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The State-Contingent Debt Premium: Evidence from French Public Bonds

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Abstract

State-contingent debt (SCD) instruments have been proposed as an improvement to sovereign debt markets, but their issuance costs are not well understood. We estimate the SCD premium at issuance and for more than a decade thereafter, employing a quasi-twin bond strategy that uses two very similar French government bonds issued in 1956: one conventional bond and one state-contingent bond with coupons linked to industrial production. At issuance, the expected yield on the SCD bond was 77 basis points higher than its twin. Due to robust growth in the French economy ex-post, the realized SCD premium at issuance was roughly twice as large (146 basis points). However, rising market prices of the state-contingent bond reduced both spreads to zero by 1964. They rose again in May 1968 following an unexpected general strike, which significantly reduced French industrial production; however, by 1970, the SCD premium had fallen to values close to zero.

JEL classification codes: H63, N14, E43, E65
Keywords: State-contingent debt; risk premia; public debt; GDP bonds; capital markets (France)

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1 Introduction

State-contingent debt instruments (SCDIs) have been proposed as a potential improvement on traditional public borrowing (Shiller 1993; Obstfeld and Peri 1998; Haldane 1999; Borensztein and Mauro 2004; Blanchard, Mauro, and Acalin 2016; Benford, Ostry, and Shiller 2018; Cohen et al. 2020; Dvorkin et al. 2022; Volz 2022), and have received renewed attention by policy makers and economists in the wake of the Global Financial Crisis and the COVID-19 pandemic (Blanchard, Mauro, and Acalin 2016; Cohen et al. 2020; Brooke et al. 2013; United Nations 2021). These instruments are designed such that sovereigns repay more in good times and less in bad times, potentially offering debt relief and reducing the likelihood of default during economic downturns. However, linking debt payments to a state variable shifts risk to lenders who therefore require a premium to hold this debt. This raises the issuance costs for state-contingent debt and reduces its potential benefits.

Are SCDIs too costly to be useful? The cost of issuing SCDIs remains poorly understood, largely because there are few instances of their widespread adoption. Thus, existing estimates of their premia have been based on calibrated theoretical models (Benford, Best, et al. 2016; Roch and Roldán 2023; Mouabbi, Renne, and Sahuc 2024), generated from hypothetical assets (Eguren-Martin, Meldrum, and Yan 2021), or empirical studies using bond issuances that are relatively small or associated with sovereign debt restructurings (Chamon and Mauro 2006; Igan, Kim, and Levy 2021). However, theoretical models rely on simplifying assumptions, and premia estimated following debt restructurings may not be useful for understanding how SCDIs would be priced in normal times because their yields could also embed debt-restructuring premia. In particular, a state-contingent warrant is typically added as a sweetener to entice investors into accepting restructured debt. Furthermore, these investors may have concentrated their purchases in distressed assets (e.g., vulture funds) and may not be informative about widespread market measures of risk premia for these assets in normal times. An ideal empirical setting for measuring the state-contingent debt premium would be one where an economy with a well-developed public debt market issued two similar government bonds during normal times, one traditional and one state-contingent.

In this paper, we take advantage of a unique historical experimental setting that allows us to estimate the state-contingent debt premium using a quasi "twin-bond" analysis: the simultaneous government issuance of traditional and state-contingent bonds in France in 1956. We hand-collected 15 years of daily bond price data from French historical newspapers to analyze two bonds issued between April and May 1956 by the French Fourth Republic. The "Bons PTT',' issued by the state agency Postes, Télégraphes et Téléphone (henceforth, BPTT) in April 1956, was a conventional non-contingent or "plain vanilla" bond that was guaranteed by the French state (Le Roux and Oger 1999). The "Bons d'équipement industriel et agricole" (henceforth, BEIA), issued by the French Treasury in May 1956, was a state-contingent bond with coupons tied to the level of industrial production of the French economy.[1] To the best of our knowledge, France's issuance in the 1956 also provides the first instance of a government issuing an output-linked sovereign bond.[2]

The two bonds used in our empirical analysis are identical in terms of place of subscription, face value, redemption value, and tax treatment. Both had a 15-year maturity, the same lottery provision determining their redemption, and were actively traded in secondary markets. They represented a significant share of borrowing by the French state in 1956. The BPTT accounted for 5% of total public borrowing in 1956 while the BEIA represented 19%

[1] Industrial production is highly positively correlated with real GDP. For example, Monnet and Puy (2021) use the same industrial production index to construct synthetic quarterly GDP series for France in the 1950s. Borensztein and Mauro (2004) suggest that an industrial-production linked bond may have an additional advantage in that it is potentially harder for a government to manipulate than GDP statistics. The industrial production index was published by the Institut national de la statistique et des études économiques (INSEE), which was created in 1947. Tavernier (2018) discusses the de facto independence of INSEE since it's establishment.

[2] At the time, state-contingent debt was a common form of borrowing in France, used not only by the government (public debt) but also by publicly held companies (semi-public debt) and private companies. In fact, about half of all debt issued by the state, by companies owned by the state, and by private companies in 1956 in France had state-contingent properties (Rozental 1959).

(Daage 1957).

The key difference between the bonds was in their coupons. The conventional BPTT had a fixed 5.5% coupon, while the state-contingent BEIA had a minimum coupon equal to 5% plus a bonus that depended on the performance of the economy's industrial production index as published by the official statistics of the French government. Other than the computation of the coupon, the one month difference in issuance date and the volume of the bonds, the terms of the two bonds were identical, allowing for a quasi-twin bond research strategy to estimate the state-contingent debt premium.

We estimate realized and expected state-contingent premia at issuance and for more than a decade after issuance. Our baseline state-contingent premia are obtained by taking the difference between the yield of the state-contingent bond and the traditional bond. To derive the *realized* state-contingent debt premium, we use secondary market prices for both bonds as well as the realized future value for industrial production to compute realized cash flows and yields to maturity for the state-contingent bond. The *expected* state-contingent debt premium is derived using expectations based on publicly available forecasts for industrial production to compute expected cash flows and expected yields to maturity for the state-contingent bond. Our baseline estimates for realized and expected state-contingent risk premia assume that default and liquidity risk are similar for the two bonds. In a robustness check, we show that, because measured liquidity premia are similar between the two bonds during our sample period, the liquidity-adjusted state-contingent premium is very similar to our baseline estimates.

A crucial input into our analysis is the evolution of the expected level of industrial production, which determines expected coupon payments for the state-contingent bond. We use official public forecasts for industrial production to compute these expected coupons. This is particularly suitable for our time period because the French economy followed an "indicative planning" approach, regularly publishing its targets for industrial production

(IP) in its plans (Kindleberger 1967). Multiple indicative plans span our sample period which, when their IP forecasts are combined with secondary market prices, allow us to estimate the time-varying expected state-contingent debt premium.

Unlike traditional sovereign debt instruments that have well-established markets and can be valued using standard methods, SCDIs are relatively rare and not necessarily well-understood by market participants. Their lack of familiarity and liquidity (arising from their novelty and potential for complexity), together with lender risk aversion, can make it difficult for sovereigns to issue these instruments at a fair price, potentially reducing the use of contingent public debt. Unsurprisingly, most recent issuances of SCDIs have been part of debt restructurings, where they can help resolve disagreements between borrowers and lenders over expected future growth and repayment capabilities. Recent examples include Argentina in 2005, Greece in 2012, and Ukraine in 2017. Outside of debt restructurings, the issuance of SCDIs has occurred in small, illiquid markets, as in Portugal (2013) and Italy (2020). Therefore, reliable empirical estimates of the state-contingent debt premium issued in a well-developed debt market and advanced economy during normal times (i.e., outside of debt restructurings and in an environment where statistical reporting is reliable) do not exist. (See Pina (2022) for a review of SCDIs issued and their characteristics.) The main contribution of our research is to provide credible estimates for this premium in an environment where state-contingent debt was regularly issued in a well-developed financial market.

Our empirical estimates show that the expected state-contingent debt premium at issuance was 77 basis points. Due to robust economic growth of the French economy, ex-post, the realized state-contingent debt premium at issuance was 146 basis points. We also show that bond prices of the state-contingent debt increased with the continued strong performance of the French economy, lowering the realized premium for most of the sample period. This premium fell to zero by 1964 before increasing after May 1968 following unexpected widespread strikes and protests that significantly reduced French industrial production. By 1970, this premium decreased again to values close to zero. We also compute estimates of the expected state-contingent debt premium using official three-year industrial production forecasts from 1958, 1962, and 1965. These estimates range between -30 and 31 basis points. We confirm these results using Monte Carlo simulations for the path of Industrial Production.

The premia we estimate are considerably lower than what has been found in the existing literature. For example, for SCDI used in debt restructurings, Igan, Kim, and Levy (2021) estimate average realized premia for the five-year period after issuance equal to 1250, 425 and 665 basis points for Argentina, Greece, and Ukraine, respectively. For the first five-year period after issuance in our sample (between June 1956 and June 1961), we estimate a realized premium of 185 basis points. It falls to only 70 basis points for the next five-year period. The average for our full sample period is 108 basis points, considerably lower than bonds that are part of restructurings. Our estimates of the expected premium are even lower, with averages ranging from 29 to 77 basis points: 77 basis points using the forecast published at issuance, an average of 28.5 basis points from Monte Carlo simulations of industrial production, and 29 basis points averaging across contemporaneous official government forecasts after issuance. To put our findings in further context, Benford, Ostry, and Shiller (2018) report a range of premia from theoretical models between 35 and 150 basis points.

Several reasons have been identified for the existence of a state-contingent debt premium. Borensztein, Jeanne, et al. (2005) collected investors' opinions on growth-indexed bonds and identified potential challenges in pricing these bonds, including issues with novelty and liquidity premia as well as concerns about the "theoretical" price. Chamon and Mauro (2006) show that the process of computing the theoretical price for growth-indexed bonds is similar to that of "plain-vanilla" bonds. In addition, they calculated the reduction in default probabilities on all debt following the issuance of growth-indexed bonds, calling it a "pleasant by-product." Chamon, Costa, and Ricci (2008) document a novelty premium for Argentinian

GDP-linked warrants. However, as Igan, Kim, and Levy (2021) show, the premium for the Argentinian GDP-linked warrants was not transitory and therefore is unlikely to represent a novelty premium. Instead, Igan, Kim, and Levy (2021) and Roch and Roldán (2023) interpret the state-contingent debt premium as an uncertainty premium. Igan, Kim, and Levy (2021) show high and persistent risk-premia in SCDIs that are pro-cyclical, i.e., lower when the economy is doing poorly. Roch and Roldán (2023) link these elevated premia to a standard aspect of SCDI design – that no payments are made below a specified threshold.

Our paper contributes to the literature on state-contingent debt by directly measuring state-contingent debt premia using a quasi-twin bond strategy, and which requires fewer assumptions than approaches relying on theoretical models or synthetic assets. In comparison to existing studies, we find smaller state-contingent debt premia at issuance, which gradually decreased until the French economy experienced a major negative shock – the general strike of May–June 1968. Following a temporary increase in 1968 and 1969, the debt premium then decreases through 1970. Additionally, we show that realized state-contingent debt spreads are positively correlated with industrial production or output gaps. We further show that the BEIA–BPTT spread has essentially no exposure to the French equity market, with equity-market betas that are small and statistically indistinguishable from zero in both contemporaneous and twelve-month-lagged specifications. This rules out compensation for standard systematic equity-market risk as an explanation and motivates the risk-aversion and ambiguity-aversion channels we emphasize below.

These spreads rose sharply after the 1968 strike, a pattern consistent with risk-averse investors demanding a higher premium in bad states. At the same time, the positive correlation between spreads and the output gap in normal times is consistent with the ambiguity-aversion channel emphasized by Igan, Kim, and Levy (2021): when output shocks are moderate, ambiguity about the realized coupon payoff dominates, and spreads widen with output. A large negative shock, such as labor unrest in 1968 that disrupted industrial production, temporarily reverses this ordering as risk-aversion concerns become first-order. This interpretation aligns with Roch and Roldán (2023) and Igan, Kim, and Levy (2021), but also highlights the fact that economic conditions are a dominant factor influencing the state-contingent debt premia.

The paper proceeds as follows. Section 2 presents the historical context and discusses state-contingent debt in France at the time. Section 3 discusses the data used in this paper as well as the method used to compute the state-contingent debt premium. Section 4 presents the results for realized and expected risk premia. Section 5 discusses potential sources for the state-contingent debt premium that are consistent with our empirical findings, and Section 6 concludes.

2 Historical Context

This section places the first known issuance of output-linked sovereign debt in historical context. It first describes the performance of the French economy around the time of issuance as well as some institutional features of the policy environment that prove important for our estimation of state-contingent debt premia. It then provides some background information on the "twin bonds" we use in our analysis and, more broadly, on the use of indexed debt in French capital markets in the 1950s.

2.1 The French Postwar Economy

Despite political instability (more than 20 national governments) and decolonization wars in North Africa and Indochina that increased military expenditures and disrupted trade, the Fourth Republic of France (October 1946 - October 1958) experienced rapid economic growth (Lynch 2006). The Fourth Republic began a period of high economic growth that lasted until 1975, an era that would later be known as "Les Trente Glorieuses."

The governments of the French Fourth Republic implemented several key domestic economic policies, including the nationalization of major industries, such as banks, insurance companies, coal mines, and significant transportation and manufacturing enterprises like the French automotive company Groupe Renault as well as the national railroads. The policy environment of this earlier era also witnessed the emergence of French economic planning, initially focusing on increasing production in industries like coal and steel and upgrading the country's infrastructure.

