two out of eight events, we find original documents confirming that new margining rules are immediately enforced after they are disclosed. In this

[20] In theory, higher margin requirements may increase trading volume if counterparty risk or information asymmetries prevent gains from trade to be exploited. In futures markets where a CCP is operating, empirical evidence consistently shows a negative relation between margin requirements and trading volume or open exposures (Hardouvelis and Peristiani, 1992; Hardouvelis and Kim, 1995). We observe a similar relation in our context.

case, the implementation date and the announcement dates are exactly the same. In contrast, we do not find documents showing delays in the implementation of margining rules. Therefore, immediate enforcement may have been common practice. Finally, as shown below, there is no evidence of pre-implementation trends which would suggest that the announcement date precedes the implementation date.

We estimate abnormal returns AR_{it} for any date t and event i using a one-factor market model,

$$AR_{it} = R_{it} - \hat{R}_{it} \quad \text{where} \quad \hat{R}_{it} = \hat{\alpha}_i + \hat{\beta}_i R_{mt}. \tag{2}$$

In Equation (2), R_{mt} is the market return at date t, R_{it} is the realized return on the stock of the CLAM at t around event i, and $\hat{R}_{it}$ is the predicted value of R_{it}. $\hat{\alpha}_i$ and $\hat{\beta}_i$ are estimated for each i on a window of 300 trading days preceding, but not including, the event window. Our object of interest is the cumulative abnormal return $CAR(\tau - 5, \bar{\tau})$, starting at the beginning of the event window $(\tau - 5)$ and running until each date $\bar{\tau} \in [\tau - 5, ..., \tau + 5]$, averaged over all N events,

$$CAR(\tau - 5, \bar{\tau}) = \sum_{t=\tau-5}^{\bar{\tau}} \left(\frac{1}{N} \sum_{i=1}^{N} AR_{it} \right). \tag{3}$$

We compute confidence intervals using formulas in MacKinlay (1997).

Estimates for the baseline model are displayed in Panel A of Table 2. Cumulative abnormal returns are not significantly different from zero before the event, but become positive and significant after initial margin requirements increase. Five days after the event, the cumulative abnormal return equals 2.3% and is significant at a 1% level, in spite of a relatively small number of events.

These estimation results, which are robust to a number of alternative specifications (see Appendix D), yield two conclusions. First, they are evidence that equity holders were perceiving the CLAM's probability of default as being non-zero. Indeed, equity holders saw higher margins as value-increasing, even if higher margins also reduce trading volume.[21] This is because margins reduce the probability of default of the CCP. A potential

[21] For this to be true, a necessary condition is that increases in margins do not reflect the CCP managers'

interpretation is that equity holders understood that risk management was too weak, due for example to the existence of a large member position. Second, the estimation results show that equity holders were not subject to significant moral hazard during the boom: they were favoring more stringent risk management.

Overall, this section shows two fundamental causes of the CLAM's default. First, retail investors defaulted massively when sugar prices collapsed. Second, the risk management practices of the CLAM were incomplete. While initial margins were closely following the level and volatility of sugar prices, they were not a sufficient instrument to manage risk. A large position could be built by Nataf. Shareholders were favoring stronger higher initial margins, which suggests that they understood that risk management could have been more stringent. As such, they reacted positively to increases in initial margin requirements.

5 Agency conflicts: CCP risk-shifting

Negative effects arising from the default of a large member can be limited if the defaulting member's position is liquidated quickly, or if renegotiation with surviving members helps avoiding the default of the CCP. We show that severe agency conflicts, in the form of risk-shifting incentives, led to a costly default of the CLAM.

5.1 Distortions before the declaration of default

After prices started to fall, several pieces of evidence show distortions of the CLAM's risk management. First, the CLAM delayed the declaration of Nataf's default to the professional association of registered brokers. For one or two days, the delay is not necessarily evidence of a distortion. Indeed, as discussed in Section 3, it was usual to consider that initial margins could cover temporary shortfalls in variation margins, when

information about future prices or trading volume. All documents instead show that the CLAM set margins in response to past sugar price changes (in a rather mechanical way, as in modern CCPs, see Section 4.2). Furthermore, since the sugar price was a global price, it is hard to imagine that the CLAM's managers could benefit from private information.

these shortfalls were due to operational reasons, such as postal delays.[22] Such shortfalls were often benign and paid for quickly. Example are given by Nataf itself, since Figure 8 shows shortfalls early in September 1974 and two times in November. These shortfalls should not be interpreted as early signs of weakness by Nataf since they were rapidly covered. Furthermore, as the market supervisor notes in an inspection report, "Nataf paid margins as no other broker before him did, covering not only variation margins with cash, but also a large part of initial margins and, for certain days, all initial margins or more". Therefore, until November 25th, the CLAM could have been thinking that the shortfall (2 million FRF) was not unusual, since initial margins paid by Nataf were still far larger (74 million FRF).

After this date, however, it should have been clear for the CLAM that the shortfall on Nataf's account was not due to operational delays, but to exceptional price changes. Therefore, the shortfall should not have been treated as usual payment delays, even though Nataf managed to bring additional cash and bank guarantees for an amount of 21 million FRF between November 27th and December 1st. Precisely, the CLAM waited until Nataf's shortfall was larger than its initial margin to declare its default, which occurred on December 2nd, as Figure 8 shows. The decision to delay the declaration of default was misguided since, on the day default was declared, there was no more initial margin left to bear the cost associated with the liquidation of Nataf's position. A direct consequence of delaying the declaration of Nataf's default is a delay in the liquidation of its defaulted position, amid falling sugar prices. While it is unlikely that the CLAM could have liquidated all of Nataf's position (56% of the total open position) within a few days, due to several consecutive limit downs, it could have eliminated some of it. In particular, the limit down was not reached on November 27th. Therefore, part of the position could also have been unwound in Paris or hedged in London and New York, where there was also limited trading volume despite limit downs.

Moreover, the CLAM continued to register trades executed by Nataf during the period in which its account balance was negative. Registering these transactions was in

[22] A strike of postal and telecommunications services in November 1974 made it difficult for registered brokers to collect margin payments from their clients.

contradiction with the CLAM's rule book (CLAM, 1971, Article 18), and can be seen as an additional distortion. From data on all trades executed by Nataf either in the name of its clients or in its own name, we see that, after its account balance became negative, Nataf was unwinding positions. Starting on November 25th and until its default, Nataf reduced his position by 34 million FRF (representing about 6% of its position on the day of default). However, the trading patterns by Nataf cannot justify the decision of the CLAM to pursue the registration of new transactions. Indeed, all exposures that Nataf was unwinding could have been equally well unwound by the CLAM if it had taken over Nataf's position. Furthermore, the reduction of Nataf's exposure during this period is in net terms, but Nataf continued to execute an important proportion of buy orders (130 buy orders out of 271 orders executed). If the CLAM had taken over Nataf's position, these orders would not have been executed and the total reduction in exposure would have been significantly larger.

The decision to pursue the registration of new trades, together with delays in declaring default suggest that the CLAM was acting to protect Nataf (by betting on a price reversal). Therefore, these first pieces of evidence are consistent with risk-shifting incentives dominating the incentive to preserve charter value.

5.2 Price manipulation using Article 22

After Nataf is declared in default on December 2nd, other clearing members with long positions were also close to default. On the next day, another fall of sugar prices to the limit down would have induced the default of two additional members, while a collapse of prices over a longer period would have threatened up to 8 or 10 members. Since the CLAM takes the entire position of defaulted members, it would have had extremely large exposures to liquidate. Limit downs on sugar prices in Paris, but also in London and New York, implied that it could not quickly sell or hedge this open position either domestically or abroad.

In this context, we show an additional distortion which, if successful, would have have enabled Nataf to survive (and thus the CLAM to avoid any equity impairment).

Specifically, near distress, the CLAM must have incentives to manipulate settlement prices for existing exposures. A high settlement price would result in lower margin calls for Nataf or other members near default, and in higher margin calls for solvent members (the sugar professionals). Settlement prices, however, were not set by the CLAM itself, but based on end-of-day transaction prices in the exchange. Yet, the CLAM used the only possibility to manipulate settlement prices: together with the professional association of registered brokers, it decided to push for the suspension of trading in the sugar market.[23] On December 3rd, under this pressure, the Minister of Commerce authorized a temporary closure of the market.

The decision to push for the closure of the market is a clear attempt to manipulate settlement prices, due to a particular feature of the sugar market's rule book. According to Article 22 of the rule book, if trading is suspended due to *force majeure* (exceptional circumstances such as a war), the technical committee sets a price for the immediate settlement of outstanding positions, which equals the average price in the last 20 trading days. In this case, the price mandated by Article 22 was around 7,400 FRF per ton, i.e., about 1,200 FRF (or 20%) above the settlement price on December 2nd. At that settlement price, Nataf would have a positive account balance, and therefore would not default (and actually make substantial gains). Consequently, the CLAM would not default either. However, the bet on Article 22 was risky, since its applicability was highly debatable, and immediately disputed. Indeed, no extraneous reason prevented the market from functioning.[24] The push for Article 22 can be seen an attempt by the CLAM to manipulate the settlement price.

The decision of the CLAM to support the closure of the market and to push for the implementation of Article 22 illustrates a distortion: while a CCP with a matched book is indifferent to settlement prices and to the distribution of margin calls among clearing

[23] In theory, the professional association of registered brokers should not favor one type of counterparty against another. However, the association was largely controlled by brokers with long positions. The brokerage firm run by the president of the association, Georges Maurer, had the second largest long position in sugar futures, after Nataf.

[24] Article 22 mentioned "general mobilization in case of war and cases of force majeure, among others" as potential reasons for closure. Furthermore, it was known that in 1933-1935, the Council of State had invalidated a similar decision in the cereals futures market (Simon, 1981).

members, this is no longer true near default. The CLAM's support to the implementation of Article 22 can be seen as an attempt to tilt margin calls towards sugar sellers, and in favor of sugar buyers, including primarily the defaulting member.

5.3 Risk-shifting incentives

In this section, we show that the distortions documented above can be understood as a form of risk-shifting. Risk-shifting arises near distress due to a convexity in the equity value function: since equity holders' payoffs are bounded below by zero, they have no incentive to take actions that reduce the probability of low outcomes; instead, their expected payoff increases if they take risky actions that yield large payoffs in good states (Jensen and Meckling, 1976; Leland, 1998).

In our particular case, delaying Nataf's liquidation despite its failure on margin calls was a way to bet on a price reversal. If the position had been liquidated immediately, the associated loss could have wiped out a large part of the CCP's equity, which is bounded below by zero. With a small probability of price reversal, Nataf would not default and the CCP's equity would not be impaired. Similarly, favoring a settlement of positions based on Article 22 was a risky bet. If unsuccessful, the CLAM would have to settle positions based on market prices and face a potentially large equity impairment. Instead, if Article 22 applies, Nataf would again be saved and the CLAM would avoid any equity loss. Therefore, distortions near distress are consistent with risk-shifting.

A necessary condition for risk-shifting to exist is that the CLAM should be in the region where its equity value function is convex in the days preceding the closure of the market. Figure 9 shows that this is the case. Specifically, we use data on the CLAM's exposure to registered brokers to plot the market value of its equity as a function of the settlement price for outstanding positions. As discussed in Section 2, a CCP that is far from distress is indifferent to the settlement price of transactions, due to its matched book. This feature of a CCP capital structure prevails for settlement prices above 6,300 FRF per ton. Below this threshold, Nataf defaults and the CLAM is unlikely to recover any additional margin it calls. In this region, any additional loss is absorbed by the

CLAM through an impairment of its equity. At the settlement price on December 2nd, close to 6,200 FRF, the CLAM is making a loss of 8.1 million FRF, which its equity (31.8 million FRF) can absorb. For any settlement or liquidation price lower than 6,200 FRF, the CLAM's equity value is decreasing quickly. In case the settlement price is below 5,900 FRF, the market value of the CLAM's equity falls to zero. Therefore, around the close of the market, the CLAM was in the region where its equity value is convex. Furthermore, the first judicial decision by the Paris Commercial Court (on December 11th) reinforced the CLAM's view that betting on Article 22 could be a profitable strategy, since it upheld the minister's decision to close the market.

Why did risk-shifting incentives dominate incentives to preserve the CCP's charter value? The first main reason is that the CLAM had relatively little equity to absorb losses (see Panel B of Appendix Figure A3). The second reason is that the governance of the CLAM was relatively poor. Specifically, its governance was dominated by registered brokers with long positions and no interest in hedging. In particular, the President of the CLAM, Gérard Bauche, was a former broker, whose own brokerage firm was still operating, with a long (albeit small) position in sugar futures. Instead, theory suggests that preserving charter value of the CCP is more likely to be a concern for hedgers, since they derive more value from the continuation of clearing services. In this respect, the situation faced by the CLAM was similar to that described by Franks and Nyborg (1996), where inefficient liquidations arise if control rights are not given to creditors with the largest benefit from keeping the firm as a going concern.

