Corporate Basis and Demand for U.S. Dollar Assets

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This version: September 29, 2024

Abstract

The corporate basis measures price differences between bonds issued in U.S. dollars and foreign currencies by the same entity. We introduce a novel decomposition into credit spread and convenience yield components, capturing investor demand for risky and safe dollar assets. With a comprehensive dataset of corporate bond issuance and pricing, we employ bond market liquidity, investor sentiment, and monetary policy as instruments to identify shocks to the demand for dollar assets. A negative shock to risky dollar asset demand shifts investors toward safe dollar assets and is associated with U.S. dollar appreciation and a subsequent decline in real economic activity.

Keywords: Dollar Asset Demand, Credit Spread, Covered Interest Rate Parity, Bond Market Liquidity

JEL Classifications: E44, F30, F31, F32, F41, G11, G12, G15, G18, G20

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¶We would like to thank Rodrigo Barria, Lorenzo Bretscher, Hui Chen, Andrea Gamba, Zhe Geng (discussant), Arie Gozluklu, Bing Han, Brandon Yueyang Han (discussant), Harald Hau (discussant), Marcin Kacperczyk, Tao Liu (discussant), Francis Longstaff, Dong Lou, Yiming Ma, Quan Qi (discussant), Giulio Rossetti, David Skeie and Haonan Zhou (discussant); seminar participants at Renmin University, Singapore Management University, Tsinghua University, Xiamen University, Warwick Business School, Zhejiang University, 53rd MMF Annual Meeting, 2023 Asian Meeting of the Econometric Society, 2023 China International Conference in Macroeconomics, 2024 China International Conference in Finance, 2022 CIFER Annual Meeting, 2023 European Finance Association Annual Meeting, 2022 Finance Management Annual Meeting, 2023 FMA European Conference, 39th Conference of the French Finance Association, 2023 IFABS Annual Meeting, and 2022 New Zealand Finance Meeting for helpful comments and suggestions. We would also like to thank Gerardo Ferrara, Philippe Mueller and Tsvetelina Nenova for help with the data. We thank Gordon Y. Liao for kindly sharing his codes. All errors are our own.

1 Introduction

The corporate basis is a measure of price discrepancies between corporate bonds issued in different currencies by the same entity. A no-arbitrage condition, it states that corporate bond yields are equalized across markets after hedging currency risk. However, since the global financial crisis (GFC), the corporate basis between the U.S. dollar (USD) and foreign currencies exhibits substantial time variation, due to economic forces such as the demand for dollar assets and scarcity of dollars in cross-border financing (Figure 1).

Prior literature primarily examines the corporate basis from the issuers' perspective, associating its variation with firms' currency preferences in debt financing (Liao, 2020; Caramichael, Gopinath, and Liao, 2021; Galvez et al., 2021). On the other hand, empirical insights into the corporate basis's relevance for corporate bond issuers remain scarce, largely owing to an absence of data on their hedging practices. In this paper, we shift the focus to the perspective of global bond market investors, a cohort known for their widespread engagement in currency hedging (Sialm and Zhu, 2023; Liao and Zhang, 2024). By introducing a novel decomposition of the corporate basis, we aim to disentangle the economic drivers behind its variation, such as the appetite for safe and risky U.S. dollar assets, and the scarcity of U.S. currency in cross-border markets. We outline the three components:

1. Credit Spread Differential (CSD): This measures the difference in credit spreads between corporate bonds denominated in non-USD currencies and their USD-denominated counterparts. This component measures the relative riskiness of dollar-denominated corporate debt.

2. Convenience Yield Differential (CYD): It measures the yield spread between foreign government bonds and U.S. Treasuries. This component measures the perceived safety of dollar-denominated debt versus that of other sovereign issuers.

3. Cross-Currency Basis (CCB): Defined as the difference between synthetic and direct dollar funding costs in foreign exchange (FX) swap markets. This component quantifies the degree of dollar scarcity and the relative cost of obtaining dollars in cross-border markets.

Through this decomposition, we identify shocks to the demand for both risky and safe dollar-denominated assets, using bond market liquidity, investor sentiment, and monetary policy as instruments. Our key contribution is to document a substitution effect between these two asset classes. Furthermore, we extend our analysis to examine the effect of dollar asset demand shocks on exchange rates, equity and commodity markets, as well as their implications for real economic activity.

We start our analysis by estimating our decomposition of the corporate basis. We exploit a universe of 30,926 corporate bonds spanning from January 2004 to March 2021, covering issuance in six major funding currencies, the Australian Dollar (AUD), Canadian Dollar (CAD), Swiss Franc (CHF), Euro (EUR), British Pounds (GBP), and Japanese Yen (JPY), relative to the U.S. Dollar (USD). Following Liao (2020), we employ cross-sectional regression analyses to account for issuer-specific characteristics, thereby precisely isolating the constituent elements of the corporate basis, namely the CSD, CYD and CCB. Critically, our approach aggregates the pricing of corporate and government bonds at the currency level, which serves to enhance the sensitivity of our estimates to market-wide demand shocks.[1] Therefore, variation in CSD and CYD reflect changes in the demand for risky and safe dollar assets, respectively.