Nationalization meant that debt issued by some of these companies was now guaranteed by the government. This debt was referred to as semi-public debt and included companies for which the majority of the capital was held by the State as well as semi-public institutions, such as Crédit Foncier or Crédit National (Daage 1957). These nationalized industries were among the first ones to issue large-scale bonds that were linked to state-variables corresponding to the financial performance of these firms, such as their product prices. The bonds of state companies (e.g., electric companies, railroads, and mining) introduced French investors to the concept of state-contingent debt, reducing investor uncertainty regarding indexed debt and how to value it – two factors highlighted in the literature as potential impediments to SCDI issuance (Borensztein and Mauro 2004). The main state-contingent bond used in our analysis was issued by the government a few years after these bonds. It resembled other French public debt with the exception of one novel feature – its coupon was linked to movements in France's industrial production index.

During our sample period, the governments of the French Fourth Republic relied on indicative planning, a form of economic planning that focused on setting targets for economic growth and used these targets to guide its policies and allocate resources. It is indicative in the sense that it "it shows the directions in which the economy ought to go rather than providing specific targets for individual plants and firms" (Kindleberger 1967, p.264).[3] Because

[3] Indicative planning provided information, forecasting, and coordination. It involved "concertation" or consensus-building across industries and trade unions, with planning and forecasting formulated at the industry level and then aggregated up to macroeconomic aggregates, but it did not involve micromanagement of firms. For the private sector, decision making rested with firm management, including the quantity and timing of new investment.

there are no private forecasts for France's economic output during our sample period, indicative planning is especially relevant to our analysis. The plans provide contemporaneous forecasts of industrial production, a key input into our computation of expected returns for the French state-contingent bond. The indicative planning approach used in postwar France provides government-announced targets for the industrial production index that were public and time-varying (Massé 1965).

The First Plan (known as the Monnet Plan) was implemented in 1946 and designed to cover 1947-50. It was aimed at providing an orderly reconstruction of productive capacity in the wake of war destruction and promoted expansion of six "basic sectors," coal, electricity, steel, cement, agricultural machinery, and transportation. The First Plan was later extended to 1953 and expanded to include some additional sectors (Estrin and Holmes 1983). Indicative planning continued well after reconstruction had been achieved during this first period, with the next two plans focusing on raising industrial production and investment. The Second Plan (the Hirsch Plan) ran from 1954 to 1957, and broadened the focus of modernization and growth through investment activities beyond basic industries and into other types of manufacturing and housing. The Third Plan covering 1958-61 focused on economic growth as well as the country's balance-of-payments problems (which were driven by a rapid increase in imports) through improved international competitiveness and productivity. It was interrupted by the fall of the Fourth Republic in May 1958, during a period marked by political instability and ongoing colonial conflicts. An interim plan was adopted in 1960 for 1960-61, and a Fourth Plan was developed for 1962-65. The Fifth and Sixth Plans covered 1966-70 and 1971-75, with the latter falling out of the sample period for the bonds considered in this paper. The targets included in each plan will be used as forecasts to compute expected bond yields.

In the years just prior to the issuance of the BPTT and the BEIA bonds (1954-55), the French Fourth Republic experienced rapid economic growth with little inflationary pressure as unused resources after the war were absorbed into production. Inflation averaged 1.4% for these two years, while the economy expanded at annualized rate of 5.5%. In 1956, the year the bonds we studied were issued, the annual inflation rate increased to 2.2%, while the growth remained strong, at around 5.2%. However, after 1956, French policymakers were unable to navigate sustained rapid growth without triggering higher inflation, which was stoked by fiscal deficits (including costs arising from financing its empire and colonial wars, particularly in Algeria), rapid credit expansion, and a tight labor market (unemployment was running less than 1%). The inflation rate rose to 7% in 1957, and eventually increased to roughly 15% in 1958, the last year of the French Fourth Republic. The central bank responded to higher inflation by raising the discount rate by 200 basis points and the finance minister raised taxes in the second half of the year. Shortly after the establishment of the French Fifth Republic on October 4, 1958, and the second of two devaluations of the French franc, the De Gaulle government implemented additional measures to stabilize inflation and promote economic growth, including restrictions on credit to industry as well as raising taxes and cutting government spending to address structural budget deficits.[4] The stabilization measures included a ban on new issuance of indexed debt, including the state-contingent debt we use in our analysis (Hauser 1964). At that time, policy makers believed that forbidding indexed debt would help to stabilize prices and reduce inflationary expectations (Deacon, Derry, and Mirfendereski 2004). This ban was lifted in 1968, but no new indexed government bonds appeared again until 1973 when two gold-linked bonds were issued.

[4]The government ran budget deficits amounting to 20% of expenditures in 1956 and 1957 during a period when bank credit also expanded rapidly, by 22% in 1956 and 15% in 1957 (Szymczak 1959; International Settlements 1958). France financed these deficits through a combination of new public borrowing and advances from the Bank of France. France lost half its official reserves during this period and was forced to devalue twice. The currency devalued roughly 30%.

2.2 State-Contingent Debt Issuance in France

This subsection introduces the two bonds that are the focus our empirical analysis and provides additional historical context as to why state-contingent bonds were issued by the government in the 1950s. The discussion highlights some aspects that are particularly relevant for the main bond used in this paper, the BEIA, which itself is described in more detail in the next section.

As briefly mentioned, state-contingent bonds were common in France during the Fourth Republic. Indexation of debt (usually with respect to prices) became more common in countries after World War II (it was adopted in Finland, France and Israel) and was viewed as the outcome of a high-inflation environment (Seligman 1963). Most indexed contracts were linked to nominal variables. The French industrial production bond we consider stands out in that it was linked to a real variable. While the contemporaneous academic and policy literature discuss indexation with respect to protecting purchasing power, we have found no clear explanation as to why the French issued an IP bond despite an extensive search of the Finance Ministry's archival records. However, using primary and secondary sources, we are able to place the issuance of the BEIA bond into the French financial and political context of the period we study.

The BEIA bond was part of an era of debt market innovation in France. In the 1950s, it became common for public and private companies to issue corporate bonds indexed to the price of products they sold or to company revenues. A. Monod Enterprises was among the first French firms to issue state-contingent bonds, linking their 1952 issuance to labor and material costs (Rozental 1959). That same year, the public electric company issued bonds tying interest payments and principal returns to the average selling price of electricity (Finch 1956). The following year, another bond linked to the price of electricity had one-tenth of its bonds retired each year through a lottery, a similar mechanism that was later implemented in the BEIA and BPTT issues. In the Somua issue of 1953, the return was given by $157 + (I_k - I_0)/I_0$, where I_k corresponds to the ratio of the value of total sales to the number of hours of direct labor, one year before the payment of the bond, and I_0, the same ratio for the base year of 1952 (Rozental 1959). As will be shown later in the paper, this formula was similar to how the coupons for the BEIA bond were computed.

By 1956, variable-return bonds constituted 53% of all outstanding private, corporate bonds, with convertible bonds adding another 12% (Rozental 1959). Major companies like Pechiney, Sidelor, Michelin, Renault, SAVIEM, and GICEL issued bonds linked to financial performance indicators such as earnings, dividends, turnover, or commodity prices. These examples illustrate how variable-return bonds were a common feature in French financial market at the time, and that the structure of the state-contingent public bond that we study in this paper, both indexation and redemption mechanisms, was not necessarily novel to French investors.

Between 1956 and 1957, the French government issued three state-contingent bonds.[5] The first, BEIA, was issued in 1956 and was indexed to industrial production. It accounted for about 19% of public debt issued in 1956, or 10% of combined public and semi-public debt once nationalized-enterprise issuance is included. The second bond, the Emprunt, or national loan of 1956, was indexed to the average of the variable-income securities index (containing 295 French stocks) and the fixed-income securities index (consisting of 62 securities). The Emprunt alone accounted for 75% of public debt issuance in 1956 (56% including semi-public debt). The third bond was the Indexés or 5% bond of 1957, which was indexed to the annual return of variable-income securities (i.e., a stock market index). This bond accounted for about 76% of public debt issuance in 1957 (or 24% if semi-public debt is included). These numbers show the prevalence of state-contingent public debt in France at the time.

[5] The 3.5% Gold Loan (Pinay Bonds), issued in 1952, was indexed to the price of gold, offering investors a safeguard against currency devaluation, but not against the state of the French economy.

Despite its importance in financing public borrowing in France, these French state-contingent bonds have been largely forgotten by the literature on SCDIs. For example, in discussing the nonexistence of financial instruments tied to national income or output, Shiller (1993) states:

> *The closest I have been able to find in any published source to the national income markets proposed in this book is an article advocating swaps and options on business cycle variables, particularly indices of consumer confidence.*

Contrast this with the statement from Paul Ramadier, the French Minister of Finance and Economic Affairs, in 1956 to *Le Monde* about these bonds:

> *The purpose of this loan was clearly defined by Mr. Ramadier: to associate savings with the equipment of the nation by making it finance part of the public investments which condition economic expansion. In return, subscribers receive progressive interest, proportional to the increase in production. They are, according to the formula of the Minister, "shareholders whose dividend varies according to the national income."*

A similar quote appeared in the *New York Times* (Heffernan 1956), where Paul Ramadier refers to the interest payment for this bond as a "dividend" that "is subject to revision annually in line with any changes in the gross national product of France as measured by a new index of industrial production."[6]

3 Data and Bond Terms

This section describes the data sources used in this paper as well as the terms and pricing for the two bonds that are used in our quasi-twin bond analysis: the "Bons Postes, Télégraphes et Téléphone" (BPTT) and the "Bons d'équipement industriel et agricole" (BEIA).

[6] See also Nevin (1962) for a suggestion to link GNP measured at constant prices, and Day (1964) for linking public debt to GNP measured at current prices.

3.1 Data Sources

Data on their terms and payments are available from France's official legal publication: the *Journal Officiel de la République*. This source also provides information on the official industrial production index values used to compute the BEIA's variable coupons. This industrial production index was produced by the government's Institut national de la statistique et des études économiques (INSEE) and is a weighted average of French industries. Forecasts for industrial production indexes are obtained from French government indicative plans (Commissariat général du Plan 1959; Commissariat général du Plan 1962; Commissariat général du Plan 1965) and discussed in Section 2.1. We hand-collected daily prices for the two bonds using *Cote Desfossés*, which is available at the French National Library and at the Capital Markets of the World (CMoW) fonds, hosted by the Geneva Graduate Institute (Geneva Graduate Institute n.d.). The data are available between April 1956, when the BPTT bond was issued, and June 1971, when the BEIA bond matured. (A few dates of *Cote Desfossés* are currently unavailable at these two locations.) We cross-check and supplement our dataset with information from the DFIH—Data for Financial History Database (Hautcœur and Riva 2018), available roughly twice per month. To obtain a forecast for industrial production at the time of issuance, our analysis also uses the press statement of the French finance minister regarding the issuance of the BEIA bonds and an internal memo authored by the Treasury Director Pierre-Paul Schweitzer, as we discuss in Section 3.3.

With the exception of how the coupons are computed, the terms of the BEIA and the BPTT bonds are essentially the same. Their terms are described in the official legal publication of the French government and parliament. The interest earned on both bonds was not taxable, and both traded actively in secondary markets. Both bonds were issued in 1956 with maturity equal to 15 years, i.e., the last payment was in 1971. The two bonds were issued with face values of 10,000, 100,000 or 1 million francs. In 1960, these issuance amounts were re-denominated to new francs (simply by dividing by 100). Both bonds paid coupons annually, and investors received 105% of the face value upon redemption.

Both also had equivalent lottery "redemption" provisions, which started in 1957 and worked as follows. Each bond had a serial number. Draws happened every year, two months before the payment of coupons. Between 1957 and 1961, five lottery draws took place, featuring tickets with numbers ranging from 00 to 99. Bonds with serial numbers whose last two digits matched the lottery numbers were redeemed in that year. The number of lottery tickets drawn per year increased to seven between 1962 and 1970. According to the legal text of the bonds, both the BPTT and BEIA bonds could not be redeemed earlier or strategically by the government.

The BPTT was first issued April 9, 1956, and paid coupons on May 1st of each year (République Française 1956a). The funds raised through the BPTT were dedicated to national infrastructure expansion, including the airmail network and telephones (Le Monde 1956a). The BPTT bond had a fixed interest rate equal to 5.5% and was therefore a conventional bond. It amounted to 5% of public debt issued in 1956.

The BEIA was issued on May 22, 1956, and its subscription closed on June 21, 1956. It paid coupons on June 1st of each year (République Française 1956b). It had a fixed interest rate of 5% plus a bonus in any given year equal to 5% of the difference between industrial production of the previous year and the level in 1955 (the official INSEE index used 1952 as its base year, and equaled 119 in 1955). The terms of the BEIA were explained in the press with examples of the computation of its payout mentioning that a minimum interest of 5% was guaranteed for subscribers, even if industrial production declined. In a statement to *Le Monde*, Mr. Ramadier, Minister of Finance and Economic Affairs, highlighted the likely return of the bond given the recent performance of France's industrial production index (Le Monde 1956b). The funds would be used to invest in agricultural and industrial infrastructure. The total BEIA issuance represented 19% of the public debt issued in 1956.

(To put this figure in modern perspective, inflation-indexed bonds represent roughly 10% of total marketable current U.S. or French debt.)

The initial offering of BEIA appears to have been well received by financial markets and the financial press. For example, on June 1st, 1956, the *Journal de Finances* favorably reported on its initial offering: "From every point of view, the formula for the Industrial and Agricultural Equipment Bonds appears well designed; it bears the mark of ingenuity developed over many years by the Treasury to offer savers investments that meet their aspirations. The information published on the initial results of the operation confirms this opinion since, four days after its opening, subscriptions already exceeded 20 billion francs."

3.2 Bond Coupons and Prices

Given the bond's terms, we can write the cash flow from owning a 100 new francs BPTT bond in year t is:[7]

$$C_{t,BPTT} = \begin{cases} 5.5, & \text{if the bond is not redeemed in year } t \\ 5.5 + 105, & \text{if the bond is redeemed in year } t, \end{cases} \tag{1}$$

while the cash flow in French new francs for the BEIA bond is:

$$C_{t,BEIA} = \begin{cases} 5 + 0.05 \times \left(\max\left(IP_{t-1} - IP_{1955}, 0\right)\right), & \text{if bond is not redeemed in year } t \\ 105 + 5 + 0.05 \times \left(\max\left(IP_{t-1} - IP_{1955}, 0\right)\right), & \text{if bond is redeemed in year } t, \end{cases} \tag{2}$$

and where IP is the industrial production index.