5.4 Distorted incentives for brokers

Before turning to the impact of risk-shifting on CCP recovery and resolution decisions, we show evidence, on the brokers' side, of a distortion that resembles the one found for the CLAM. Specifically, brokers in the sugar market operate with almost-matched books: they execute orders on behalf of clients and take little or no exposures in their own name. When there are no concerns about the default of the CCP or of ultimate investors, brokers should be indifferent about the execution price that each investor obtains, since they

primarily act as intermediaries. Instead, when some investors are more likely to default, either because their account balance is closer to zero or the size of their position is larger, brokers may have an incentive to execute trades at prices that favor these investors, at the expense of other investors. If this is the case, investors closer to default get reduced margin calls, at the expense of solvent investors who can still pay margins.

To show evidence of such distortions, we use a record of all transactions executed by Nataf after sugar prices started to fall. These data, covering 5 trading days between November 22nd and November 28th, include the name of the counterparty, the volume and maturity of each transaction, as well as the execution price. There are 314 such trades, for 67 investors. Based on family names, we match these transaction data with data on the open position of each investor as of December 2nd, and with data on the account balance of each investor. This second dataset, collected by the Department of Commerce after the market closure, allows computing the average price at which investors bought or sold outstanding contracts. The characteristics of investors sending either buy or sell orders are compared with those of the entire client base of Nataf in Panel A of Table 4. Overall, retail investors with long positions whose orders were executed had been buying futures at a lower price than other investors, and therefore face lower losses. Surprisingly, we do not see a higher proportion of executed sell orders for distressed investors.

For a trade j executed on behalf of investor i at date t and with future maturity m, we estimate

$$\text{Exec. price}_{i,j,m,t} = \beta_0 \cdot \text{Exposure}_{i,t} + \beta_1 \cdot \text{Trade size}_{i,j,m,t} + FE_m + FE_t + \epsilon_{i,j,m,t}, \quad (4)$$

where *Exec. price* is the execution price of the trade and *Exposure* is a measure of investor i's exposure to the price collapse. *Trade size* controls for the size of each trade, expressed in number of tons. Finally, maturity and day fixed effects (FE_m and FE_t) are included, to isolate price dispersion within a given day and contract maturity.

We estimate Equation (4) separately for buy and sell transactions. We use two measures of investor exposure. First, the average execution price for the existing position of each trader. For an investor with a long position, a high average execution price for

existing trades means that his account balance is turning negative more quickly when sugar prices drop. Second, we use the size of an investor's existing position, expressed in number of contracts, as an additional measure of exposure. We do so because initial margin calls are proportional to the size of positions. If brokers distort execution prices to favor clients that are closer to distress, we expect higher measures of investor exposure to be associated with lower execution prices for buy orders and with higher execution prices for sell orders.

Estimates are collected in Panel B of Table 4. Evidence from buy orders is consistent with distortions in execution prices. Investors which are more exposed to the collapse in sugar prices are given significantly cheaper execution prices when buying sugar futures. This is true regardless of the variable used to measure exposure, and suggests that Nataf had incentives to help investors closer to distress. One potential concern is that the inclusion of both maturity and time fixed effects in a relatively small sample implies that our estimates are based on limited day-maturity variation. We highlight that most observations (47.8%) are concentrated on one day in which the limit down was not hit and that trading is itself concentrated within a few contract maturities (32.8% and 26.4% of trades for the March 1975 and the May 1975 maturities, respectively). Therefore, our estimates are based on sizable within maturity-day variation.

Evidence for sell orders is also consistent with the existence of distortions, since investors with a large exposure are given higher execution prices when selling. However, the estimate is statistically significant in only one case. There can be three reasons why results are weaker for sell orders. First, since sell orders correspond to investors liquidating their positions, the concern that they may default on their margin calls in the future is presumably smaller, so that incentives to distort execution prices are lower than for buy orders. Second, the number of observations for sell orders is smaller, so that tests may lack statistical power. Third, one may be concerned that buyers and sellers correspond to different pools of investors. In particular, investors selling are likely to be the most distressed investors, in which case we may expect stronger results for sell orders. This concern is not warranted, as Panel A shows: the pool of investors buying and selling

are extremely similar and, if anything, investors selling face lower losses than investors buying.

We further find evidence of a channel through which this effect is likely to work. In 1974, all trades by a broker within a given day were typically registered at the CLAM only at the end of the day. This practice allowed reshuffling counterparties across trades before novation, to favor certain counterparties at the expense of others. Anecdotal evidence collected by supervisors provide support to this explanation.[25]

5.5 Failed renegotiation plans

Next, we show that risk-shifting also induced the CLAM to reject renegotiation plans that could have enabled a quick reopening of the market. Indeed, after the closure of the market, a number of attempts to negotiate a recovery took place, initiated mostly by sugar professionals. In parallel, several lawsuits took place, in which judges were asked whether the closure of the market was legal, and thus whether Article 22 should apply for the settlement of existing positions. The main issue for the CLAM and all other parties was to find a settlement price for outstanding positions.

Renegotiation proposals were pushed by sugar professionals, represented by Marcel Varsano.[26] Together with the market's technical committee, they strongly opposed the implementation of Article 22. Therefore, margins called by the CLAM based on Article 22 were not paid, and no settlement price was agreed upon between the parties. Instead, Varsano proposed that sugar professionals buy the defaulted exposure of Nataf, and eventually that of other brokers in distress, at the settlement price on December 2nd, 6,217 FRF. This proposition was relatively generous, since this price was not market price, but a limit down price: therefore, sugar professionals would have been foregoing potentially large gains. Figure 9 shows that the equity loss for the CLAM would have been limited to 25.5% of its market capitalization.

[25] As a consequence of these concerns, the rules of the exchange after its re-opening in 1976 mandated the immediate registration of new trades with the clearinghouse.

[26] Varsano was both the president of the market's technical committee and the head of a large sugar dealing firm (*Sucre et Denrées*, which had a short position).

However, the CLAM refused this proposal, which proved to be a fatal decision. Under this proposal, the equity of the CLAM would have been impaired to a limited extent, but its default would have been avoided and the market could have reopened quickly. Instead, the CLAM acted as if the implementation of Article 22 would be upheld in court, and continued betting on it. If this article were to apply, the equity of the CLAM would not have been impaired at all. In the subsequent weeks, global sugar prices continued to fall (see Panel B of Figure 2). Therefore, sugar sellers revised their renegotiation proposal. Until the resolution came to an end, they maintained an offer to buy the defaulted position of Nataf, and eventually that of other brokers, at a price of 5,700 FRF, even after prices fell far below 5,700 FRF. This came to be known as the "Varsano proposal". Even though the proposal would have accelerated a reopening of the market, it was never accepted.

The rejection of renegotiation proposals can be seen as additional evidence in favor of risk-shifting. Indeed, the Varsano proposals can be seen as value-increasing outcomes that were rejected because the CLAM's managers, in the interest of equity holders, gambled for resurrection. Therefore, this result suggests a broader conclusion: weakly capitalized or poorly governed CCPs may fail to accept value-increasing renegotiation plans near distress.

5.6 The resolution of the CLAM

Finally, we briefly describe the resolution of the CLAM. The shift from a tentative recovery to a resolution plan occurred in June 1975. After a series of judicial procedures, described in Appendix Table A1, the initial decision of the minister of commerce to close the market was overturned by the Council of State. This implied that positions could not be settled based on Article 22, and therefore that the CLAM would not have sufficient equity to absorb losses under any plausible scenario. After that, an administrator was appointed by the government, in order to find an agreement on a settlement price and on a plan to share additional losses. We highlight three features of the resolution plan, which was approved by all parties in December 1975. Additional details on the allocation of losses are postponed to Appendix Table A3.

First, the positions of sugar future sellers were settled at a price of 6,017 FRF, i.e., 200 FRF below the price prevailing on December 2nd. At the time the plan was agreed upon, sugar prices had been further falling to a level of about 1,500 FRF per ton. Therefore, sellers forgo a large part of the gains they were entitled to. Second, the professional associations of sugar producers and of beet producers paid an additional 15 million FRF to make the final agreement feasible. This is consistent with the idea that members with an interest in hedging attach more value to the continuation of clearing services and are therefore willing to absorb a larger share of losses to obtain a quick reopening. Third, there was no direct cost incurred by the government, while large equity holders (banks and insurers) lost almost everything: they sold their shares for 1 FRF per share. Both facts are consistent with the idea that moral hazard due to bailout expectations was low for equity holders.

A natural question is whether the re-opening of the sugar market, more than a year after its closure, could have been accelerated if an administered resolution plan had been implemented earlier. Similarly, Duffie (2015) argues that a key question when a CCP fails pertains to when a resolution process should override contractual default management processes. Our analysis of risk-shifting in Sections 5.3 and 5.5 suggests that this is indeed the case. The incentives of the CLAM to reject renegotiation and to bet on Article 22 were arguably maximizing equity holders' expected value, but not total CCP value. This is a standard distortion due to risk-shifting problems. In this context, it is possible to hypothesize that a resolution authority maximizing total CCP value could have been beneficial through an earlier intervention.

6 Policy implications

Our study has important implications for current policy debates, even though the design and regulation of CCPs have partially changed over time.

6.1 CCP risk-shifting in the current context

Our case study shows that risk-shifting incentives in CCPs can be large. This is arguably still the case today. First, modern CCPs remain thinly capitalized relative to their largest potential clearing obligations (Duffie, 2015). Second, while the structure of CCP default waterfalls (i.e., loss allocation schemes in case of member default) now enables sharing losses with surviving members, which mitigates risk-shifting, other factors amplify the potential for risk-shifting in the current environment. Compared to the CLAM, some modern CCPs have become significantly larger, and are potentially "too-big-to-fail" (Tucker, 2013). To the extent policymakers provide implicit or explicit guarantees to CCPs, these guarantees create additional convexity in CCPs' equity value function. Relatedly, risk-shifting in our context was exacerbated by the CLAM's bet on Article 22. While this specific aspect of the Paris market may not exist today, similar distortive devices are widespread. Fundamentally, Article 22 amounts to an exogenous device that the CLAM could use to delay the declaration of Nataf's default and impairments to its own equity. Nowadays, expectations of bailouts for defaulting members could play a similar role: a CCP may find it optimal to delay the liquidation of a member's position, expecting that this member will soon be bailed out by a government. Finally, one may argue that the possibility to delay the liquidation of defaulted exposures is now restricted by regulation. However, a CCP engaged in risk-shifting could hide information to the regulator about the true actions it is taking in order to return to a matched book. Given these elements, current policies should consider the possibility of CCP risk-shifting as material.

To limit risk-shifting incentives, CCP could be better capitalized. However, given the size of cleared markets, it is unlikely that CCPs can operate with equity levels that completely rule out risk shifting. In this context, the governance structure of a CCP can also prevent risk-shifting near default. Our findings highlight the importance of two types of members: (i) hedgers, who value the continuation of clearing services, and (ii) liquidity providers, who derive little value from future clearing services. A governance structure that gives more weight to hedgers is less likely to allow for risk-shifting strategies. Furthermore, our findings have implications for the current debate on the trade-off between

rules and discretion in CCP management (see, for example, ISDA, 2015). While discretion over risk-management can enable the CCP to use more information about member's conditions, we show that managerial discretion can also be used to lower total CCP value. Thus, if risk-shifting incentives are large enough, a management of CCPs based on strict rules, near distress, can reduce expected default costs. Relatedly, our findings give ground to the idea that, if private attempts to negotiate a recovery are inefficiently distorted by risk-shifting incentives, the early intervention of a resolution authority is desirable. The current regulatory environment is evolving in this direction.

Part of the reason why risk-shifting incentives were large at the CLAM is because all losses were borne by equity holders. Instead, as mentioned, modern CCPs have richer pre-specified procedures to share losses with surviving members. In a typical case, only one tranche of equity is impaired before additional resources are called from members (e.g., replenishment of the default fund), or losses are directly imposed onto members (e.g., in case of contract tear-ups, see Duffie, 2015), before additional equity is impaired. In this case, equity holders share losses with CCP members, either fully or up to a pre-specified limit. An important question is whether such default waterfalls are sufficient to fully rule out risk-shifting. First, we stress that shifting losses to surviving members comes at a cost, since one of the main reasons to establish CCPs in the first place is to protect members against default losses. Second, imposing losses to equity holders is also necessary to give them "skin-in-the-game", i.e., incentives to properly manage the CCP. Thus, fully insulating equity holders from losses is unlikely to be efficient, even if it reduces risk-shifting. In practice, indeed, the resources of surviving members that can be impaired are often capped (e.g., limits on replenishment of default funds are widespread). Thus, while our study is silent on the optimal design of CCP capital structure, we show that potential risk-shifting incentives should be an important part of policy discussions even when default waterfalls are in place.