We next identify a substitution effect between risky and safe dollar assets. As motivating evidence, we use foreign investors' net acquisitions of these assets, based on data from the Treasury International Capital (TIC) system, a comprehensive record of monthly cross-border transactions involving U.S. assets facilitated by U.S.-based broker-dealers. Our analysis reveals a significant surge in foreign demand for safe dollar assets during the 2008 Global Financial Crisis and the European debt crisis of 2011-2012, alongside a sharp divestment from risky dollar assets. These findings reinforce our narrative of a substitution effect.

To formally establish the substitution effect, we employ a structural Vector Autoregression (SVAR) model to examine the intertemporal comovement of the corporate basis's components. Our identification strategy utilizes external instruments (IV) to isolate the causal impact of shocks on the credit spread (CSD) and convenience yield (CYD), following the methodology in Gertler and Karadi (2015). We construct bond market liquidity and sentiment as instruments for CSD by estimating aggregate illiquidity of USD versus non-USD corporate bonds, and by creating a proxy to capture fluctuations in relative sentiment between U.S. and international credit markets. These instruments are chosen based on their capacity to influence demand for USD-denominated corporate bonds while remaining exogenous to factors affecting the appetite for safe dollar assets and dollar scarcity in cross-border markets.

Additionally, we construct an instrument for CYD based on U.S. monetary policy surprises. This instrument is derived from a principal components analysis of high-frequency fluctuations in federal funds rates and Eurodollar futures interest rates around scheduled Federal Open Market Committee (FOMC) announcements (Nakamura and Steinsson, 2018). We hypothesize that a contractionary shift in U.S. monetary policy drives increased demand for Treasury securities from passive international investors favoring low-

1. Chaudhary, Fu, and Li (2023) show that the bond price impact of demand shocks increases monotonically with the aggregation level. Li and Lin (2022) also provide consistent evidence from the stock market.

risk assets, as observed by Yellen (2011). As a result, we expect investors to reallocate toward safe dollar assets, thereby reducing their demand for risky dollar assets.

Our IV estimates provide strong evidence of the substitution effect between risky and safe dollar assets. Using bond illiquidity and sentiment as instruments for the CSD shock, we find that a one standard deviation increase in USD credit spreads relative to those in foreign currencies (18.2 basis points) leads to a 3.56 basis point rise in CYD. Conversely, when using monetary policy surprises as an instrument for CYD shocks, we establish that a one standard deviation increase in CYD (18 basis points) induces an 11.18 basis point decline in CSD. These results confirm the proposed substitution effect between the two asset classes.

Next, we examine the impact of shocks to dollar asset demand on financial markets and the broader macroeconomy. We find that demand for both risky and safe dollar assets significantly predict exchange rate movements. An increase in the corporate basis, driven by the CSD component, results in a marked depreciation of the USD. In contrast, an increase in the Treasury premium, reflecting demand for safe dollar assets and cross-border liquidity scarcity, leads to USD appreciation. Therefore the flight to safety and the substitution between risky and safe dollar asset demand leads to a USD appreciation, a result consistent with the evidence on the U.S. Treasury premium and the strength of the USD presented in Jiang, Krishnamurthy, and Lustig (2021).

Lastly, we find spillovers of a negative shock to the demand for risky dollar assets to measures of economic activity, which includes key indicators such as the Consumer Price Index (CPI), industrial production, unemployment rates, real Gross Domestic Product (GDP), real investment, and real consumption. These findings are consistent with previous research on the effects of credit spreads on real economic outcomes (Gilchrist and Zakrajšek, 2012; Gertler and Karadi, 2015).

Related Literature. Our paper relates to a literature studying the determinants of the U.S. Treasury premium, which includes changes in Treasury ownership, tight banking regulation and sovereign default risk (Du, Im, and Schreger, 2018; Jiang, Krishnamurthy, and Lustig, 2021; Augustin et al., 2021; Klingler and Sundaresan, 2020; Duffie, 2020; Vissing-Jorgensen, 2021; He, Nagel, and Song, 2022). Du, Im, and Schreger (2018) measure the U.S. Treasury premium as the difference in the convenience yield of U.S. Treasuries and non-U.S. government bonds, and Jiang, Krishnamurthy, and Lustig (2021) show that the safety and convenience of U.S. Treasuries can be used to predict the strength of the USD. Our contribution is to decompose time series variation in the corporate basis into factors that capture the demand for risky and safe dollar assets.

We also contribute to the literature on the determinants of covered interest parity (CIP) deviations and the corporate basis (Du, Tepper, and Verdelhan, 2018; Liao, 2020; Caramichael, Gopinath, and Liao, 2021). Du, Tepper, and Verdelhan (2018) document a persistent CIP deviation after the GFC, and a number of studies provide explanations on banking regulation, heterogeneous funding costs, interest rate differentials, monetary policy, and effective funding rates in OTC markets.[2]

Our paper is closest to Liao (2020), which studies the decomposition of the corporate basis into a credit spread and CIP component, where the former is calculated as the difference between corporate bond yields and London Interbank Offered Rate (LIBOR) swap rates. Our primary innovation over this methodology is to decompose the corporate basis into three components, the credit spread, convenience yield and CIP deviation across currencies, thereby offering more insights into their joint dynamics and the substitution between safe and risky asset demand.[3] The addition of a convenience yield component is complementary to the findings of Diamond and Van Tassel (2022), who identify convenience yield differences as an important driver of corporate basis variation.