For any year t, expected cash flows can be computed by taking into account the probabil-

[7] In the computations of spreads, we forward the cash flows of the BPTT bond one month using the monthly yield for a French perpetual government bond in order to match the payment dates between the BPTT and the BEIA bonds.

ity of a bond being redeemed as well as the expected coupons for the state-contingent debt. To illustrate how the lottery provision affects expected bond payments, consider a holder of a bond in January 1970 before the lottery draw. The expected cash flows for the holder of this bond are computed as:

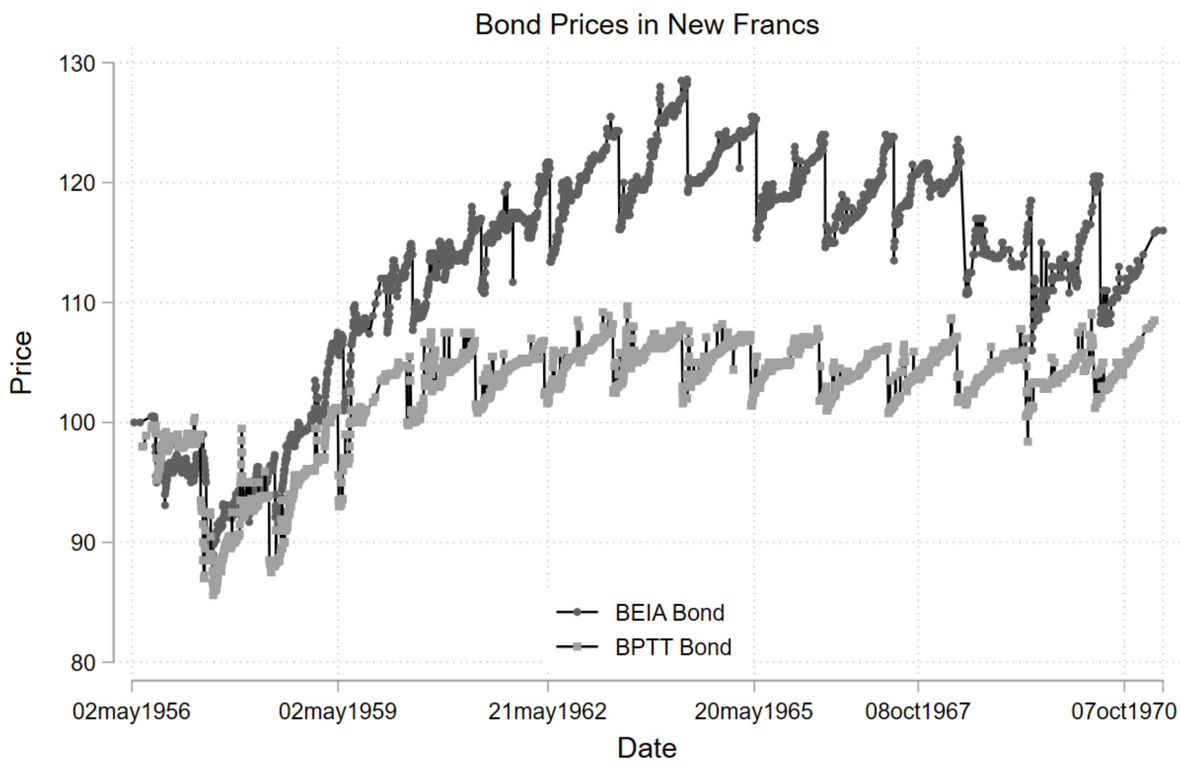
$$C^e_{1970} = 50\% \left(105 + \text{Coupon}^e_{1970}\right) + 50\% \left(\text{Coupon}^e_{1970}\right), \tag{3}$$

$$C^e_{1971} = 50\% \left(105 + \text{Coupon}^e_{1971}\right). \tag{4}$$

In January 1969, there would be three expected coupons, c^e_{1969}, c^e_{1970}, and c^e_{1971}, and so on and so forth for other years.

Figure 1 shows the secondary market prices for the BPTT and BEIA bonds, plotting the average monthly price between April 1956 and June 1971. (As common in Europe at the time, the traded prices are "dirty," in the sense that they include accrued interest since the last coupon payment. "Dirty prices" thus account for the seesaw pattern shown in the secondary bond market prices, increasing up to the coupon payment and then dropping immediately after.) The figure shows that until 1958 the two bonds had similar prices. However, beginning in that year, the prices of the two bonds diverged, with the price of the state-contingent bond (BEIA) increasing more, peaking in 1964 and remaining above the price of the conventional bond (BPTT) until maturity. Figure 1 also shows how a negative output shock affected these bond prices differentially. For example, when the French economy slowed down due to an unexpected general strike, the price of the state-contingent bond fell, but the price of the traditional, plain-vanilla government bond did not change.

Figure 1: Daily Bond Prices 1956-1971



Note: The figure displays secondary market prices for the "Bons d'équipement industriel et agricole" (BEIA), a state-contingent bond linked to industrial production, and for the Bons PTT (BPTT), a conventional bond. Prices shown are the average traded price (the "dirty price" that includes accrued interest) for each month. Source: Authors' calculations using hand-collected data published in *Cote Desfossés*.

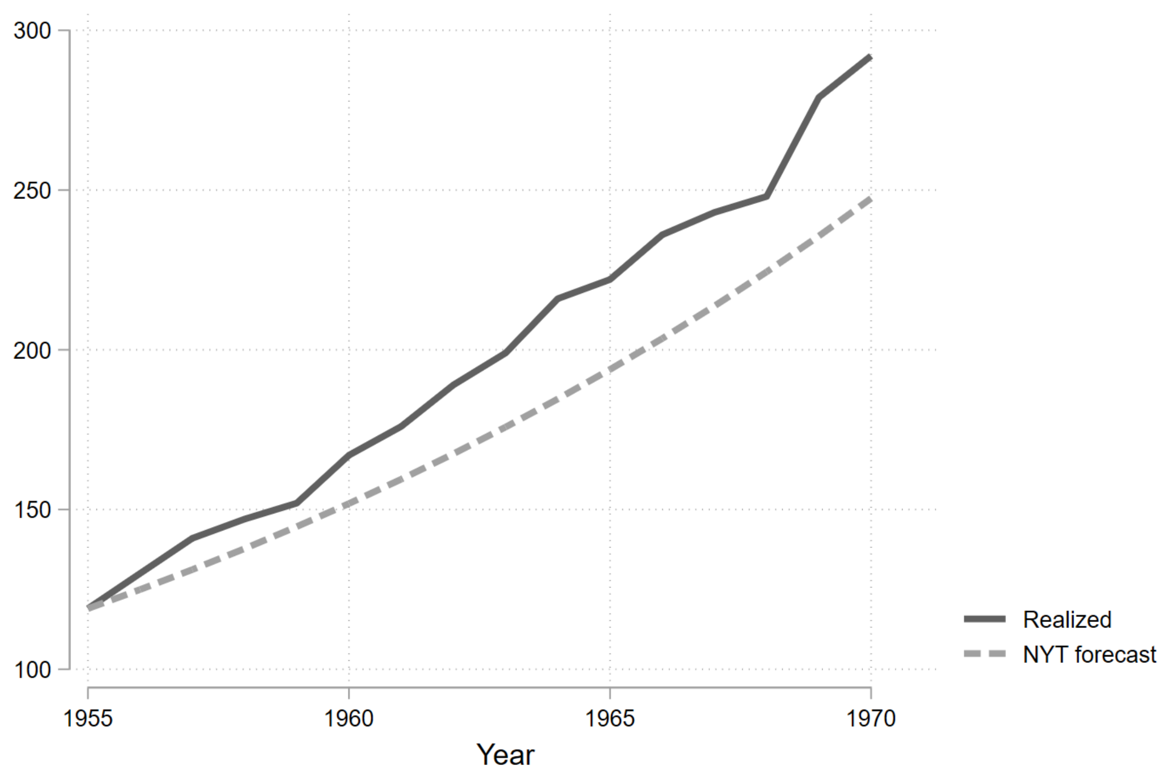
3.3 Realized and Expected Values for the Industrial Production Index

One crucial input for computing the expected state-contingent debt premium is the expectations for future values of industrial production at different points in time. Unfortunately, no private or financial market forecasts of French output were produced in France until after our sample period (Estrin and Holmes 1983). Hence, we rely on public statements by government officials as well as publicly available targets published by the public planning commission, which we discuss further in this sub-section.

Figure 2 plots the realized level of the Industrial Production Index (full line) as well as the implicit forecast for Industrial Production at issuance (dashed line), based on a press statement issued by French Minister of Finance, Paul Ramadier. The press release reported in *The New York Times* stated that "if the French economy kept growing at the rate expected by official economic thinking, the new bond [would yield] a return of 8.65% in the tenth year and about 11% in their fifteenth year" (Heffernan 1956). Using records from the French Ministry of Finance's archives located in Savigny-le-Temple, we are able to trace back the origin of these statements to an internal memo signed by the Treasury Director Pierre-Paul Schweitzer (Ministère des Finances, Direction du Trésor 1956), which reads: "It would, of course, be risky to assume that over the 15 years of the loan's duration the industrial production index can increase regularly by 9% per year. However, a reasonable hypothesis is to assume an average annual growth rate of the order of 5%, a rate which has been retained as an objective in the third Plan of modernization and equipment currently in preparation. In this average perspective, the index would reach around 150 in 1960, thus giving holders an interest of 6.55% in the fifth year, then 8.65% in the tenth year, and 11% in the fifteenth year."

Drawing on these two primary sources, we use the forecast of 5% growth for Industrial Production as our baseline. Figure 2 shows that that realized industrial production greatly

Figure 2: Industrial Production Index for France 1955-1970



Note: Realized industrial production index (solid line) and forecast at issuance (dashed line), 1955-1970. The base year (1955) and final year (1970) correspond to the range of values used to compute the variable return on the BEIA bond. Sources: INSEE and *The New York Times*, as described in the text.

exceeded the expected level around the time of issuance. These data are thus consistent with an increase in the price of the bond as shown in Figure 1.

In addition to this forecast at the time of issuance, we also use data on the targets for industrial production published in official production plans as part of the government's indicative planning. The published index in the Second to Fifth Plans is slightly different from the one used to compute the coupons for the BEIA bond in that it does not include construction or public works. However, it is very highly correlated with the overall production index since construction and public works represented a relatively small share of GDP (5.64% of GDP in 1960). (The correlation coefficient of the percentage change in the two indices between 1952 and 1970 is equal to 0.97.) Accordingly, to compute forecasts of industrial production, we assume that construction and public works had the same forecasted growth rate as each plan had for overall industrial production. Note, also, that these forecasts are reported as values for industrial production for a specific year. To determine yearly values, we assume a constant growth rate between the forecast date and the forecast's final year, which is the number provided in the plans.[8]

Using these forecasts, we obtain four waves of expectations for industrial production. First, the forecast published in the *New York Times* and in the internal government memo is shown in Figure 2. Then, we use the three forecasts published in each indicative plan. The Second Plan predicted that the industrial production index without public works and construction would be equal to 124 in 1957. The realized index value of IP turned out to be 146. Recall that bond payments were based on an industrial production index including public works and construction for which we do not have a direct forecast. Following our assumption that construction and public works have the same growth rate as the forecast in the plan, we obtain an expected value for the relevant industrial production index equal to

[8]Wickham (1963) shows that the deviations from the forecast IP between the first and fourth plans shrunk, indicating improved forecasting.

123 and a realized value equal to 141.

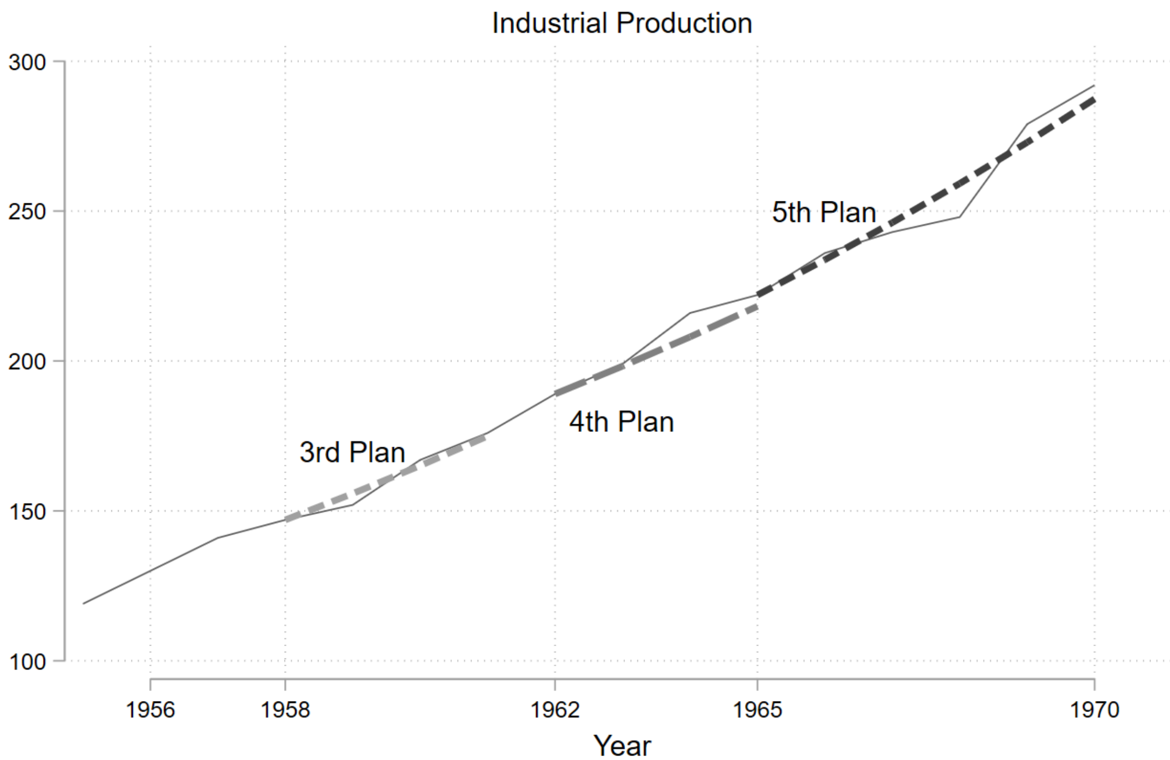
Industrial production in the Third Plan for 1961 was expected to be 175, while the realized value of the index turned out to be 176.[9] The Fourth Plan forecast industrial production (IP) at 218 for 1965, while the realized value was 222. For the Fifth Plan, the forecast was 259 for 1968 and 287 for 1970; realized values were 248 and 292, respectively (Commissariat général du Plan 1959; Commissariat général du Plan 1962; Commissariat général du Plan 1965). These figures show that official forecasts closely matched actual industrial production.