6.2 Design of margin requirements

Our results also have implications for the design of margin requirements. Current CCPs employ margining system that are more sophisticated than those used by the CLAM. For example, most modern CCPs adjust initial margin requirements for concentration risk, i.e., penalize large exposures. Our analysis gives support for this practice. However, our study also shows that crowded trades, i.e., correlated positions across members, regardless of the absolute size each member's position, can be a risk for CCPs. This point has recently been made in different contexts by Cruz Lopez et al. (2016) and Menkveld (2017). It remains highly relevant, since current margining methodologies compute margin calls on a member-by-member basis, regardless of correlated exposures across members.

Relatedly, our results highlight the need for CCPs to monitor the pool of ultimate investors in cleared contracts. This issue arguably remains extremely important today, for two reasons. First, the membership of CCPs is currently expanding quickly, to increasingly opaque institutions. For example, it is now common for asset managers or hedge funds (whose creditworthiness is hard to assess) to be CCP members. Second, the practice of client clearing is developing quickly: investors clear trades through a broker, implying that CCPs have limited oversight over these investors. In addition to membership requirements, margins can play a useful screening role: by asking for higher margins for more opaque investors, a CCP can exclude those who are financially more constrained, thus fragile.[27] Margining methodologies could be revised to incorporate these concerns.

7 Conclusion

CCPs are becoming critical institutions in post-crisis financial markets, due to regulatory requirements to centrally clear all standardized derivatives. In this paper, we conduct the first empirical study of the failure of a CCP. We argue that three main causes led to the failure of the CLAM in 1974. First, the composition of the pool of investors,

[27] The idea that higher collateral requirements can induce more constrained investors to exit the market is modeled by Rampini and Viswanathan (2010).

which comprised unsophisticated and non-diversified retail investors, implied that many defaults occurred when sugar priced dropped. Second, the CLAM failed to contain the growth of a large position by one of its member. Third, risk-shifting incentives dominated incentives to preserve the CCP's charter value. We finally show that these findings have important implications for current policy debates: policies should consider the risk of CCP risk-shifting, and improve the design of margin requirements.

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Table 1 – Descriptive statistics on sugar futures brokers and investors

This table provides descriptive statistics on sugar futures brokers and investors. Panel A describes registered commodity brokers (35 institutions) plus the London-based International Commodities Clearing House. Exposures are described as of December 2nd, 1974, i.e., the date on which the default of Nataf was declared, before the market was temporarily closed. Panel B describes individual investors, as reflected in sub-accounts opened and managed by brokers at the CLAM in the name of their individual clients. We consider that a broker/investor holds a long (resp. short) position if the number of future contracts bought is strictly larger (resp. strictly lower) than the number of future contracts sold, regardless of the market value of his portfolio. The total number of brokers/investors holding long and short positions, as well as the total number of brokers/investors realizing gains or losses, do not sum up to the total number of brokers/investors, due to the existence of accounts with a balanced position. See Appendix B for details on the data.

Panel A: Registered commodity brokers

	N. Obs.	% Obs.
Number of brokers + affiliated CCP	36	100.0
Of which:		
Foreign	6	16.7
Holding accounts on behalf of individual investors	18	50.0
Holding long positions on December 2nd, 1974	24	66.7
Holding short positions on December 2nd, 1974	12	33.3
Realizing losses given prices on December 2nd, 1974	11	30.6
Realizing gains given prices on December 2nd, 1974	22	61.1

Panel B: Retail investors

Number of investor sub-accounts with the CLAM	683	100.0
Of which:		
Holding long positions on December 2nd, 1974	566	82.9
Holding short positions on December 2nd, 1974	18	2.6
Realizing losses given prices on December 2nd, 1974	636	93.1
Realizing gains given prices on December 2nd, 1974	37	5.4

Table 2 – Event study around initial margin increases

This table performs an event study on the CLAM's stock price around increases in initial margin requirements in 1974. The date of the event is denoted τ and we focus on an event window covering five days before and after the event. Panel A estimates the main specification, using cumulative abnormal returns over the entire event window. Abnormal returns are computed using a one-factor market model estimated in the 300 trading days preceding each event window. Panel B provides a number of robustness checks. The first specification includes the large increase in margins of January 1974 as an additional event (see footnote 13 for a description of this event). The second specification uses abnormal returns estimated in the 300 trading days preceding the first event window. The third specification uses abnormal returns estimated using a 2-factor model, where the second factor is the return on an index for financial firms. p-values are in parentheses. *, ** and *** denote respectively statistical significance at the 10%, 5% and 1% levels. See Appendix B for details on the data.

Panel A: Baseline specification

	Cumulative abnormal return	95% confidence interval	p-value
$\tau - 5$	-0.001	[-0.014 ; 0.011]	0.590
$\tau - 4$	0.001	[-0.020 ; 0.021]	0.471
$\tau - 3$	-0.000	[-0.021 ; 0.020]	0.521
$\tau - 2$	-0.004	[-0.028 ; 0.020]	0.658
$\tau - 1$	-0.000	[-0.028 ; 0.028]	0.504
τ	0.006	[-0.025 ; 0.036]	0.336
$\tau + 1$	0.006	[-0.025 ; 0.036]	0.331
$\tau + 2$	0.013*	[-0.009 ; 0.035]	0.097
$\tau + 3$	0.017**	[0.001 ; 0.034]	0.022
$\tau + 4$	0.013*	[-0.005 ; 0.032]	0.067
$\tau + 5$	0.023***	[0.007 ; 0.039]	0.006

Panel B: Robustness checks

	Incl. January event		With pre-1974 beta		2-factor model	
τ	0.005	(0.125)	0.005	(0.152)	0.006	(0.141)
$\tau + 1$	0.008*	(0.063)	0.004	(0.179)	0.005	(0.130)
$\tau + 2$	0.015**	(0.013)	0.012**	(0.044)	0.013**	(0.031)
$\tau + 3$	0.017**	(0.032)	0.016*	(0.068)	0.017*	(0.055)
$\tau + 4$	0.014	(0.137)	0.011	(0.214)	0.013	(0.169)
$\tau + 5$	0.022**	(0.037)	0.020*	(0.075)	0.023*	(0.054)

Table 3 – Defaults by retail investors to Nataf

This table provides descriptive statistics on the default of retail investors via-à-vis Nataf. Panel A shows the distribution of average prices at which retail investors holding positions on December 2nd, 1974, bought sugar futures via Nataf. We also report the month in which this level of sugar prices was reached. Panel B shows the percentage of retail investors with negative balance under several price scenarios. Panel C displays the distribution of gains and losses by these investors under the same price scenarios. Settlement prices of 7,454 FRF/ton and 6,217 FRF/ton correspond respectively to the price mandated by Article 22 of the market's rulebook and to the price on December 2nd, 1974, when the market closed. The price of 5,917 FRF/ton is a settlement price that was discussed during the recovery and resolution phase. See Appendix B for details on the data.

Panel A: Average price paid by retail investors

	Min	10pc	25pc	50pc	Mean	75pc	90pc	Max
Average buy price	2,084	4,879	5,525	6,201	6,080	6,784	7,275	8,005
Month	Jan.	Oct.	Oct.	Nov.	Nov.	Nov.	Nov.	Nov.

Panel B: Share of investors with negative balance

	7,454 FRF/ton	6,217 FRF/ton	5,917 FRF/ton
Share of negative balances	0.043	0.496	0.582

Panel C: Distribution of gains and losses (in Th. FRF)

	Min	10pc	25pc	50pc	Mean	75pc	90pc	Max
Settlement price:								
7,454 FRF/ton	-36.6	28.7	77.1	138.9	464.1	281.1	605.6	31,061.8
6,217 FRF/ton	-25,534.1	-152.9	-62.9	2.3	-44.1	71.7	206.6	15,996.0
5,917 FRF/ton	-31,189.1	-208.8	-106.7	-31.9	-157.1	41.4	128.0	12,666.0

Table 4 – Execution price of orders by Nataf on behalf of its clients

This table regresses the execution price of orders by Nataf on behalf of its clients on measures of exposures by these clients to the collapse in sugar prices (Equation 4). Panel A shows characteristics of the pool of investors sending buy and sell orders. Investors sending both types of orders are in both pools. We also compare their characteristics with those of the entire pool of Nataf clients. To do so, we report the average price at which existing positions have been bought, as well as the gains or losses on December 2nd, 1974. Panel B shows regression estimates for buy and sell orders. The first measure of exposure is the average execution price of pre-existing trades for each client (Columns 1, 2, 4, and 5). It captures how quickly a client's balance turns negative when prices fall. The second measure of exposure is the size of an investor's pre-existing position, expressed in number of contracts (Columns 3 and 6). We include a measure of the size of each trade as a control variable. D and MAT correspond respectively to trading day and to contract maturity fixed effects. The sample period includes 5 days of trading between November 22nd and November 28th, 1974. p-values are in parentheses. *, ** and *** denote respectively statistical significance at the 10%, 5% and 1% levels. See Appendix B for details on the data.

Panel A: Pool of investors

	Min	10pc	25pc	50pc	Mean	75pc	90pc	Max
Average buy price (in FRF/ton)								
All investors	2,084	4,879	5,525	6,201	6,080	6,784	7,275	8,005
Investors buying	2,084	3,894	4,776	5,749	5,526	6,517	6,813	7,743
Investors selling	3,784	3,976	4,775	5,634	5,591	6,228	7,298	7,572
Gain/loss (in Th. FRF)								
All investors	-25,534.1	-152.9	-62.9	2.3	-44.1	71.7	206.6	15,996.0
Investors buying	-25,534.1	-170.7	-34.6	58.5	-73.7	238.4	562.0	15,996.0
Investors selling	-25,534.1	-74.9	11.7	67.2	-192.8	190.9	301.7	15,996.0

Panel B: Regression on buy orders

	Dependent variable: Execution price					
	Buy orders			Sell orders		
Average buy price of existing trades	-0.019** (0.014)	-0.015** (0.029)		0.033 (0.115)	0.059** (0.039)	
Size of existing position			-0.204*** (0.000)			0.238 (0.482)
Trade size control	No	Yes	Yes	No	Yes	Yes
N. Obs.	68	68	74	33	33	39
R^2	0.134	0.185	0.419	0.004	0.051	0.040
Fixed effects	D, MAT	D, MAT	D, MAT	D, MAT	D, MAT	D, MAT

Figure 1 – Schematic representation of the clearinghouse

This figure provides a schematic representation of the clearing process in the Paris Commodity Exchange. Sellers and buyers of sugar futures are represented respectively in green and pink. Based on the most common exposures observed in the data, sugar professionals are sellers and retail investors are buyers. Each broker or professional participant holds a deposit account on the balance sheet of the CLAM, represented by a square. This account is used to pay initial and variation margins. Retail investors, or clients, trade through a registered broker. They may either pay margin through the main broker account (Clients 2, 3 and 4) or hold a separate sub-account in their name in the books of the CLAM (Client 1). Sub-accounts are opened at the demand of brokers and managed by them.