Figure 3 compares the objectives for industrial production (as published in the French government plans) with realized industrial production. Looking at these time-varying forecasts, it is possible to see that there are some years when realized industrial production was below expected. For example, in 1959, actual industrial production was lower than projected in the Third Plan. The opposite happened in 1964, when the Fourth Plan's forecast ended up lower than realized industrial production. Finally, in the summer of 1968, industrial production fell significantly below the forecast made in the Fifth Plan. (Between May and June 1968, France experienced civil unrest and labor strikes. About 9 million workers, 18% of the French population, were involved in the general strike (Ross 2008).)[10] These short-run deviations from expected industrial production allow us to observe how the estimated risk premium responds, in expectation, to earlier realizations that fell below forecast. In other words, they provide short-horizon experiments to investigate how the compensation demanded by investors depends on actual uses of the state-contingency. We now turn to the calculation of risk premia.

[9]These values are all re-based for the base year 1952 even though they are published in the Plans with different base years. They are also transformed to match the overall industrial production index including public works and construction as explained above.

[10]Monnet (2018) argues that the widespread labor strikes beginning in May 1968 and their effect on industrial production were unanticipated.

Figure 3: Forecasts and Realized Industrial Production, 1959–1970



Note: The full line shows realized values for industrial production. The dashed lines represent forecasts at different points in time according to the 1959, 1962 and 1965 Plans.

4 The State-Contingent Debt Premium

In this section, our primary goal is to measure the state-contingent debt premium. A state-contingent debt premium may be the consequence of investor risk-aversion, which makes fluctuations in payments less attractive for investors and who therefore need to be compensated with higher expected returns (Pina 2024). Alternatively, it can be the consequence of novelty (Chamon, Costa, and Ricci 2008), ambiguity, or liquidity premia (Igan, Kim, and Levy 2021; Roch and Roldán 2023). We first describe the strategy to identify the compensation required by investors to hold state-contingent debt, and then show the results for realized and expected levels of industrial production. In the next section, we explore which theoretical explanations are consistent with our empirical findings.

4.1 Estimating the State-Contingent Debt Premium

The prices of both bonds at issuance are equal to par or $p_0 = 100$. Our approach is to compute the expected cash flows for each t from a bond purchased at price p_t, and to derive the internal rate of return (IRR), equivalent to the bond's yield to maturity. This approach assumes that bondholders purchase the bond at t and hold the bond until maturity or until it is redeemed through a lottery provision.[11] The state-contingent debt premium is simply the difference between yields of the state-contingent bond (BEIA) and the traditional bond (BPTT). Although we collected daily data, we perform our baseline analysis of state-contingent debt premia at the monthly level for two reasons. First, this reduces the impact of noise trading on the computation of risk premia. Second, it matches the horizon over

[11] An alternative method would be to compute a price-based return, where the total bond return is given by the percentage change in the price of the bond plus the coupon divided by the previous price. This is the method used in Meyer, Reinhart, and Trebesch (2022) to average across bond returns. However, the data on French state-contingent bonds will sometimes yield negative values for a daily or monthly total return. Therefore, our analysis focuses on using the internal rate of return method. Another option would be to compute the theoretical price using a discount rate to compute the present value of expected cash flows and compare it to the empirical price. Given that there is a quasi-twin bond, the yield to maturity approach relies on fewer assumptions, such as the need to determine the relevant discount rate.

which we estimate time-varying liquidity premia in the robustness section.

The quasi-twin bond strategy has many advantages and has been employed in a variety of other settings (Accominotti, Albers, and Oosterlinck 2024); however, a few challenges remain. The first is the redemption lottery, which impacts both bonds used in our study, and makes any individual bond's maturity date unpredictable. Thus, even for the benchmark BPTT bond, which has a fixed coupon, it is necessary to compute expected cash flows at each period in time. To compute the expected coupon and the yield to maturity, consider a BPTT bond that was bought in month m and year y, where $m = 5$ and $y = 1$ represents May 1956. Let n represent the number of months until the next coupon payment which, for the BPTT bond, occurs annually on May 1st, between 1957 and 1971. At $m = 5$ and $y = 1$, or May 1956, n is equal to 12. At $m = 6$ and $y = 1$, n is equal to 11, and decreases once per month until $n = 12$ again at $m = 5$ and $y = 2$. This can be represented by the following expression:

$$n(m) = \begin{cases} 5 - m & \text{if } 1 \leq m \leq 4 \\ 17 - m & \text{if } 5 \leq m \leq 12, \end{cases} \tag{5}$$

where $n(m)$ represents the number of months until the next coupon payment. Then, for each m, y, we compute the expected yield to maturity, $x_{m,y}$, using the following expression:

$$p_{m,y} = \sum_{i=0}^{15-y} \frac{C^e_{y+i}}{(1 + x_{m,y})^{\frac{i \times 12 + n(m)}{12}}} \tag{6}$$

where $y = \{0, 1, 2, 3, \ldots, 15\}$, $p_{m,y}$ is the price of the bond at month m and year y, and C^e_{y+i} represents the expected payments from the bond.

The second issue is how to estimate expected coupons for the state-contingent debt. We use the projections of industrial production published by the French government in their indicative plans (and discussed in the previous section) to compute expectations for industrial production. Indicative planning provides a source to compute the expected coupons, and one that was freely available to investors. However, given that these IP forecasts are for three to five years, it is crucial to match the number of expected coupons with the range of the forecast provided in the plans. That is, if the forecast is for the next three years, we compute coupons only over three years; we assume that the bond is bought immediately after paying a coupon and redeemed at the end of the forecast.

A third potential issue concerns differences in the issuance amounts of the two bonds used in the quasi-twin experiment. In 1956, the total issuance of BPTT was 217.24 million new francs, while that of BEIA was 813 million new francs. Since both issuances represented a significant share of public debt issued in 1956, as a baseline, we assume that there is no difference in their liquidity premia. In a robustness check, we show that there were no significant liquidity differences between the two bonds considered here.

Armed with yields to maturity for each bond, we estimate the time-varying state-contingent debt premium as the difference between the yield on the state-contingent bond and the yield on the quasi-twin conventional bond (and under the assumptions of no differential default or liquidity risk), or

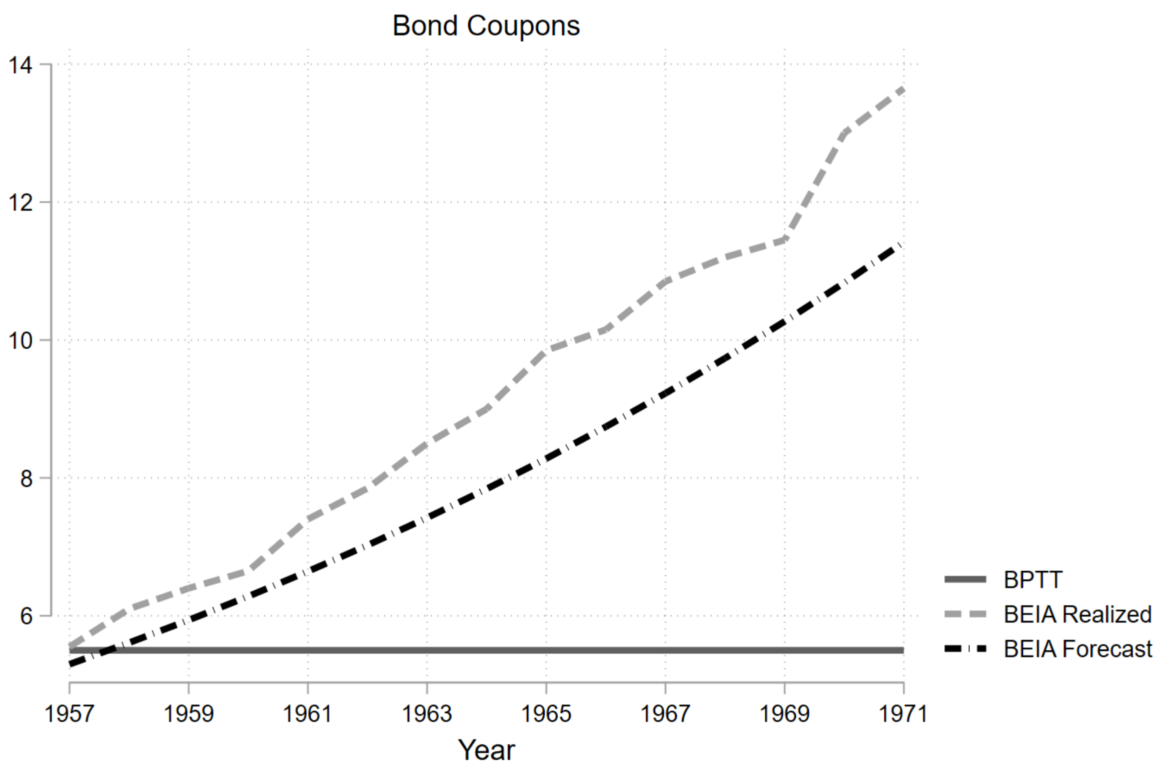
$$\text{SCD Premium}_{m,y} = x_{m,y}^{\text{SCD}} - x_{m,y}^{\text{Conventional}}. \tag{7}$$

4.2 The Realized State-Contingent Premium

Figure 4 plots the *expected* cash flows from holding the BPTT bond (solid line), the expected cash flows from holding the state-contingent BEIA bond using the forecast for industrial production at the time of issuance (dotted line), and the realized cash flows from holding the BEIA (dashed line).

Figure 5 plots realized yields to maturity between May 1956 and 1971. Each dot repre-

Figure 4: Forecasts and Realized Coupons, 1956-1970



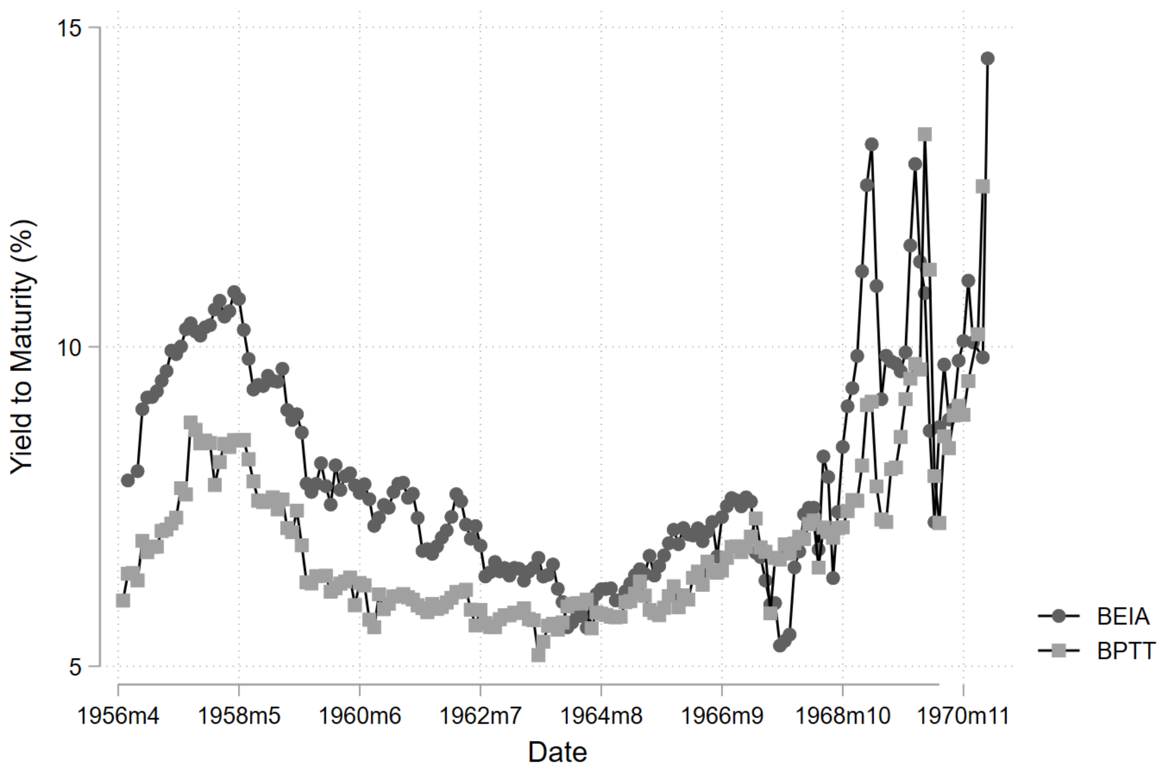
Note: Expected coupon payments in francs on a 100 new franc bond for the BPTT (solid line), expected cash flows for the BEIA using the forecasts for industrial production at issuance (dotted line), and cash flows with realized industrial production for the BEIA (dashed line).

sents an estimated yield to maturity. Figure 6 computes the realized spread as the difference between the two yields to maturity. Again, each point represents an observation for which it was possible to compute the yields of both bonds. The average realized spread was 114 basis points. Over time, the realized state-contingent risk premium initially declined. This is consistent with the performance of the French economy, which moved the state-contingent bond well beyond the threshold at which the bonus would not be paid. In fact, at the end of 1963 and the start of 1964, the realized spread was negative. In 1964, growth in industrial production fell and the estimated risk premium increased. However, by the start of 1968 it was once again negative as the French economy continued its rapid expansion. In May-June 1968, the French economy entered a period of unanticipated significant turmoil and the estimated risk premium increased substantially. Student protests broadened into a widespread general strike that unexpectedly reduced production in the summer of 1968, with the IMF estimating that GDP fell by 2% in response (International Monetary Fund 1969, p. 78). Towards the end of our sample period, spreads fluctuate more but remain at an elevated level.

4.3 The Expected State-Contingent Premium

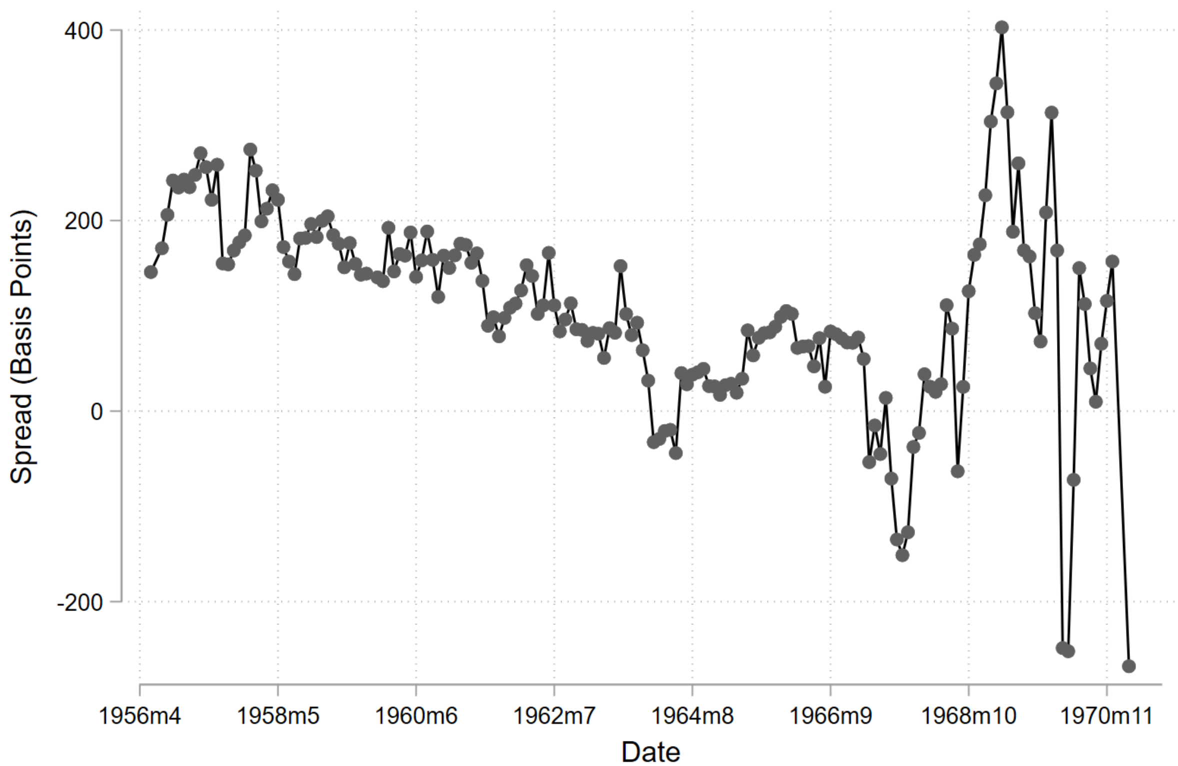
Using the date of issuance forecast mentioned in the *New York Times* and confirmed in the Ministry of Finance's archives, we obtain an expected spread at issuance equal to 77 basis points, a value that is lower than the realized premium at issuance (146 basis points). It is also possible to compute three additional expected spreads using the forecasts provided by the indicative plans from the French government. As mentioned earlier, these plans had horizons of three to five years. To simplify, we assume that both bonds are redeemed at the end of each forecast, and that each bond is bought right after paying a coupon. For example, the Third Plan was completed during 1958 and provided forecasts for industrial production for 1959, 1960, and 1961. Computing the internal rate of return under the

Figure 5: Realized Yields to Maturity



Note: Yields to maturity for the state-contingent bond (BEIA) and the traditional bond (BPTT), computed using equation (6) and based on realized values of industrial production.

Figure 6: Realized State-Contingent Debt Premium



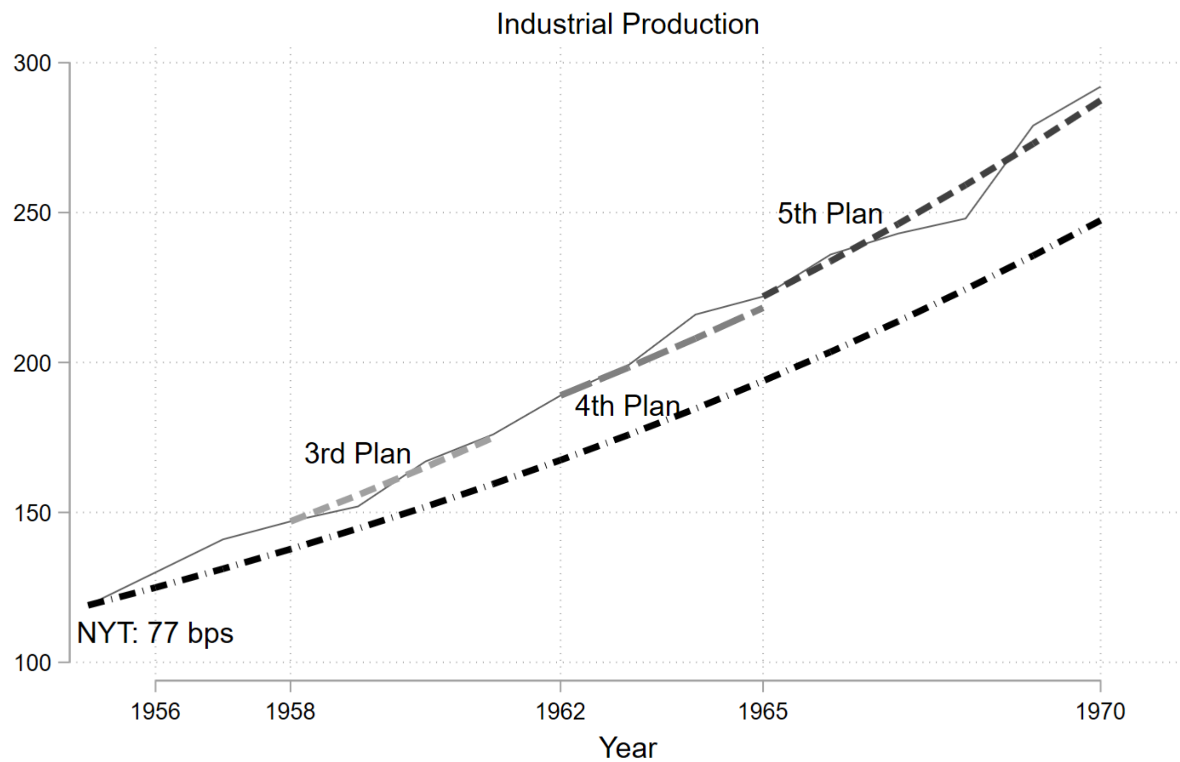
Note: State Contingent Debt Premium computed using equation (7), measured in basis points, for the actual realized values of industrial production.

assumption that both bonds are redeemed in 1961 yields an expected state-contingent debt premium equal to 20 basis points in 1958. Performing the same exercise for the Fourth Plan in 1962, one obtains an expected state-contingent debt premium equal to -30 basis points in 1962. Finally, for the Fifth Plan, we run two exercises – one with a three-year maturity (to match the other forecasts) and one with a five-year maturity – as in the indicative plan itself. For the three-year maturity exercise, we assume that the bond was bought in 1965 and redeemed in 1968. For the five-year exercise, we assume the bond was redeemed in 1970. The three-year maturity exercise has an estimated expected state-contingent debt spread of 31 basis points in 1965. The five-year exercise shows an estimated expected state-contingent debt spread of 95 basis points in 1965. Figure 7 summarizes the results for the expected state-contingent debt premium.

Taking the average of the three estimates for the three-year maturity expected state-contingent debt spreads, one obtains a state-contingent debt premium equal to 7 basis points. These findings highlight how maturity may play a role in the determination of the expected state-contingent debt premium. They also suggest that when the economy is performing relatively well, the state-contingent debt premium is decreasing. However, a negative output shock, as occurred in 1968, quickly increased the state-contingent bond premium. Referring back to Figure 1, we can see that following May 1968, bond prices for the state-contingent bond (BEIA) significantly declined while those for the traditional bond (BPTT) did not. In other words, following the unexpected negative shock to industrial production, the spread between the two bonds went from about zero to about 150 basis points, and remained elevated until 1970. These findings appear to be consistent with an asymmetric response of the risk premium to shocks.

Finally, how much insurance was provided by the state-contingent bond in May-June 1968, when the negative output shock occurred? To answer this question, we can compare the coupon payment on the BEIA bond in 1969, which reflects the realization of industrial

Figure 7: Expected Industrial Production and the Expected State-Contingent Debt Premium



Note: The dashed lines show different waves of expected levels of industrial production while the solid line shows realized industrial production. The numbers represent the expected state-contingent debt premium measured in basis points at different times: 1956 (issuance), 1958, 1962, and 1965. Next to each premium is the source for expected levels of industrial production as explained in the text.

production in 1968, with the expected coupon at the start of 1968, before the massive labor strike. Given the structure of the bond, the expected coupon in 1969 was 7.01 (new) francs. The realized coupon was 6.45 (new) francs, which corresponds to 92% of the expected value. We can also compute the maximum reduction implied by the structure of this bond. If the industrial production index had collapsed to the level of 1955, the coupon would be 5 (new) francs, 71% of the expected payment on this bond.

4.4 Monte Carlo Estimates for the expected state-contingent premium

As an alternative to using official forecasts, we estimate expected state-contingent premia using Monte Carlo simulations. The simulation process consists of several steps.

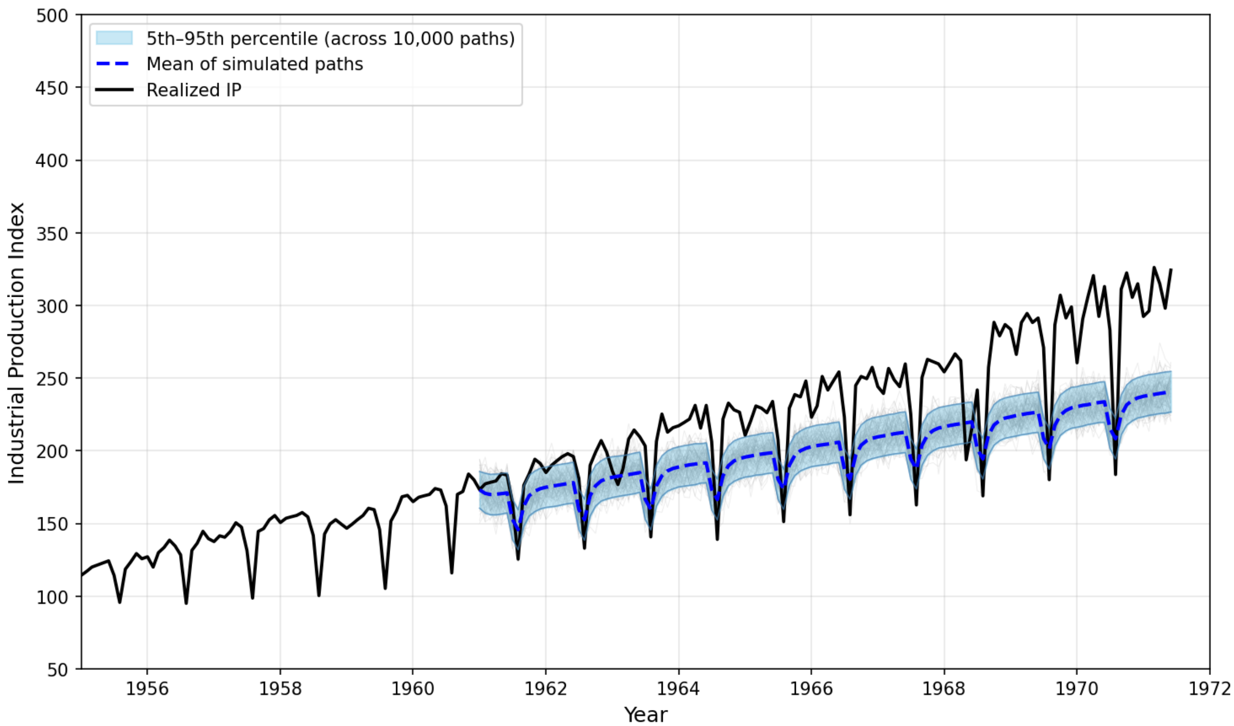
First, for each month between June 1956 and April 1971, we estimate an AR(1) model with a linear trend and summer dummy variables using an expanding window of monthly data beginning in April 1946. The linear trend captures the long-term growth in industrial production, while the summer dummy for July and August accounts for the well-documented seasonal decline in French industrial output during these months. This expanding-window approach ensures that, at each date, we use only backward-looking information available to market participants. Specifically, we estimate the following model using ordinary least squares:

$$IP_t = \alpha + \gamma \, Summer_t + \delta \, t + \beta \, IP_{t-1} + \varepsilon_t, \quad \varepsilon_t \sim N(0, \hat{\sigma}^2), \tag{8}$$

where $Summer_t$ is a dummy variable equal to one in July and August, t is a linear time trend, and $\hat{\sigma}^2$ is the estimated residual variance.