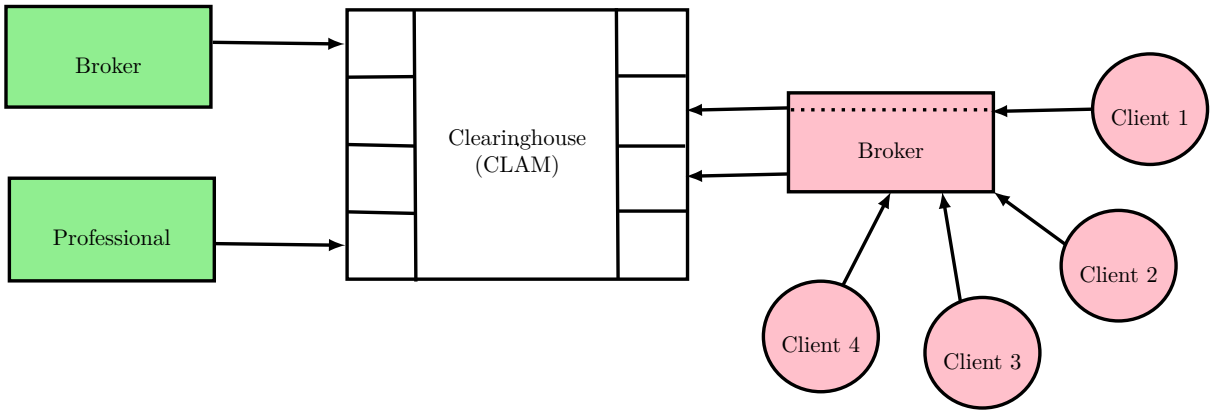
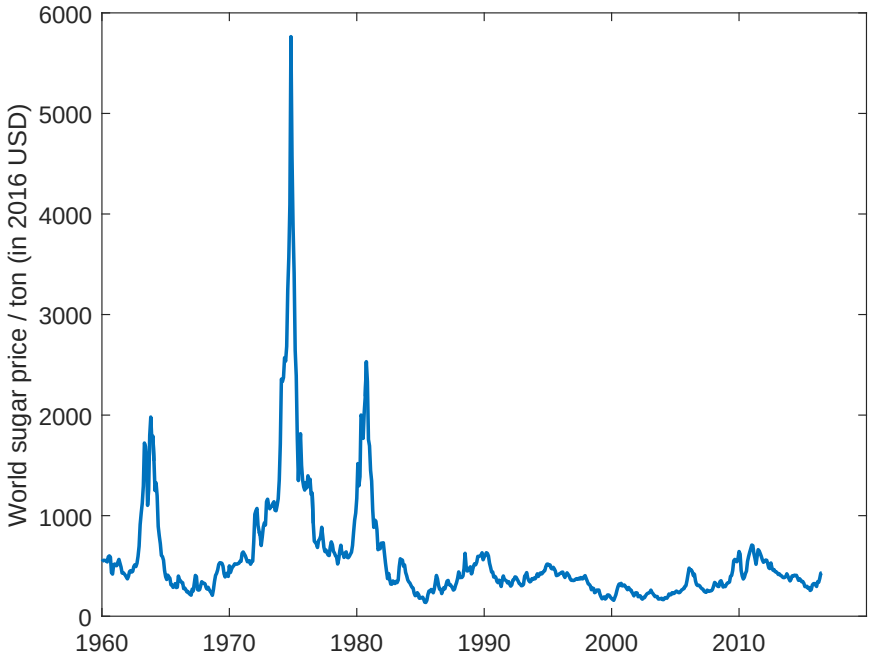


Figure 2 – Sugar price

This figure plots the price of sugar. Panel A plots the world sugar price in the spot market over the 1960-2016 period, at a monthly frequency, expressed in 2016 USD per ton. Data are obtained in nominal terms from the World Bank Global Economic Monitor Database, and converted to real terms using the US consumer price index obtained from the Saint-Louis Federal Reserve's FRED database (series identifier: CPIAUCSL). Panel B plots the spot and nearest-term future sugar prices in Paris over the period from January 1973 to June 1975, at a daily frequency, in current FRF per ton. The dashed vertical line corresponds to December 2nd, 1974, when the default of Nataf was declared. Data are collected from *Les Echos*. See Appendix B for details on the data.

Panel A: World sugar price, 1960-2016



Panel B: Spot and future prices in Paris, 1974-1975

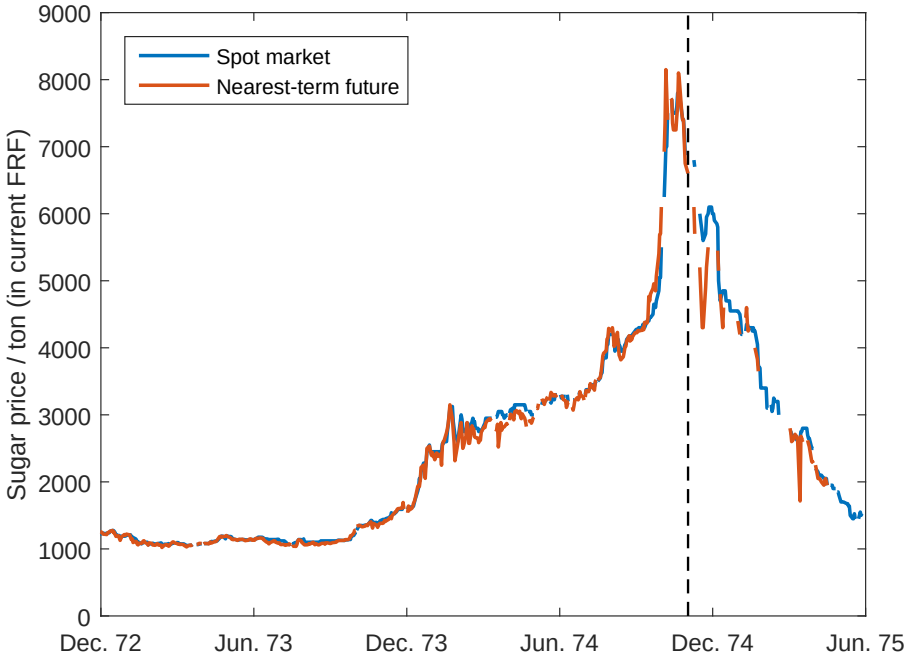
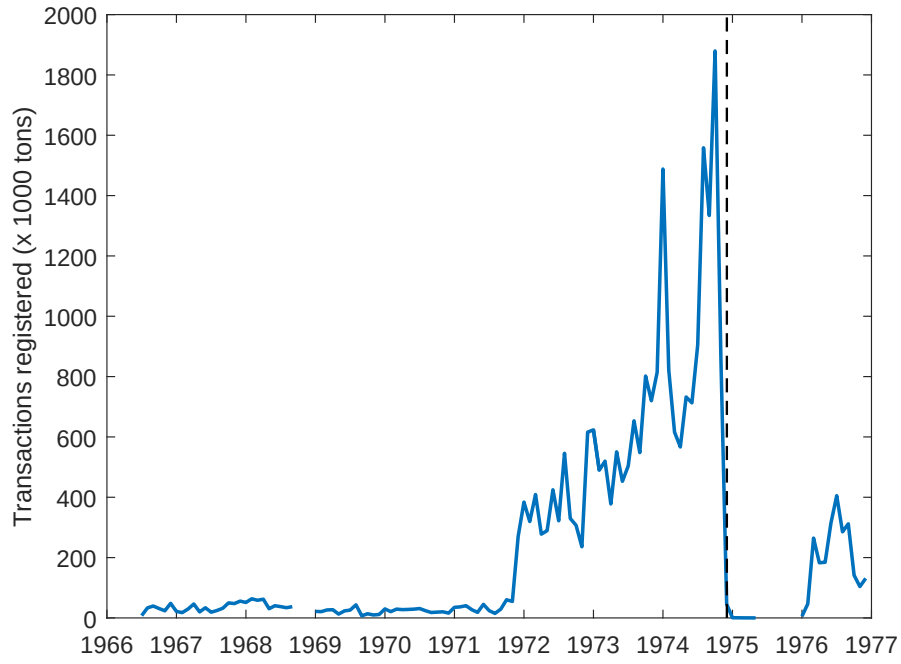


Figure 3 – Transactions registered by the CLAM, 1966-1977

This figure plots the volume of transactions in the Paris Commodity Exchange, registered at the CLAM. Data are at a monthly frequency over the 1966-1977 period. Panel A plots the number of transactions registered in the white sugar market after the introduction of the main future contract ("contract n^{o}2") in July 1966. The transaction volume is expressed in thousand tons of white sugar. Panel B plots the number of transactions registered in the cocoa and coffee markets, expressed in thousand tons. Trading on coffee futures started in December 1972. Starting in 1976, data correspond to transactions registered at the *Banque Centrale de Compensation*, the successor of the CLAM. In both panels, the dashed vertical line corresponds to December 2nd, 1974, when the default of Nataf was declared. See Appendix B for details on the data.

Panel A: Sugar market



Panel B: Coffee and cocoa markets

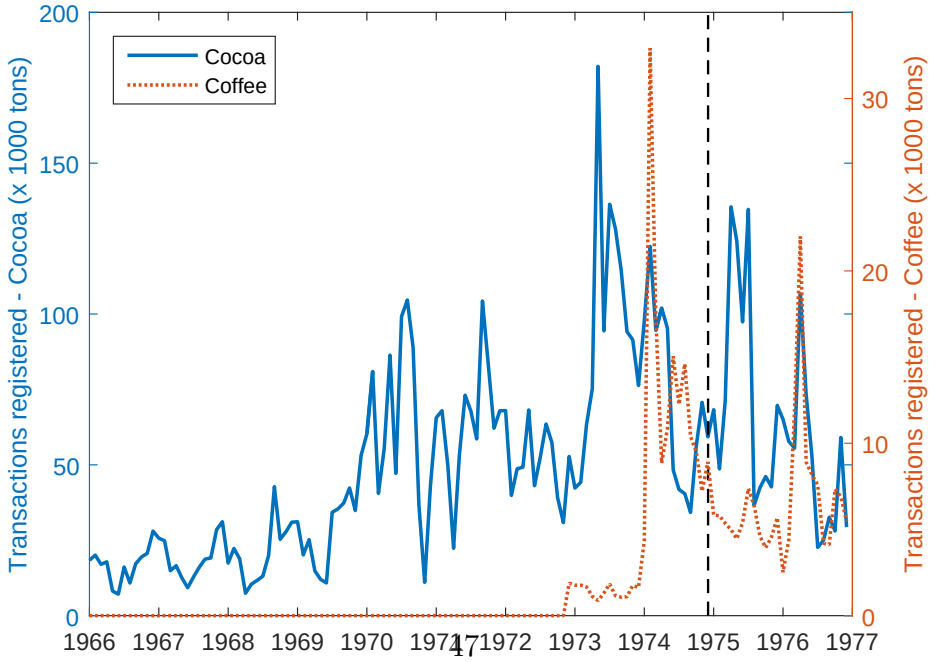
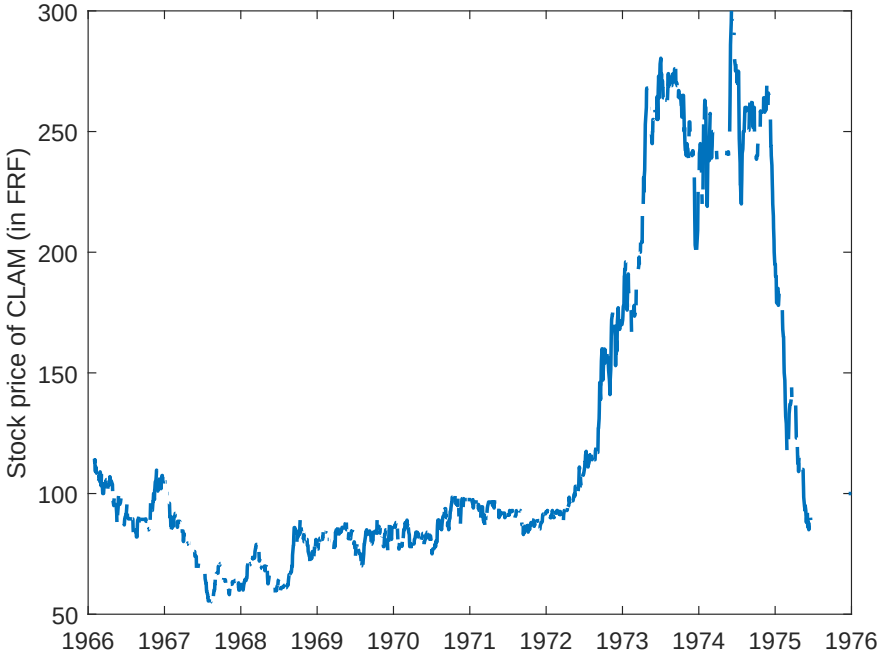


Figure 4 – Stock price of the CLAM

This figure plots the stock price of the CLAM at a daily frequency. Panel A plots the stock price over the period from February 1966 to December 1975. Blank spaces correspond to days on which there is no trading recorded and no available data on bids and asks. Panel B plots the CLAM's stock price from January 1974 to May 1975. The shaded area corresponds to a period of strike in the Paris Stock Exchange, during which there are no quoted prices (28th March to 8th May 1974). The first vertical line (21st November 1974) corresponds to the highest sugar price and the second vertical line (2nd December 1974) corresponds to the failure of Nataf, which leads to the closure of the sugar futures market. See Appendix B for details on the data.