Second, for each month, we generate 10,000 simulated paths of future industrial production values from the current date until the final redemption in January 1971. Each path is drawn by iterating the estimated AR(1) model forward, adding normally distributed shocks calibrated to $\hat{\sigma}$. Figure 8 illustrates the simulated paths for a representative date, together

Figure 8: Monte Carlo Simulated Paths for Industrial Production



Note: This figure shows 10,000 simulated paths (thin gray lines) for industrial production based on the estimated AR(1) model with linear trend and summer dummies, using data available up to December 1960 as an example. The solid black line represents the realized industrial production index. The dashed blue line is the mean across the simulated paths and the shaded band is the 5th-95th percentile band. The simulation uses only backward-looking data available at each point in time.

with the realized path and the mean of simulations.

Third, for each simulated path, we compute the corresponding sequence of BEIA coupon payments using the contractual formula $c_t = 5 + 0.05 \times \max(IP_{t-1} - 119, 0)$. To compute expected cash flows, we apply conditional redemption probabilities, that is, the probability of being redeemed in each future year given that the bond has survived to the current date. The expected cash flow in each future period s for a bondholder at date t is thus:

$$E_t[CF_s] = P(\text{survive to } s \mid \text{alive at } t) \times \left[E_t[c_s] + P(\text{redeemed in } s \mid \text{survive to } s) \times 105\right], \tag{9}$$

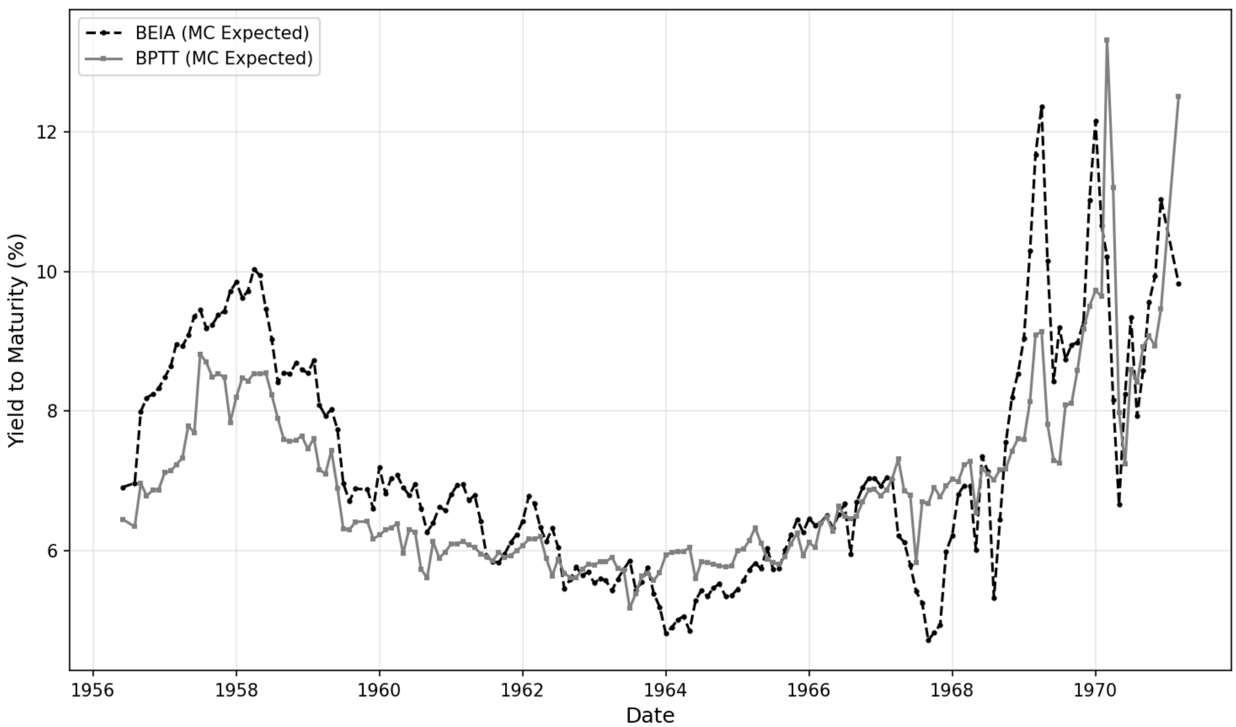
where the expectation of future coupons $E_t[c_s]$ is computed by averaging across the 10,000 simulated IP paths, and 105 reflects the redemption premium of 5% above par.

Finally, we compute the yield to maturity for each bond as the internal rate of return that equates the observed market price to the stream of expected cash flows. The Monte Carlo expected state-contingent debt premium is the difference between the expected YTM on the BEIA and the expected YTM on the BPTT.

Figure 9 displays the expected yields to maturity for both bonds. The expected YTM on the BEIA consistently exceeds that on the BPTT, implying a positive expected state-contingent debt premium throughout most of the sample. Both yields are consistent with the realized yields reported in Figure 5. Figure 10 plots the Monte Carlo expected premium alongside the realized premium. Over the full sample, the average Monte Carlo expected state-contingent debt premium is approximately 29 basis points, well below the average realized premium. This gap reflects the fact that industrial production growth exceeded backward-looking forecasts during much of our sample period.

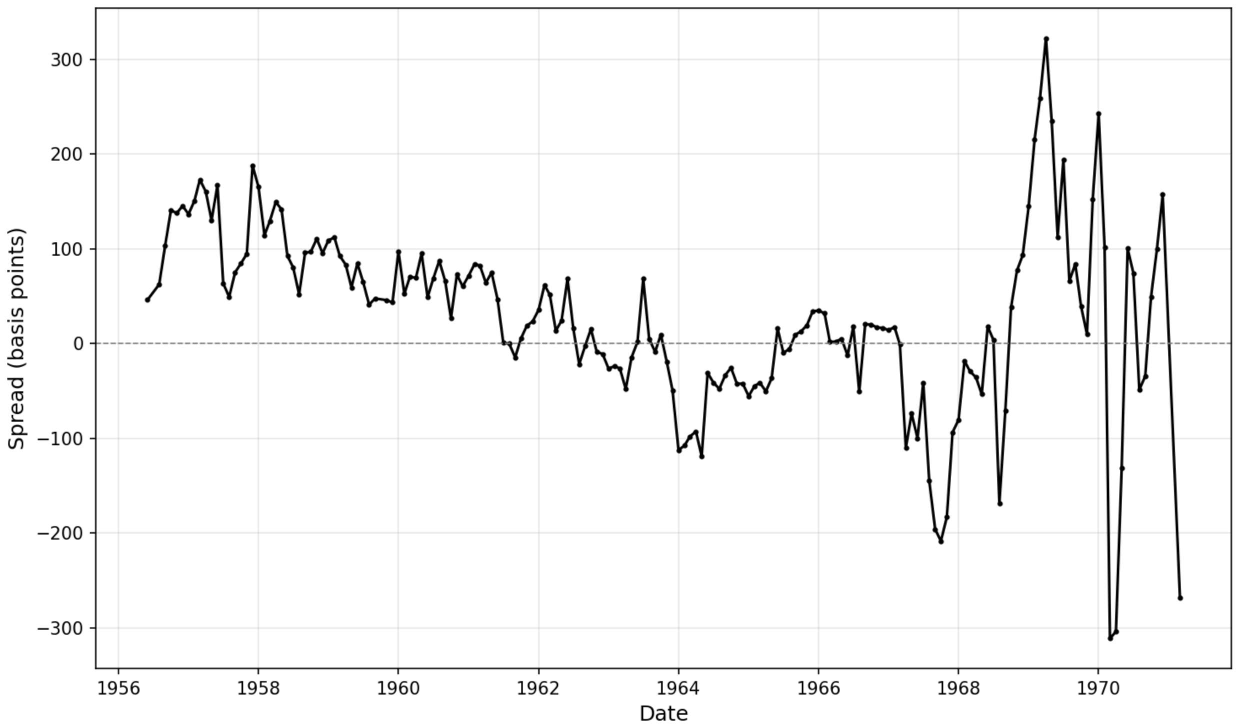
During the first part of our sample period (1956–1963), the expected premium averaged 62 basis points, as the AR(1) model gradually incorporates the postwar economic expansion. Then, between 1964 and April 1968, as realized IP exceeded model forecasts and the bond

Figure 9: Monte Carlo Expected Yields to Maturity



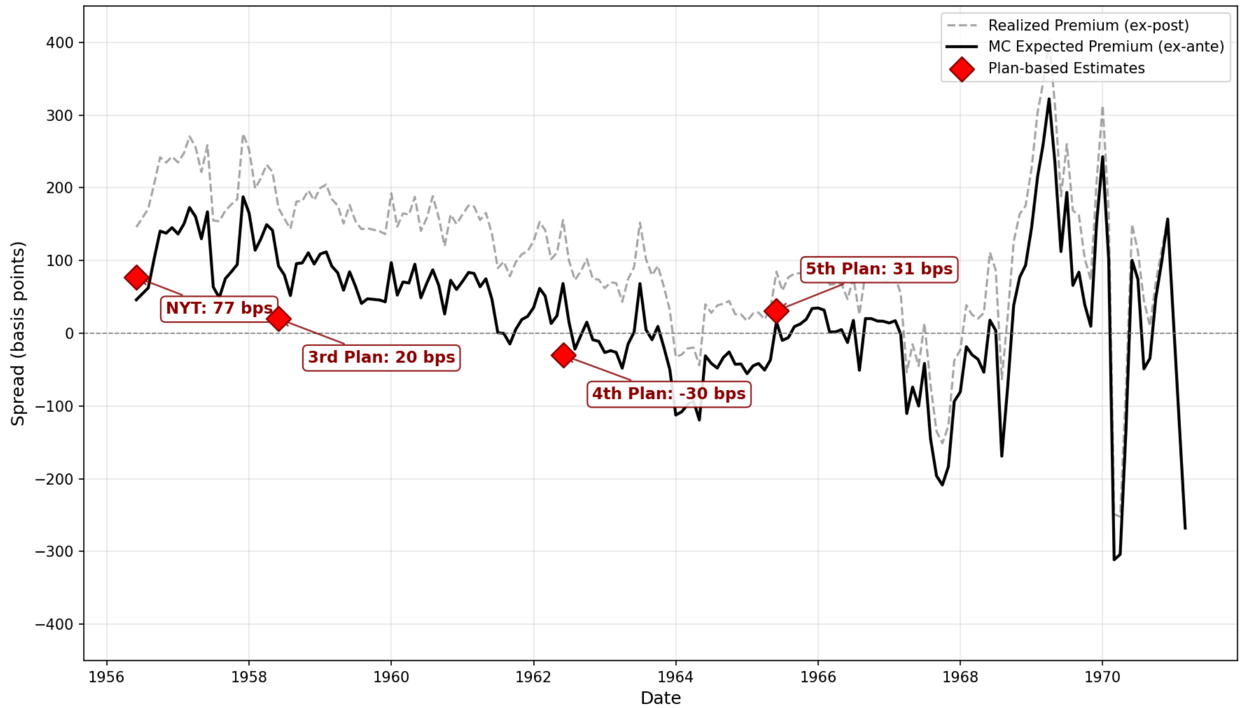
Note: Expected yields to maturity computed using Monte Carlo simulations for the state-contingent bond (BEIA, dashed line) and the traditional bond (BPTT, solid line). At each date, the YTM is computed as the internal rate of return equating the observed market price to the stream of expected future cash flows, where expected BEIA coupons are averaged across 10,000 simulated IP paths.

Figure 10: Monte Carlo Expected State-Contingent Debt Premium



Note: The solid line shows the Monte Carlo expected state-contingent debt premium computed using only backward-looking information at each date.

Figure 11: Monte Carlo Expected vs. Plan-Based State-Contingent Debt Premium



Note: The solid black line shows the Monte Carlo expected state-contingent debt premium, the dashed line shows the realized premium, and the diamond markers indicate plan-based point estimates: NYT forecast at issuance (77 bps), Third Plan in 1958 (20 bps), Fourth Plan in 1962 (−30 bps), and Fifth Plan in 1965 (31 bps for three-year horizon, 95 bps for five-year horizon).

approached maturity, the expected premium declined to an average of -41 basis points. Following the May 1968 general strike and the associated collapse in industrial production, the expected premium surged to an average of 187 basis points, consistent with the sharp repricing visible in Figure 1. This pattern reinforces the finding that the state-contingent debt premium responds asymmetrically to shocks.

Figure 11 compares the Monte Carlo expected premium with the plan-based estimates from the previous subsection. It is worth noting that the Monte Carlo exercise only differs in the expected coupons for the BEIA bond. Comparing to the realized premia estimates, the two measures share the same market prices and the exact same computation for the BPTT bond. Price movements explain most of the variation in both the realized and the Monte Carlo series. The difference between the two captures how much of the observed spread exceeds the risk-neutral value implied by an AR(1) Industrial Production forecast.

5 Unpacking the State-Contingent Debt Premium

In this section, we examine arguments made in the literature about the state-contingent debt premium using our data and empirical estimates. We begin by asking whether the premium can be interpreted as compensation for bearing systematic risk, using a standard CAPM framework. We then turn to liquidity risk. Note that the BEIA issuance is roughly four times larger than the BPTT, so there could be liquidity differences between the two markets. Because there are no available data on volume traded or bid-ask spreads for these bonds, we show that implicit bid-ask spreads based on Roll (1984) were small and similar for the two bonds. [12]

One potential remaining issue is that the traditional bond, BPTT, had been issued multiple times before 1956. The state-contingent bond, BEIA, was issued for the first time in 1956. However, other state-contingent bonds had been issued in the past. If novelty risk plays a role, the computed state-contingent debt premium we compute may be overestimated. Although it is difficult to observe the novelty premium, as Chamon, Costa, and Ricci (2008) and Consiglio and Zenios (2018) note, it should be transitory.