Panel A: Stock price over 1966-1975 period



Panel B: Stock price around the CLAM failure

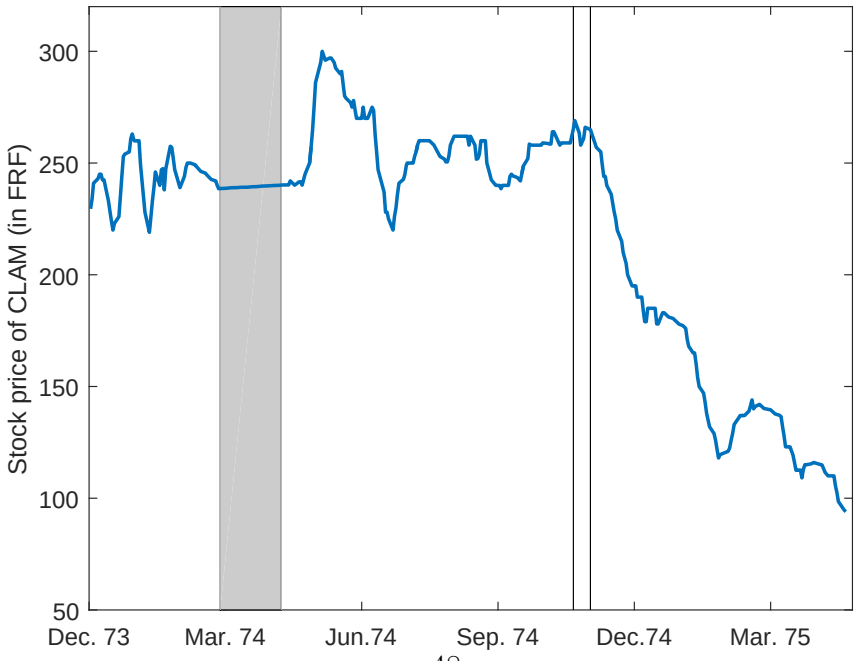
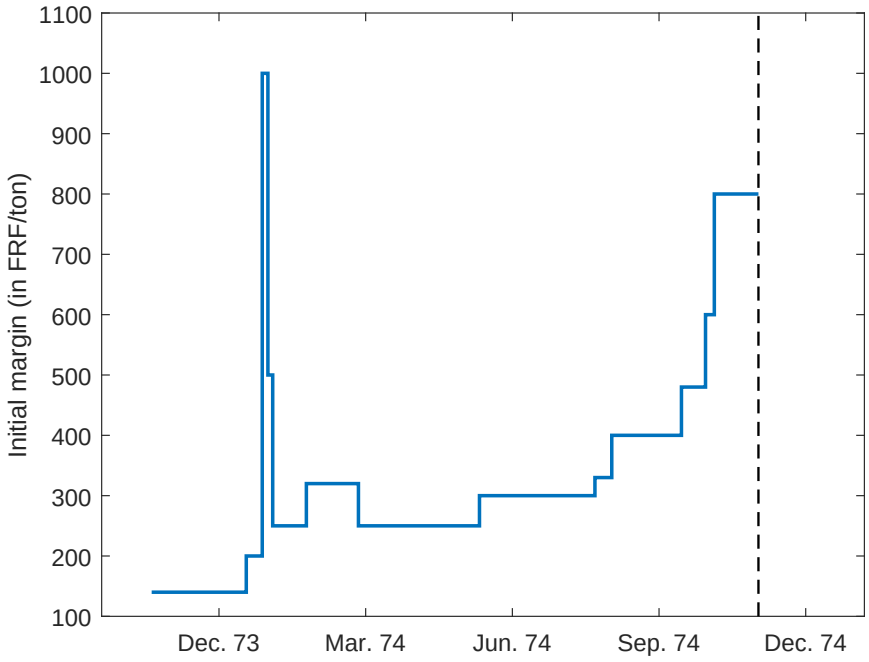


Figure 5 – Initial margin requirement in 1974

This figure plots the initial margin requirement set by the CLAM from November 1973 to early December 1974. Panel A plots the absolute level of initial margin required, expressed in FRF per ton or sugar. Panel B normalizes this margin requirement by the price of the nearest-term sugar future in the Paris market. In both panels, the dashed vertical line corresponds to December 2nd, 1974, when the default of Nataf was declared. See footnote 13 for a description of the unusual increase in margins in January 1974. Data on initial margin requirements are obtained from documents in the National Archives, and data on future prices from *Les Echos*. See Appendix B for details on the data.

Panel A: Initial margin per ton of sugar



Panel B: Initial margin over sugar price

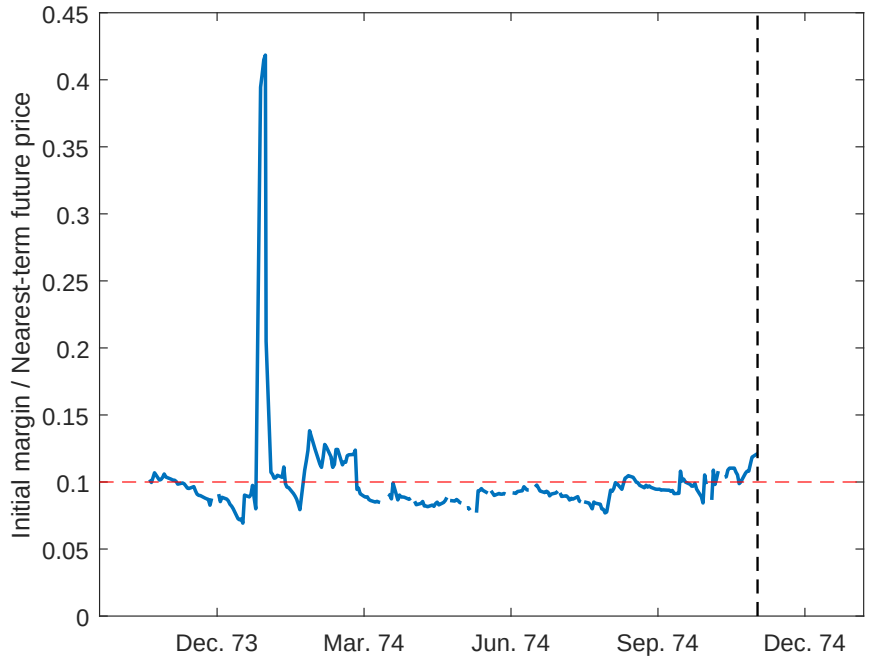
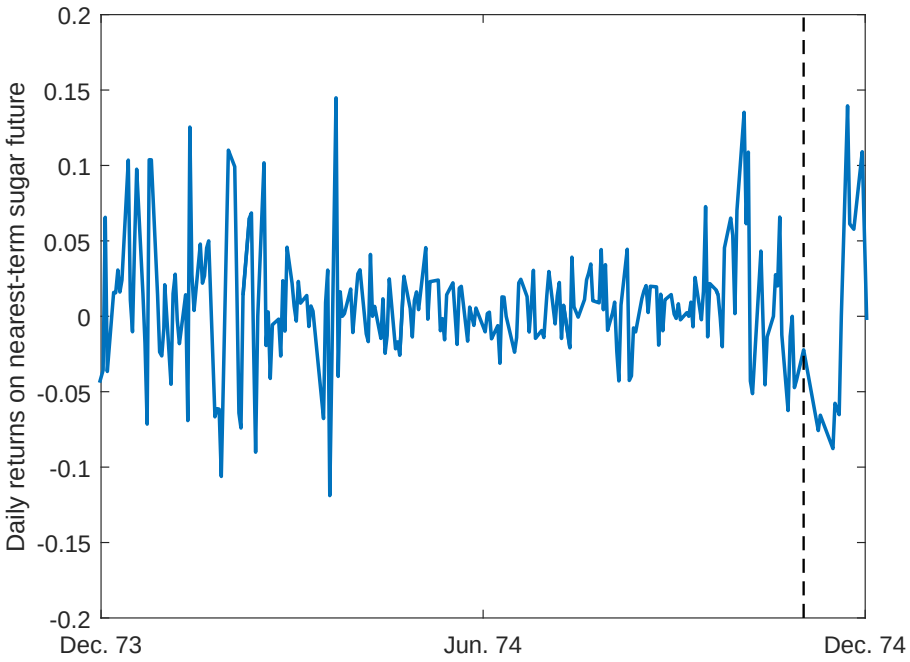


Figure 6 – Volatility and Value-at-Risk

This figure displays the volatility of sugar prices and the Value-at-Risk (VaR) of the CLAM. Panel A plots daily returns on the nearest-term sugar future contract in the Paris Commodity Exchange, between January 1974 and December 1974. In Panel B, we plot the 98% VaR at a daily frequency, normalized by the CLAM's initial margin requirement. The VaR is computed each day using sugar price data on the last 200 trading days. In both panels, the dashed vertical line corresponds to December 2nd, 1974, when the default of Nataf was declared. Data on initial margin requirements are obtained from documents in the National Archives, and data on future prices from *Les Echos*. See Appendix B for details on the data.

Panel A: Daily returns on nearest-term sugar future



Panel B: Value-at-Risk / Initial margin requirement

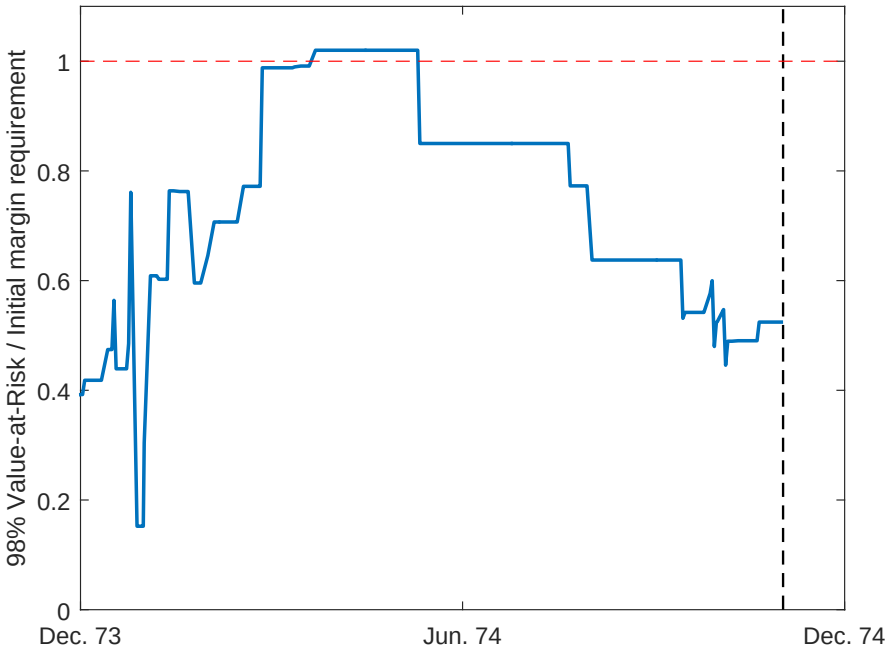
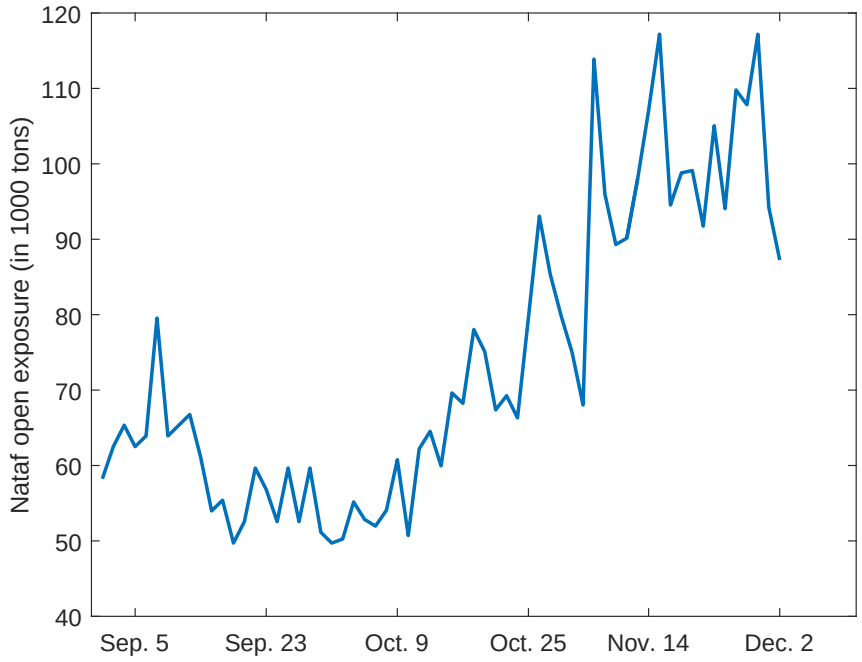


Figure 7 – Build-up of Nataf's position

This figure illustrates the build-up of Nataf's long position in sugar futures. Panel A shows the open position in number of Nataf in tons of sugar, and Panel B the share of this position relative to the open position of the CCP. The open position of the CCP corresponds to the net volume of physical sugar or the monetary amount that would change hands if all positions were to be settled on a given day. Nataf's position is approximated using data on initial margins required. We ensure that our approximation is equal to known values of the position as of end-September, end-October and end-November. See Appendix B for details on the data.