Finally, we explore the cyclical properties of our estimated state-contingent debt premium and discuss how these related to explanations based on risk and ambiguity aversion.

5.1 Systematic Risk and the State-Contingent Debt Premium

We examine whether the BEIA-BPTT total return spread is exposed to systematic equity market risk. If the state-contingent premium compensates investors for bearing aggregate

[12] See Accominotti, Albers, and Oosterlinck (2024) for a use of this method in a different historical laboratory.

risk, the spread return should co-vary with a broad market factor. To implement this test, we compute monthly total returns for both bonds (month-over-month price changes plus accrued coupon income) and regress the monthly spread return on the return of a French equity market index.[13]

Because the BEIA coupons are backward looking, that is, each year's coupon payment is determined by industrial production in the *prior* calendar year, we show results for two asset pricing regressions. One where the payoff-relevant state variable is always lagged by twelve months, and one where it is contemporaneous. Table 1 presents the results.

Table 1: CAPM Beta of the State-Contingent Debt Premium (Monthly)

	Spread (Lag 12m)	Spread (Contemp.)	BEIA	BPTT
Stock Mkt Return (t-12)	-0.011			
	(0.027)			
Stock Mkt Return (t)		0.015	-0.000	-0.016
		(0.025)	(0.020)	(0.022)
Constant	0.003***	0.002**	0.007***	0.005***
	(0.001)	(0.001)	(0.001)	(0.001)
Observations	160	170	172	170
R-squared	0.002	0.002	0.000	0.004

Note: The dependent variable is the monthly BEIA−BPTT spread total return in columns (1) and (2), the total return on BEIA bond in column (3) and the total return on BPTT bond in column (4). Column (1) uses the twelve-month-lagged French equity market return as the regressor. Columns (2)-(4) use the contemporaneous equity return. The sample covers September 1956 to December 1970 (four months—July–August 1956 and October–November 1959—are excluded due to missing trading prices). Equity index: "l'indice des valeurs françaises à revenu variable," base 100 in 1949. HC3 heteroskedasticity-robust standard errors in parentheses.

The twelve-month-lagged market beta is -0.011 and statistically indistinguishable from zero (column 1). The contemporaneous specification (column 2) yields a similarly small and insignificant beta of 0.015. Running the regressions on each bond separately, the BEIA

[13]The equity index, "L'indice des Valeurs Françaises 'a Revenu Variable," with base 100 in 1949, is from (*Bulletin Mensuel de Statistique*). Because the equity index is presented in this publication in terms of returns, we use total returns on the bonds rather than the yield-to-maturity-based measure used elsewhere in the paper to ensure that the units of both series employed in our regression analysis are comparable. An alternative approach would use a consumption-based SDF or a multi-factor model.

has a contemporaneous market beta that is effectively zero, while the BPTT has a slightly negative but insignificant beta of -0.016. The BEIA-BPTT total return spread therefore exhibits essentially no co-movement with the French equity market, regardless of whether one uses the lagged or contemporaneous specification.

These results suggest that the BEIA-BPTT spread exhibits no economically or statistically meaningful exposure to the equity market. Standard systematic-risk compensation therefore does not seem to account for the observed premium. We turn next to alternative explanations: liquidity, novelty, risk aversion, and ambiguity aversion.

5.2 Liquidity Premia

A key assumption underlying our calculation of the state-contingent debt premium is that the liquidity premia for both the traditional bond (BPTT) and the state-contingent bond (BEIA) are identical, allowing us to attribute any differences in yields exclusively to state-contingent factors. However, given the larger volume of the state-contingent bond, differences in liquidity premia could potentially bias our estimates. Unfortunately, direct measures of liquidity, like daily volumes or bid-ask spreads, are not available for these bonds. Therefore, we estimate the implicit bid-ask spread using a Roll test (Roll 1984), which can be implemented with daily price data and has been shown to effectively capture liquidity spreads (Goyenko, Holden, and Trzcinka 2009).

The Roll measure, or implicit bid-ask spread, relies on the principle that, in the absence of new information, short-term price movements predominantly reflect the bid-ask bounce, or prices tend to alternate between bid and ask prices. A negative serial covariance arises in price changes because transactions tend to alternate between purchases at the ask price and sales at the bid price, causing consecutive price changes to be negatively correlated. Thus, greater negative serial covariance indicates a greater bid-ask spread, reflecting higher transaction costs and lower liquidity.

The Roll test assumes that the likelihood that each transaction occurs at the bid price or the ask price is equal (50%), that the bid-ask spread is constant throughout the period analyzed, and that short-term price changes are driven purely by the bid-ask bounce rather than by new fundamental information. Let r_t represents the daily return computed from log price:

$$r_t = log(P_t) - log(P_{t-1}). \tag{10}$$

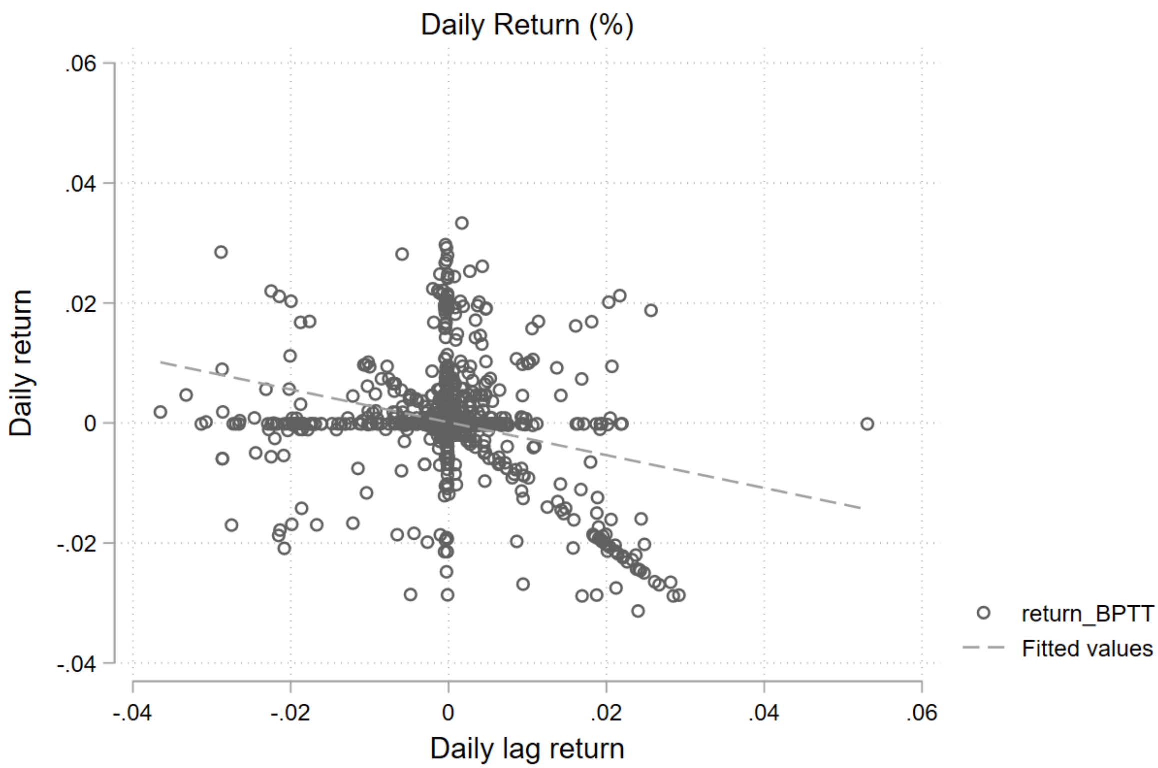
The implicit bid-ask spread in returns is then given by

$$S = 2\sqrt{-\operatorname{Cov}(r_t, r_{t-1})}, \tag{11}$$

provided that $\operatorname{Cov}(r_t, r_{t-1}) < 0$. The factor of 2 accounts for the round-trip cost of transacting at both the bid and the ask prices. A negative serial covariance $\operatorname{Cov}(r_t, r_{t-1})$ indicates the presence of the bid-ask bounce effect, allowing for the estimation of S. A larger estimated spread implies lower liquidity as it suggests higher transaction costs due to a wider bid-ask spread.

An important step in applying the Roll measure to our bond data involves correcting for the fact that, as briefly discussed earlier, we collected secondary market prices that include accrued interest, also known as "dirty prices." Bonds naturally experience a gradual price increase as the coupon payment date approaches. Immediately following the coupon payment, the bond price experiences a predictable drop. If not corrected, these predictable price movements could introduce bias and spurious serial correlation in price changes, potentially affecting the Roll measure. To address this, we de-trend log prices separately within each coupon period using a linear trend, isolating liquidity-induced price fluctuations from deterministic price movements related to coupon accrual and payment. To implement the Roll measure, we use our hand-collected daily price data from the *Cote Desfossés* held by the French National Library and the Capital Markets of the World archive, spanning the

Figure 12: Return serial correlation for BPTT



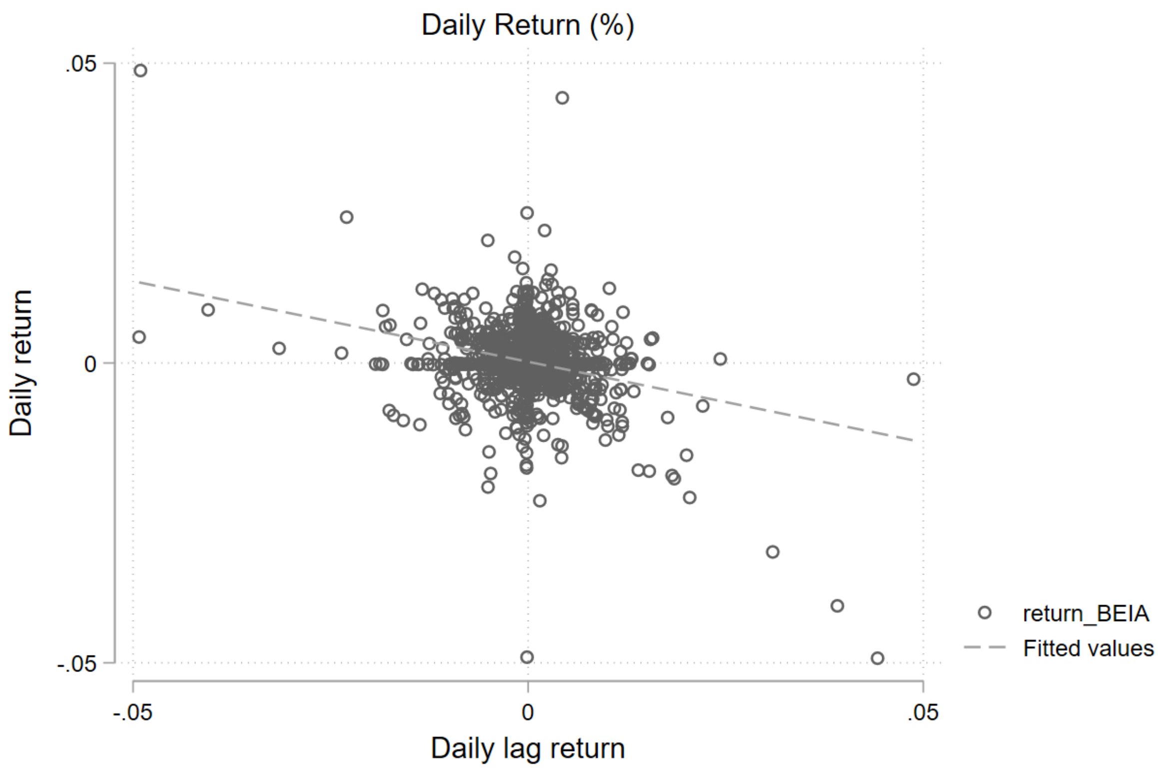
Note: Scatter of r_{t-1}^{BPTT} vs. r_t^{BPTT} with the OLS fit line from $r_t^{BPTT} = \alpha + \beta\, r_{t-1}^{BPTT} + \varepsilon_t$. The negative slope ($\hat{\beta} < 0$) indicates first-order negative autocorrelation.

period from May 1956 to 1971. A few observations are missing due to a lack of transactions on specific days, archival limitations, holidays, or disruptions such as those caused by strikes in 1968. We further exclude non-trading days, including weekends and French public holidays, and omit price observations on coupon payment dates to avoid artificially induced volatility.[14]

Figure 12 plots the comovement between today's return, and yesterday's return for the BPTT, while Figure 13 does the same for the BEIA, together with the fitted values. We use

[14]Starting on August 14, 1956, when BEIA prices were first posted, we have a total of 451 missing observations for the BPTT out of 3,717 trading days, while for the BEIA, there are 455 missing observations over the same period.

Figure 13: Return serial correlation for BEIA



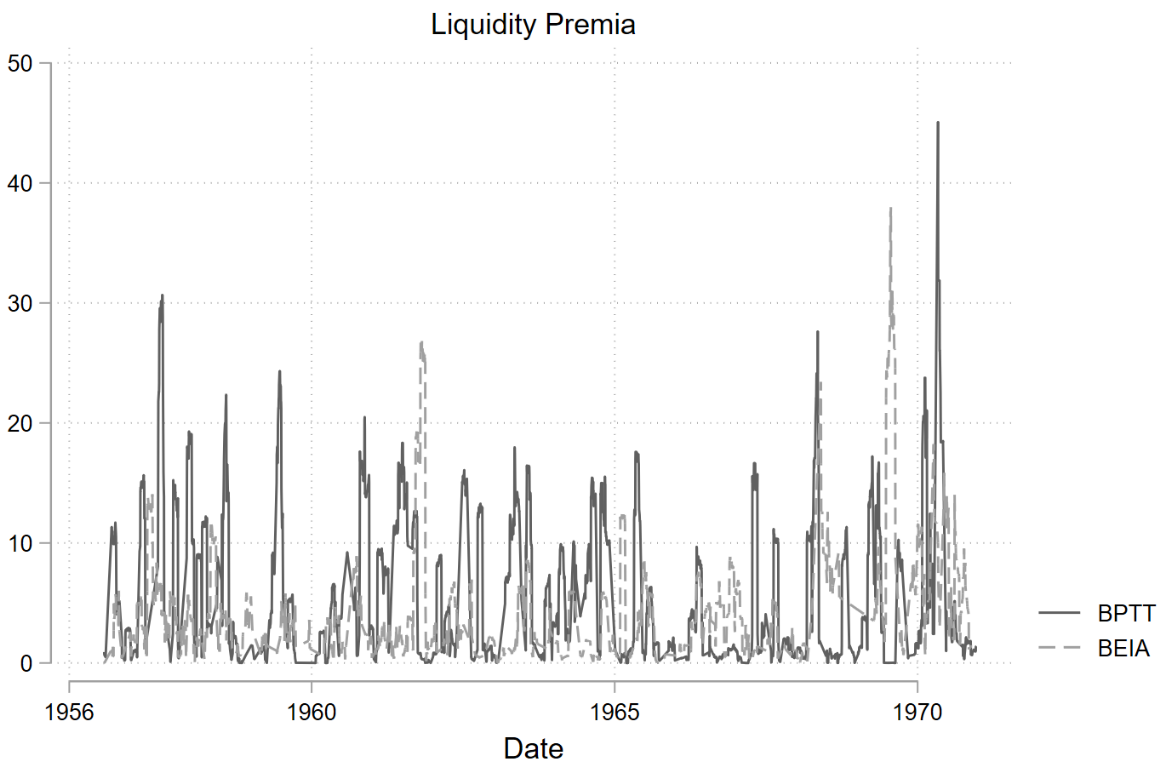
Note: Scatter of r_{t-1}^{BEIA} vs. r_t^{BEIA} with the OLS fit line from $r_t^{BEIA} = \alpha + \beta\, r_{t-1}^{BEIA} + \varepsilon_t$. The negative slope ($\hat{\beta} < 0$) indicates first-order negative autocorrelation.

end-of-day prices for the two bonds. Both bonds display negative serial covariance returns for most of the sample. Therefore, we can apply the Roll test.

We use a rolling 21-day window to compute the serial covariance of detrended price returns. We obtain daily estimates of liquidity premia for each bond over the subsequent 21-day trading period, which roughly corresponds to a month. Figure 14 shows the results for the estimated liquidity premia for both bonds.

Over our sample period, the average implied bid-ask spread is 6 basis points for the BPTT bond and 5 basis points for the BEIA bond. These results are robust to using different 41,

Figure 14: Estimated Liquidity Premia for the BEIA and the BPTT bonds



Note: This figure computes estimated liquidity premia using the implicit bid-ask spread computed with the Roll method with a rolling 21-day window.

61, 81 or 101 day windows. They are also robust to excluding the time trend; however, it is possible to see substantial time-variation in estimated liquidity premia.

Given the similar estimates for liquidity premia for both bonds, it follows that the liquidity-adjusted premia are quite similar to the unadjusted estimates, and provides evidence that differential liquidity premia was not significant for these two bonds. Hence, for our sample, liquidity does not significantly distort our measured state-contingent debt premium.[15] This result contrasts with the findings in Igan, Kim, and Levy (2021), who show

[15]Let l represent the liquidity premium and x the yield to maturity. The corrected premium is obtained as SCD $\text{Premium}_{m,y} = x^{\text{SCD}}_{m,y} - l^{\text{SCD}}_{m,y} - \left(x^{\text{Conv}}_{m,y} - l^{\text{Conv}}_{m,y}\right)$.

larger and more volatile liquidity premium in recent state-contingent debt instruments.

5.3 Novelty Premium

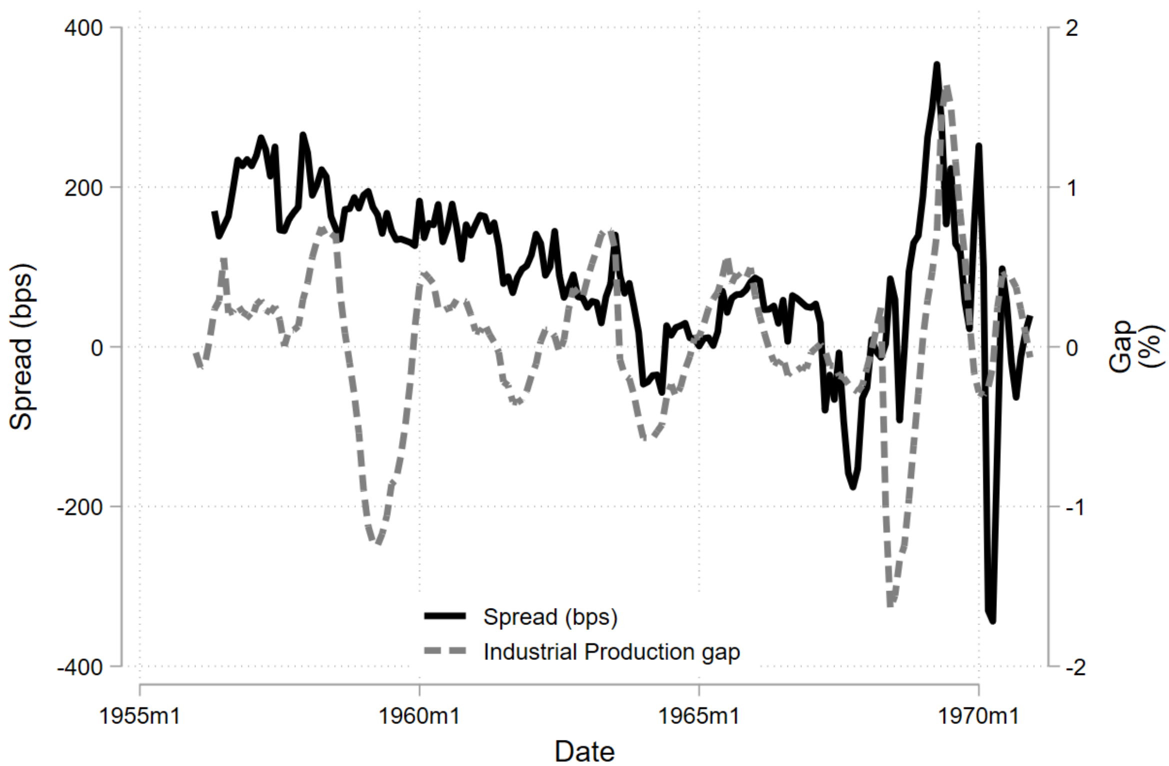
As Chamon, Costa, and Ricci (2008) argue, a novelty premium should produce decreasing spreads over time as investors become familiar with a new instrument, a factor we can examine given the long span of our data relative to more recent SCD issuances. Visual inspection of the realized series shows a downward drift; however, this trend is interrupted in 1963 and again in 1968. A regression of the monthly realized spread on a linear time trend (Table 2) yields a coefficient of -0.95 basis points per month, significant at the 1% level. Note, however, that a simple time-series regression of this kind cannot separate novelty from maturity. Bonds traded later in the sample mechanically have shorter residual maturities, so a declining spread may reflect investors pricing a shorter remaining stream of state-contingent coupons rather than a fading novelty effect. To hold maturity fixed, we compare our ex-ante estimates of the expected state-contingent debt premium at a three-year horizon in 1958, 1962, and 1965. The estimates for these three dates are respectively 20, -30, and 31, and thus do not exhibit a monotonic decline over our sample period. Moreover, they are smaller than the corresponding estimates at longer horizons (77 basis points over 15 years in 1956 and 95 basis points over five years in 1965). We therefore do not interpret novelty as the primary driver of the observed spread dynamics in our sample.

5.4 Cyclicality, Risk, and Ambiguity Aversion

We use monthly data on business cycle variables from Monnet (2014) to investigate the cyclical properties of our measured realized state-contingent debt premium. Figure 15 plots the estimated state-contingent debt premium together with the Industrial Production Gap estimated using the HP-filter with smoothing parameter equal to 14,400.

Table 3 displays the results of a regression of realized state-contingent spreads on a linear time trend and on the industrial production (IP) gap. The industrial production gap is

Figure 15: The State-Contingent Debt Premium and the Output Gap



Note: This figure displays the estimated state-contingent debt premium (left axis) together with the Industrial Production Gap (Gap, right axis) estimated using the HP-filter with smoothing parameter 14,400.

Table 2: Novelty Premium

	(1) Realized Spread (basis points)
Linear Time Trend	-0.946***
	(0.174)
Constant	191.1***
	(10.68)
Observations	174
R-squared	0.216

Note: The table presents results from a regression of spreads (in basis points) on a linear time trend using monthly data. The constant is the regression intercept (fitted spread at t=0), and the time trend coefficient indicates the average change in spreads over time. Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1

expressed in percentage-point deviations from trend. In column (1), the coefficient of roughly 54 implies that a one-percentage-point increase in the IP gap is associated with an increase of about 54 basis points in the realized spread. Across all specifications shown in the table, the contemporaneous IP gap enters with a positive sign, indicating that the spread is pro-cyclical, widening when output is above trend and narrowing when it is below. This procyclicality is inconsistent with standard risk aversion, which would predict a counter-cyclical spread, or a higher premium in bad states when investors' marginal utility of consumption is high. Igan, Kim, and Levy (2021) argue that procyclicality of this kind may instead reflect ambiguity aversion.

Given that the coupon payment is computed with respect to the value of industrial production in the previous year (defined as the average of the monthly values), we include specifications with contemporaneous values of the industrial production gap as well as lagged values. Columns (1) to (4) show that the contemporaneous industrial production gap is consistently significant, while the six- and twelve-month lags lose statistical significance when the contemporaneous gap is included (Column 4).

Column (5) replaces the fixed lags with a variable lag tailored to the timing of the coupon payment. The BEIA coupon is paid on June 1st of year $t+1$, and is based on the average level of industrial production in the previous year t. We therefore construct a *relevant lagged gap* equal to the twelve-month moving average of the output gap that is most informative about the next June coupon, which is defined as follows: for observations in May of year $t+1$, it is the twelve-month average through December of year t (five-month lag); for April, it is four months lagged; through January, it is one-month lagged. For observations from June through December of year t, the lagged gap is simply the trailing twelve-month average ending in the current month since that is the best available forecast of the June $t+1$ coupon. In Column (5), this lagged gap has a negative sign, but statistically insignificant coefficient, while the contemporaneous gap remains positive and statistically significant. Investors appear to price the spread off current economic conditions rather than off the backward-looking quantity that mechanically determines the next coupon.

However, we view the ambiguity-aversion interpretation of our data as an incomplete account. The most striking example of what that perspective misses in our data appears is May 1968, when a general strike caused a sharp drop in industrial production. The realized spread rose immediately, remained elevated throughout 1969, and only declined in 1970. Under ambiguity aversion, the spread should have fallen in this bad state. Instead, we observe the opposite.

Table 3: State contingent debt premium and output gap

	Realized Spread (basis points)				
	(1)	(2)	(3)	(4)	(5)
Linear time trend	-0.962***	-0.932***	-0.837***	-0.852***	-0.946***
	(0.165)	(0.182)	(0.191)	(0.183)	(0.161)
IP gap at t	54.29***			50.53***	57.78***
	(15.39)			(17.39)	(15.69)
IP gap at $t-6$		-21.54		-21.47	
		(22.49)		(22.68)	
IP gap at t-12			-32.94**	-10.93	
			(14.78)	(14.81)	
Relevant lagged gap					-41.80
					(26.73)
Constant	94.77***	95.70***	93.88***	93.23***	95.27***
	(8.342)	(8.622)	(8.320)	(7.964)	(8.159)
Observations	174	169	163	163	174
R-squared	0.288	0.210	0.185	0.250	0.310

Note: This table presents the results from regression specifications examining the relationship between bond spreads and a time trend variable as well as the industrial production gap (gap). Models include various lags of the industrial production gap to capture both immediate and delayed effects on bond spreads. Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

6 Conclusion

We estimate premia on state-contingent debt instruments relative to conventional bonds using a quasi-twin bond strategy and unique bond data from postwar France. Our empirical approach is novel in that this state-contingent bond was issued in a developed economy, outside of a debt restructuring, and in a context where indexed bonds were relatively common. Given that we have a natural control bond, our methodology relies on a limited number of assumptions and therefore provides direct computations of risk premia.

The analysis of bonds issued in France in 1956 shows that the initial expected yield for the state-contingent bond was 77 basis points higher than its conventional counterpart. The realized yields at issuance were even larger, 146 basis points. However, by 1964, the premium had fallen to zero. It then increased after the shock of the labor strike in the summer of 1968. Monte Carlo simulations corroborate this pattern. Because both bonds were issued through subscription at a fixed price rather than by auction, estimates for the first few observations of our sample period should be interpreted with caution: initial market prices may not reflect fundamentals and some time is likely needed for secondary-market pricing to reflect state-contingent premia.

Overall, our results suggest that the state-contingent debt premium may be relatively low in good times, when the bonds are paying well above the minimum threshold, but may actually be large at issuance or in bad times. Crucially, these may be the periods when this debt is most useful for borrowers. Our findings are consistent with the existence of a novelty premium in state-contingent debt, a pro-cyclical risk premium outside of extreme events, but a counter-cyclical risk premium during large shocks. The spread also displays no meaningful exposure to the French equity market, indicating that the premium does not reflect compensation for systematic risk. However, contrary to previous research, our results suggest that state-contingent debt may not be prohibitively expensive, preserving the potential benefits of state contingency.

Future research could extend our analysis to other state-contingent public bonds in France or to private bonds with state-contingent features. Although it may be difficult to implement a twin-bond strategy for these bonds, other approaches may be employed to explore this unique laboratory from history. Finally, investigating the long-term performance of SCDIs, particularly their impact on debt sustainability, is another area calling for additional research. Our findings contribute to the understanding of state-contingent debt markets and highlight the costs of issuing these types of debt; however, a full account of costs and benefits is necessary to inform policy makers and market participants.

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