Panel A: Open position by Nataf (in 1000 tons)



Panel B: Share of Nataf position to CCP position

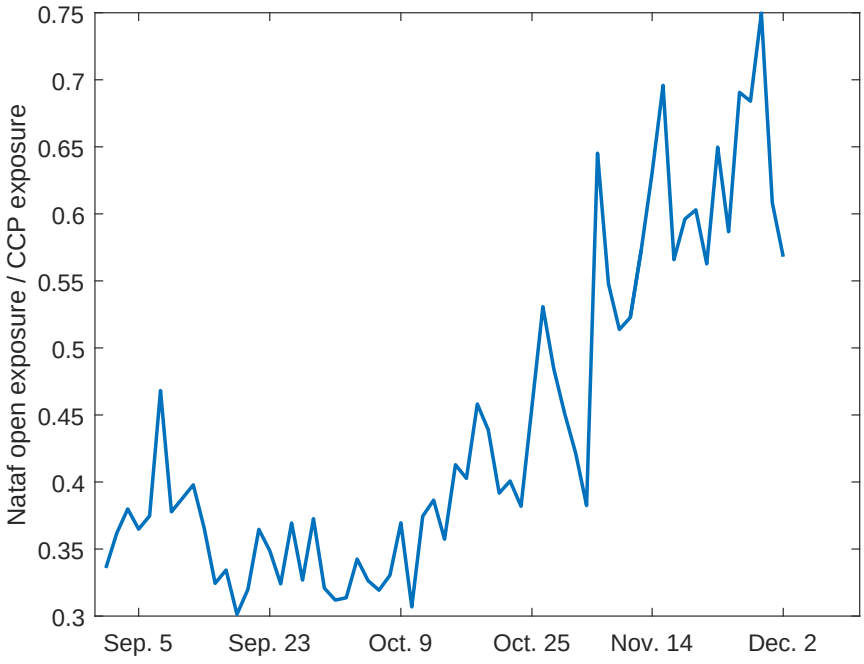
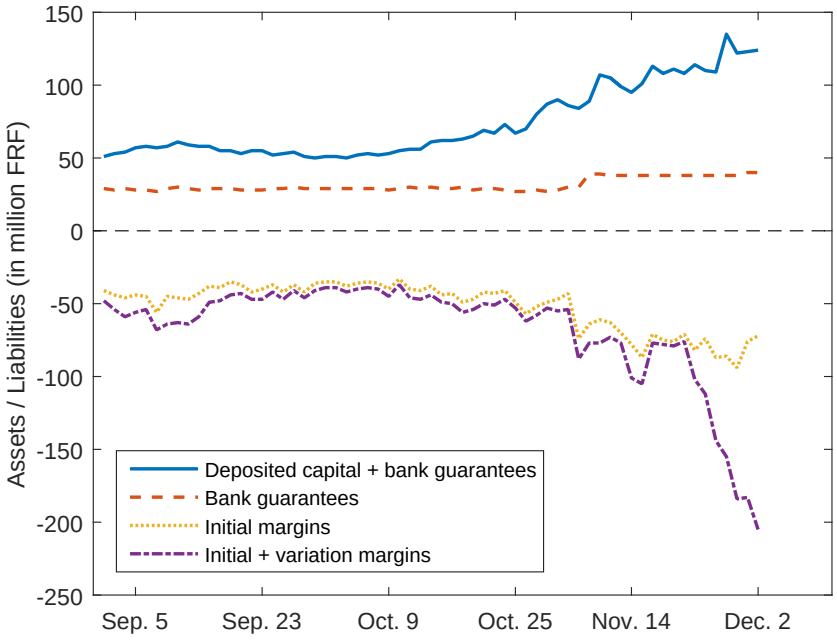


Figure 8 – Balance on Nataf's account (September - December 1974)

This figure depicts Nataf's account at the CLAM in the three months preceding its default, from September 2nd to December 2nd, 1974. Panel A breaks down the assets used to meet initial and variation margins. Assets comprise bank guarantees (red line) and deposited capital, i.e., cash (difference between the blue and the red lines). These assets are used to pay for initial margins (yellow line) and variation margins (difference between the yellow and purple lines). Panel B plots the balance on Nataf's account (in blue). The balance is defined as in Equation (1). The red line plots Nataf's balance under the assumption that initial margins can be used to meet variation margins call. The vertical line corresponds to November 21st, when sugar prices reached their highest level. Data are obtained from the archives of the Paris Chamber of Commerce. See Appendix B for details.

Panel A: Breakdown of Nataf's account at the CLAM



Panel B: Balance on Nataf's account at the CLAM

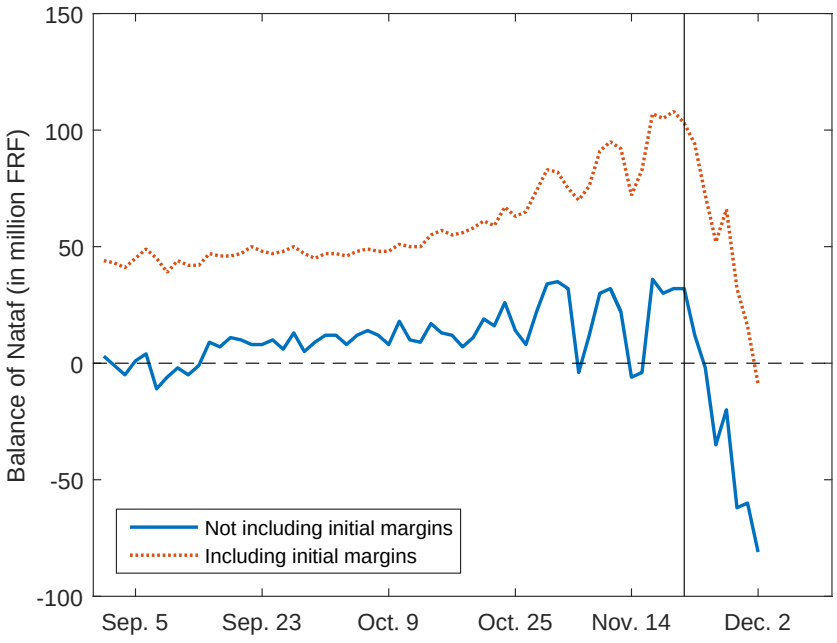
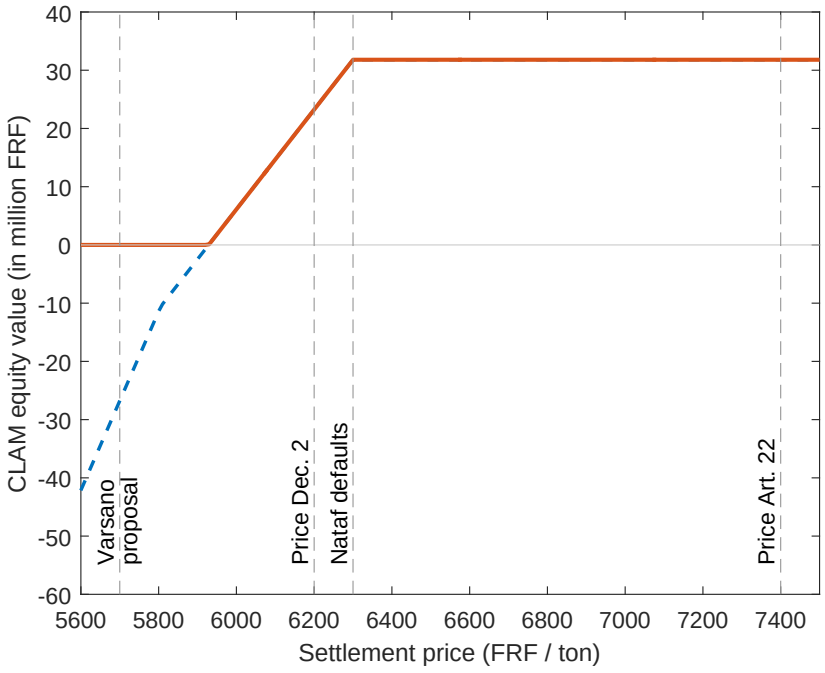


Figure 9 – Equity value of the CLAM

This figure plots the market value of the CLAM's equity, in million FRF, as a function of the settlement price for outstanding exposures on December 2nd, 1974. The calculation of the equity market value is based on the CLAM's stock price on December 2nd, 1974. For any settlement price above 6,300 FRF (including the price mandated by Article 22 of the sugar market's rulebook, i.e., 7,400 FRF), the balance on Nataf's account is positive and it does not default. For a settlement based on the price prevailing on Dec. 2nd (6,200 FRF), the CLAM incurs a loss of 8.1 million FRF but does not defaults. For any settlement price below 5,920 FRF, the loss due to Nataf's default is larger than the CLAM's equity. In this region, the blue line plots total losses incurred by equity, while the orange line plots the equity value under limited liability. A second kink at 5,820 FRF corresponds to the default of additional registered brokers if prices fall below this threshold. The implementation of the Varsano proposal (settlement at 5,700 FRF) does not allow the CLAM to absorb losses. See Appendix B for details on the data.



A Additional institutional description

This appendix provides additional institutional details on the Paris Commodity Exchange and on the CLAM. A more general description of the exchange can be found in Tardieu and Porteu de la Morandière (1974), Saclé and Goldschmidt (1974), Menu (1980) and Simon (1981).

Price fluctuation limits

The Paris Commodity Exchange featured price fluctuation limits, called "limit-up" and "limit-down". In any given trading day, all transactions had to be executed within these price limits, defined with respect to the previous day's settlement price. Until November 1974, limits up and down on sugar contracts were close to proportional to the level of settlement prices. For a price below or equal to 250 FRF, the limit was 25 FRF; within the {251 FRF, 450 FRF} bucket, it was 35 FRF; within the {451 FRF, 650 FRF} bucket, it was 55 FRF, and so on. Starting on November 8, 1974, the proportional limit was changed to a constant limit of 300 FRF per trading day. Since future prices on that day (for the nearest-term delivery) were 7,400 FRF per ton, the proportional limit was 745 FRF. Therefore, the change substantially narrowed price fluctuation limits. Similar limits still exist on most commodity future exchanges worldwide.

Membership requirements

The CLAM did not have membership requirements that it could directly control. However, there were indirect membership requirements, since clearing members (with few exceptions) had to be registered brokers. Becoming a registered broker required demonstrating sufficient financial strength. The precise nature of the requirements was managed by the professional association of registered commodity brokers (*Compagnie des commissionnaires agréés*). Among other requirements, registered brokers needed to show sufficient financial strength, with an equity of at least 1 million FRF. This requirement has been raised several times in the years preceding the sugar crisis.

Default fund

The CLAM did not have its own default fund. Separately, the professional association of registered commodity brokers managed a fund aimed at protecting individual investors against the default of their broker (*Caisse Mutuelle de Garantie*). Indeed, brokers did not post margin to their clients. The minimum amount held within this fund was 5 million FRF, and its maximum amount was 50 million FRF. An above limit is in place to ensure that surviving members do not assume unlimited liabilities for the default of other members. When the fund is replenished, contributions are proportional to the turnover of each member over the past 12 months.

Clearing fees

To register a transaction, the CLAM charges a fee per ton of sugar. Clearing fees do not depend on the level of sugar prices. In addition to clearing fees, a tax is also levied on each trade, equal to 1/10,000 of the notional value of each transaction.

Bank guarantees

The use of bank guarantees to cover margin payments was widespread. In a typical arrangement, a registered broker brings to the CLAM a letter of credit by which a bank commits to meet the broker's payments upon demand, for a certain period of time and up to a limit. When bank guarantees are used, the CLAM earns interest on the amount drawn. The CLAM can decide to refuse certain bank guarantees. For example, in the third quarter of 1974, it put a cap on the guarantees that could be provided by one bank (*Banque Vernes et Commerciale de Paris*), which had issued letters of credit for an amount greater than its equity. Based on data covering all brokers after the closure of the market, we find that 28 out of 35 brokers were pledging bank guarantees to the CLAM, for a total amount of 384 million FRF. In contrast, the use of securities to meet variation margin calls was extremely limited. Only one broker was posting securities to the CLAM, for an amount of 350,000 FRF.

Position limits

The CLAM did not enforce limits on the position that each registered broker could take. Throughout the history of the exchange, it was often the case that a few registered brokers concentrated a large share of the open position. To understand how such exposures are built, it should be reminded that, to an overwhelming extent, registered brokers do not trade on their own account, but on behalf of clients, for which they execute orders. A broker increases its share of the open position not by building up its own exposure, but by attracting more trading orders from investors. While Nataf attracted a large number of orders, there is no evidence that its commercial practices were different from that of other brokers.[28] Due to their role of intermediaries for the execution of orders, registered brokers have balance sheets that resemble that of a CCP, with almost-matched books, and with a net open position usually equal to zero or small. Also note that the share of the open position of a registered broker within the open position of the clearinghouse varies not only because a clearing member increases trading, but also because other members close positions or reduce trading. This factor partly explains the growth of Nataf's position.

Board

Even though the CLAM is a private corporation, its board of directors did not primarily represent its equity holders. This is a consequence of the fact that the CLAM had a monopoly status and operated as a public utility for the Paris Commodity Exchange. According to its statutes, its board is composed of 12 members, which should receive the approval of the Department of Commerce. These members comprised four registered brokers, five representatives of commodity professionals, and three representatives a large banking groups. A representative of the Department of Commerce attended all board meetings.

[28] In subsequent judicial cases opposing investors to brokers about fraudulent practices or false advertising, Nataf is under-represented relative to other brokers.

Exchange governance and supervision

The governance and surveillance of the Paris Commodity Exchange are decentralized. A technical committee (*comité technique*), comprising both registered brokers and representatives of other market participants, ensures that transactions take place according to the market's rule book. Furthermore, the Paris Chamber of Commerce is in charge of the overall surveillance of operations. The government's involvement, through the Department of Commerce, is limited to one representative seating in several committees of the exchange.

B Data sources

Documentation and data are obtained from several archive sources.

- **Archives of the French Department of Commerce**, located in the National Archives in Pierrefitte-Sur-Seine (*Archives nationales*), in particular files 19910031/1 to 19910031/23 (*Commerce et Artisanat ; Direction du commerce intérieur ; Sous-direction activités commerciales; Marchés à terme de marchandises, 1939-1989*). These archives contain a large number of documents, including legal and statistical information on the Paris Commodity Exchange, confidential policy briefs, reports and preparatory notes from meetings involving officials at the Department of Commerce. It also contains copies of original documents produced by the CLAM and by Nataf. A large number of judicial documents are also obtained.

- **Archives of the Paris Chamber of Commerce** (*Chambre de Commerce et d'Industrie de Paris*), located in Paris. Most of the relevant documents are in boxes numbered 135-W. They contain a large variety of legal and statistical information, as well as notes and reports. Since the Chamber of Commerce was involved in the supervision of the Paris Commodity Exchange, we also find a number of supervisory reports pertaining to registered brokers.

- **Archives of the French Ministry of Finance** (*Centre des Affaires Economiques et Financières*, or *CAEF*), located in Savigny-le-Temple. We hand-collect daily stock market data for the CLAM, from February 1966 to December 1975, including the stock price, dividend payments, and the number of shares outstanding. We consistently use the ex-dividend stock price. When there are no transactions on a given day, we instead use bids or asks (8% of observations). A stock price for the CLAM is available before 1966. However, the main white sugar future contract (so-called "contract n°2") did not trade before July 1966. All stock price data are from the *Cours authentique et officiel*, the daily newspaper published by the professional association managing the Paris Stock Exchange (*Compagnie des agents de change*).

From the same source, we also collect daily data on stock market indices for the overall market and for the financial sector, over the 1972-1975 period. From the CAEF, we finally collect a few notes on the sugar crisis in boxes numbered 1A-0000371/1 and 2, and 1A-0000204/1.

- **Archives of the Bank of France** (*Banque de France*), located in Paris. We obtain supervisory reports produced by the Bank of France about the CLAM. This includes a detailed report by J. Le Poupon (*Commission de Contrôle des Banques*, 22 April 1975), and a number of other notes. The archives also contain detailed balance sheet data for the CLAM, at a quarterly frequency, and over an extended period of time, as well as many annual reports by the CLAM.

- **National Library of France** (*Bibliothèque nationale de France*), located in Paris. From the economic newspaper *Les Echos*, we hand-collect daily data on spot and future sugar prices in the Paris, London and New York commodity markets. Prices are broken down by the maturity of each contract. These data are collected for years 1974 and 1975.

- **French Economic, Social and Environmental Council** (*Conseil économique, social et environnemental*), located in Paris. We obtain the report by Menu (1980) in original form, as published in the *Journal Officiel*, the official gazette of the French Republic.

C The 1974 sugar shortage in newspapers

This appendix illustrates the worldwide shortage of physical sugar in 1974 by reproducing an article published in the New York Times on November 6, 1974 (Figure A1). This article discusses the shortage in the UK. Similar newspaper articles were extremely common throughout the second semester of 1974 in the US, the UK, France and other countries. Among other statements, one can read

> *"An acute shortage of sugar has spread through Britain, prompting panic buying in some areas and widespread hoarding. Prices of sugar around the world have more than doubled in the last few months, but with the increasing problem here, travelers have been discovered "smuggling" packets into the country, hiding sweetener in their clothing — even though it is not contraband."*
>
> *"The shortage has spread to breakfast cereals. Sugar-coated varieties are in great demand, "but you can't find them any more," said one house wife here. [...] At the same time, a delegation of housewives was granted permission to inspect the Tesco warehouses to determine whether the company was stockpiling sugar while awaiting higher prices. The group said tonight that no evidence of stockpiling had been found."*

Furthermore, one can read on the picture, taken in a London supermarket, *"Please limit your total purchases to 2lb of ANY sugar."*

Figure A1 – New York Times article on the 1974 sugar shortage

Union-Induced Delivery Ban Adds to Ills

By TERRY ROBARDS
Special to The New York Times

LONDON, Nov. 5—An acute shortage of sugar has spread through Britain, prompting panic buying in some areas and widespread hoarding.

Prices of sugar around the world have more than doubled in the last few months, but with the increasing problem here, travelers have been discovered "smuggling" packets into the country, hiding sweetener in their clothing — even though it is not contraband.

The shortage here is partly related to an ongoing debate over sugar supplies in the European Economic Community and is being viewed by some consumers here as further evidence that Britain is not benefiting from membership in the Common Market.

Shoppers paid about 12 cents a pound in supermarkets three months ago, but now find prices as high as 32 cents a pound and the shelves often bare. Price increases occur almost daily and many stores are holding sugar supplies in reserve for regular customers.

The shortage has spread to breakfast cereals. Sugar-coated varieties are in great demand, "but you can't find them any more," said one house wife here.

Sir John Cohen, chairman of the big Tesco Stores, Ltd., supermarket chain, called today for the Government to consider rationing as a way to conserve existing suppies. He said he had been in touch with Shirley Williams, Secretary for Prices and Consumer Protection, about possible rationing and would speak with other officials.

Ate the same time, a delegation of housewives was granted permission to inspect the Tesco warehouses to determine wheth er the company was stockpiling sugar while awaiting higher prices. The group said tonight that no evidence of stockpiling had been found.

The National Consumer Protection Council, an action group consisting mostly of housewives, called Monday for sugar rationing to soften the impact of a union-imposed delivery stoppage. "The housewife has already had enough trouble over sugar," a spokesman said.

The scarcity had been intensified on Monday when workers forced Tate & Lyle, Britain's largest sugar refiner, to halt deliveries in most of England. The two-week blockade was in protest against what they fear will be rising imports from the Common Market and a subsequent loss of jobs in the refining industry here.

Tate & Lyle's Silvertown plant in London's East End, which produces some 22,000 tons of sugar weekly, supplies half of this nation's needs and is said to be one of the world's largest refineries. Deliveries from there were banned as of Monday morning.

John Edmunds, director of

Continued on Page 67, Column 6

Syoma/Selwyn Tait

Shelves that used to be filled with sugar are nearly empty at many supermarkets in Britain. Signs in this London store urge shoppers to limit purchases to two-pound bag.

Sugar Shortage Is Acute in Britain as Prices Soar

Continued From Page 65

the General and Municipal Workers Union that imposed the blockade, said its purpose was to "stiffen the resolution" of Frederick Peart, Agriculture Minister, in his dealings with the European Community.

Ruling Scheduled

The Common Market is scheduled to issue a ruling in two weeks on whether sugar imports should be allowed from such Commonwealth countries as Australia. A previous agreement on Australian imports has already been set aside.

The British Government has fully accepted the worker's contention that imports of refined sugar from the Common Market should not be substituted for the raw sugar imports on which the refinery workers depend for their jobs, according to a spokesman for the Ministry of Agriculture.

Mr. Edmunds also explained that "Our action is in the nature of an ultimatum to the company. We have told them we are prepared to produce and pack the sugar, but they must put it into stock and not deliver it. The company has been told that if they start delivering, apart from special cases like hospitals, then further action will take place."

The delivery stoppage has occurred at a critical moment, when sugar supplies already were extremely short due to worldwide increase in demand and a relatively inelastic supply. Many Britons have been hoarding for months and reports of 50-pound caches are not unusual.

Leonard Reeves-Smith, chief executive officer of the British Food and Drink Federation, called the blockade "the most irresponsible act that one can imagine in the present situation."

"Both the trade and the public have been bedeviled with the sugar situation for months," he added. "We have managed to keep going through a difficult period, but it leaves me speechless that anyone can further exacerbate the situation."

A spokesman for Tate & Lyle said damage to food and soft drink companies from the sugar stoppage could be serious indeed.

D Event study - Robustness tests

We discuss the robustness of the results of the event study from Section 4.4. Panel B of Table 2 shows robustness to a number of alternative specifications.

First, the results are robust to including the large increase in margins decided in January 1974 (Column 1). Second, a potential concern is that abnormal returns are incorrectly estimated since, for a given event, the estimation window includes the stock price around previous events. To address this concern, we estimate a unique market model in the 300 days prior to the first event, during which there was no change in margin requirements, and find similar results (Column 2). We also check that our results hold when estimating abnormal returns using a 2-factor model, where the second factor is an index of returns on financial firms (Column 3). Finally, since our estimation relies on a small number of events, we check in unreported regressions that our results are robust to the exclusion of each individual event.

One last potential concern pertains to the interpretation of the results. Since equity holders should react to the announcement of more stringent risk management, it might be expected that the stock price jumps on the event day. Instead, our estimates suggest an incorporation of the news within stock prices over several days. A likely explanation is that the liquidity of the stock was limited, so that the speed at which information could be incorporated into prices was reduced. Indeed, the CLAM's shares were registered shares, which are more costly to trade. Furthermore, a significant fraction of the equity base was held by blockholders who did not trade on a day-to-day basis (see Appendix Table A2).

Table A1 – Timeline of events during the 1974 sugar crisis

Date	Event
21 Nov. 1974	Sugar prices hit their highest level, 8,150 FRF/ton.
21 Nov. - 2 Dec. 1974	Sugar prices hit the limit down 7 times. Long investors cannot close their open positions. Brokers cannot liquidate positions of investors not responding to margin calls.
2 Dec. 1974	A broker holding 56.8% of the (long) open position, Maurice Nataf, is declared in default. Other brokers are close to default.
3 Dec. 1974	The quotation of future prices is suspended by the minister of commerce, with the support of the CLAM and of the professional association of registered brokers. They invoke Article 22 of the sugar market's rule book. According to this article, if quotations are suspended due to exceptional circumstances, existing trades must be cleared based on the average settlement price prevailing over the past 20 trading days. The market's technical committee opposes the suspension of trading.
5 Dec. 1974	The market re-opens. The CLAM announces on Dec. 6th that it will not register new trades before a settlement price for existing positions is fixed by the technical committee.
11 Dec. 1974	The Paris Commercial Court (*Tribunal de commerce*) validates the suspension of trading and the settlement of existing positions based on Article 22. The average price over the past 20 trading days (7,459 FRF for the March 1975 maturity) is higher than the settlement price prevailing on Dec 2nd (6,217 FRF). This decision favors investors with long positions against hedgers (short positions). Based on this settlement price, both Nataf and the CLAM would not default. Therefore, both defend the implementation of Article 22. After the decision of the Paris Commercial Court, the CLAM immediately liquidates open positions based on Article 22, and call margins from sellers. The sellers refuse to pay. Several sugar professionals appeal the decision on the next day.
4 Feb. 1975	The Paris Court of Appeal invalidates the earlier decision by the Paris Commercial Court. The settlement price must be based on actual market prices, not computed on the basis of Article 22. This ruling favors hedgers (short positions) against retail investors (long positions). A settlement of contracts based on market prices would induce the CLAM to default, due to losses on its exposure to Nataf and possibly to the default of other brokers.
20 Jun. 1975	The decision of the minister of commerce to suspend trading on Dec. 3 is invalidated by the Council of State (*Conseil d'Etat*), further threatening the CLAM. By that date, sugar prices have been further falling to 1,450 FRF/ ton. After this decision, it becomes clear that no recovery can take place, and that the CLAM needs to go through a resolution procedure.
22 Jun. 1975	The French government dismisses the board of the CLAM and appoints an administrator. The liquidation of the CLAM starts.
7 Nov. 1975	An agreement to share losses among all parties and settle contracts is proposed and signed by all parties on Dec. 19.
26 Jan. 1976	The sugar market re-opens with a new clearinghouse.

Table A2 – Ownership structure of the CLAM

This table provides details on the ownership structure of the CLAM, as of end-January 1975. The main source is a confidential report commissioned by the Bank of France after the closure of the sugar market. See Appendix B for details on the data.

Type of shares		Registered shares
Number of shares		120,000
Number of shareholders		669
	Number of shares	% of total shares
Assurances Générales de France (AGF)		
AGF Vie	54,001	45.00
Banque Générale du Phénix	12,000	10.00
La Métropole	3,827	3.19
Union des Assurances de Paris		
Union Capitalisation	2,500	2.08
Le Continent Incendie	184	0.15
Banks		
Paribas	2,518	2.10
Société Générale	3,116	2.60
Crédit Lyonnais	3,054	2.55
Board members		
Gérard Bauche (CEO)	1,200	1.00
Henri Cayre	1,281	1.07
Sugar professionals		
Beghin-Say	1,874	1.56
Individual shareholders		
3 individuals owning > 1% each	7,827	6.52
Other shareholders	26,618	22.18

Table A3 – Allocation of losses and resolution of the CLAM

This table provides details on the allocation of losses during the resolution of the CLAM. Sources: Simon (1981) and archive documents. See Appendix B for details on the archive sources.

Party	Allocation of losses
	CLAM
CLAM	Contributes the entire value of its assets (15 million FRF in liquid assets, 35 million FRF in real estate, 100 million FRF in debt claims).
	Investors
Buyers of sugar futures	Exposures are cleared based on the settlement price of Dec. 2nd (6,217 FRF for the nearest-term future) plus 100 FRF.
Sellers of sugar futures	Exposures are cleared based on the settlement price of Dec. 2nd (6,217 FRF for the nearest-term future) minus 200 FRF.
Nataf clients	Obtain 35% of 6,017 FRF.
International Commodities Clearing House	Exposures are cleared based on the settlement price of Dec. 2nd (6,217 FRF for the nearest-term future) minus 200 FRF.
	Equity holders
Blockholders (AGF and banks)	Sell their shares for 1 FRF per share to a subsidiary of Crédit Lyonnais (called SINFIC), and contribute to the creation of the successor CCP.
Minority shareholders	Sell their shares to SINFIC for 100 FRF per share.
	Sugar professionals
Professional association of sugar producers	Contributes 7.5 million FRF.
Professional association of sugar beet producers	Contributes 7.5 million FRF.
	Other stakeholders
Professional association of registered brokers	Contribute 23 million FRF, plus 5 million FRF in the name of the professional association of introducing brokers.

Figure A2 – Sugar future prices in Paris, London and New York

This figure plots the daily price of the nearest-term sugar future contract in the Paris, London and New York markets. Data are at a daily frequency over the period from January 1973 to June 1975, in current FRF per ton. Data in the London market are in pounds per long ton, and data in New York in cents per pounds. Both series are converted to current FRF using data on exchange rates from the Saint-Louis Federal Reserve's FRED database (series identifiers: EXFRUS for the FRF/USD exchange rate and EXUSUK for the USD/GBP exchange rate). Prices in Paris are for contracts on white sugar, while prices in London and New York are for contracts on brown sugar. The dashed vertical line corresponds to December 2nd, 1974, when the default of Nataf was declared. Data are collected from *Les Echos*. See Appendix B for details on the data.

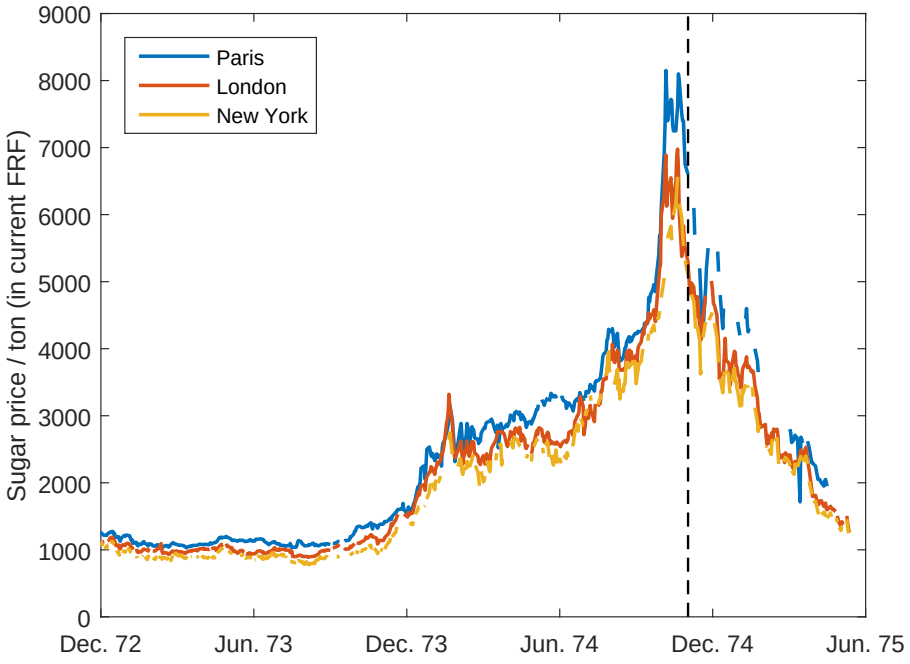
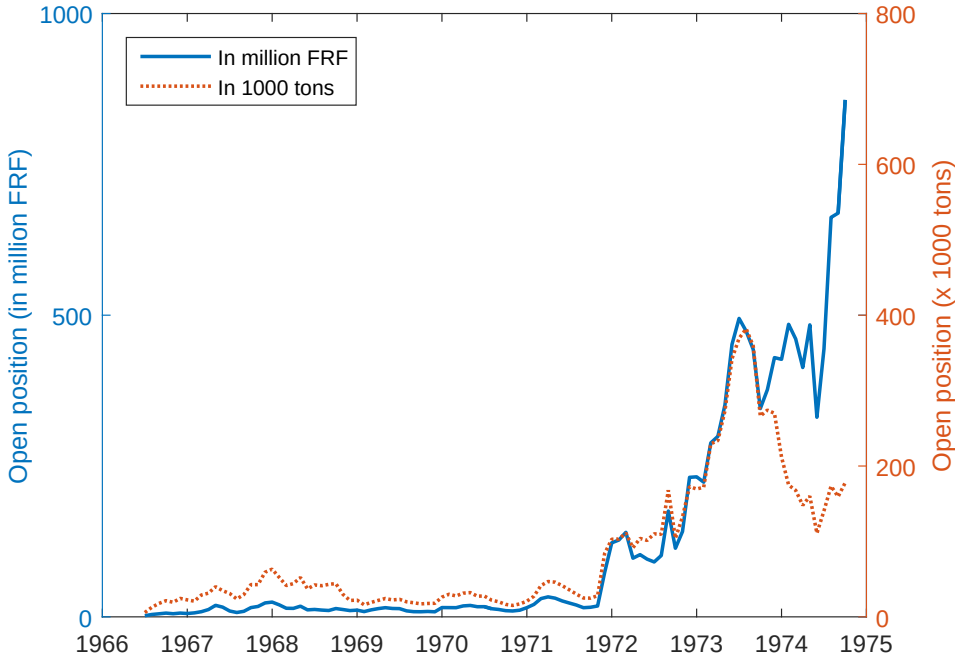


Figure A3 – Open position of the CLAM

This figure plots the open position of the CLAM on sugar futures, at a monthly frequency, from July 1966 to December 1974. The open position corresponds to the net volume of physical sugar or the monetary amount that would change hands if all positions were to be settled on a given day. It captures the exposure of the CLAM, after netting long and short positions for each clearing member. In Panel A, the open position is expressed both in thousand tons (dotted line) and in million FRF (solid line). The exposure in FRF on a given day is obtained by multiplying the exposure in tons by the price of a ton of sugar on that day. In Panel B, we plot the ratio of the open position of the CLAM in FRF, normalized by the market capitalization of the CLAM. See Appendix B for details on the data.

Panel A: Open position of the CLAM



Panel B: Open position of the CLAM over market capitalization

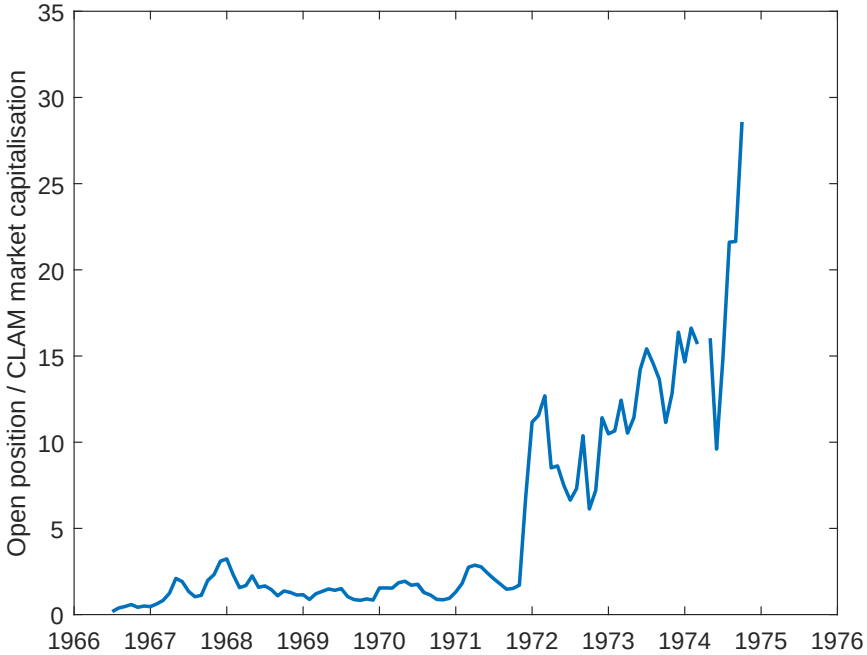
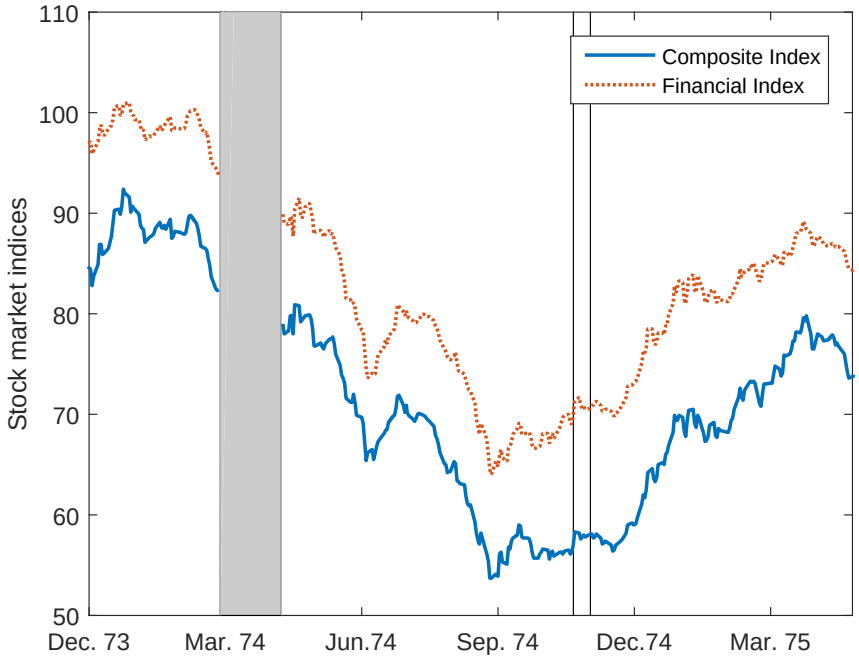


Figure A4 – Stock market indices

This figure plots two stock market indices at a daily frequency from January 1974 to Mai 1975. The first index (solid line) is a composite index, covering stocks from all sectors; the second index (dotted line) is an index covering only stocks from the financial sector. These indices were computed daily by the professional association managing the Paris Stock Exchange (*Compagnie des agents de change*). The shaded area corresponds to a period of strike in the Paris Stock Exchange, during which there was no quoted prices (28th March to 8th May 1974). The first vertical line corresponds to the highest sugar price (21st November 1974) and the second vertical line corresponds to the failure of Nataf (2nd December 1974), which leads to the closure of the sugar futures market. See Appendix B for details on the data.



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