Finally, our study draws upon the literature studying the impact of bond market frictions on corporate bond pricing (Bao, Pan, and Wang, 2011; Dick-Nielsen, Feldhütter, and Lando, 2012; Friewald, Jankowitsch, and Subrahmanyam, 2012; Friewald and Nagler, 2019; He, Khorrami, and Song, 2022). While most of these studies concentrate on pricing implications for the U.S., a notable exception is Huang, Nozawa, and Shi (2023), which demonstrates the importance of bond illiquidity in accounting for pricing errors of structural credit models across countries. We complement this body of work by presenting evidence that liquidity shocks in the U.S. dollar bond market significantly influence the cross-border demand for risky dollar assets. Notably, our instruments, which include measures of bond illiquidity and market sentiment, emerge as robust predictors of the credit spread differential between USD and non-USD bonds.

The remainder of the paper is structured as follows. In section 2, we discuss our framework for estimating the determinants of the corporate basis and the data sources. Section 3 presents our main empirical findings on the substitution effect between safe and risky dollar assets, and the effect of shocks to risky dollar asset demand on financial markets and real economic activity. Section 4 concludes.

2. These studies include, but are not limited to, Borio et al. (2016), Avdjiev et al. (2019), Rime, Schrimpf, and Syrstad (2022), Abbassi and Bräuning (2021), Bräuning and Ivashina (2020), Viswanath-Natraj (2020), Cenedese, Della Corte, and Wang (2021), Cerutti, Obstfeld, and Zhou (2021), Augustin et al. (2024), and Zeev and Nathan (2024).

3. An important difference with Liao (2020) is that we measure credit spreads as the difference between corporate and government bond yields. The sum of our credit spread and convenience yield component is equal to the credit spread defined in Liao (2020). For more details we refer readers to the outline of our decomposition of the corporate basis in Section 2.

2 Definitions and Data

2.1 Decomposition of Corporate Basis

Consider corporate debts denominated in EUR and USD. In Eq. (1), we represent the yield disparity as the EUR bond yield minus the USD bond yield while controlling for foreign exchange (FX) risk. This representation captures the excess return that investors demand from investing in EUR-denominated corporate debt over a synthetic yield strategy. The latter involves holding a USD-denominated bond from the same issuer ($y_{\$,t}$) and hedging the associated currency risk in the FX market. The cost of FX hedging is denoted as $-(f_t - s_t)$, where s_t and f_t represent the spot and forward (log) exchange rates quoted in EUR per USD. Furthermore, we express the corporate basis in Eq. (2) as the combination of a CSD, which captures variations in the demand for risky assets across currencies, and the U.S. Treasury premium (Du, Im, and Schreger, 2018; Jiang, Krishnamurthy, and Lustig, 2021).

$$\Psi_t = \underbrace{y_{e,t}}_{\text{EUR-denominated bond yield}} - \underbrace{(y_{\$,t} + f_t - s_t)}_{\text{FX-hedged USD-denominated bond yield}} \tag{1}$$

$$= \underbrace{\left[(y_{e,t} - y^G_{e,t}) - (y_{\$,t} - y^G_{\$,t})\right]}_{\text{Credit spread differential}} + \underbrace{\left[(y^G_{e,t} + s_t - f_t) - y^G_{\$,t}\right]}_{\text{U.S. Treasury premium}} \tag{2}$$

$$= \underbrace{\left[(y_{e,t} - y^G_{e,t}) - (y_{\$,t} - y^G_{\$,t})\right]}_{\text{Credit spread differential}} + \underbrace{\left[(y^G_{e,t} - y^{rf}_{e,t}) - (y^G_{\$,t} - y^{rf}_{\$,t})\right]}_{\text{Convenience yield differential}} + \underbrace{\left[(y^{rf}_{e,t} + s_t - f_t) - y^{rf}_{\$,t}\right]}_{\text{Cross-currency basis}} \tag{3}$$

Our focal point in this paper is the decomposition presented in Eq. (3). $y^{rf}_{e,t}$ and $y^{rf}_{\$,t}$ denote the risk-free rates for euros and dollars, respectively, and $y^G_{e,t}$ and $y^G_{\$,t}$ are the corresponding government bond yields. Departing from previous studies on the corporate basis, we dissect the Treasury premium into two components: the relative expensiveness of the U.S. Treasuries, which is denoted by the convenience yield differential, and the cross-currency basis. Consequently, our decomposition encompasses three integral elements: differences in risky asset yields (credit spread differential), differences in sovereign yields (convenience yield differential), and FX market frictions (cross-currency basis). We provide more details on each component below.

Credit spread differential (CSD). CSD is the difference in credit spread between bonds with denominations in foreign currencies and bonds denominated in the dollar. A decrease in CSD indicates a reduced demand for risky USD assets, and corresponds to an increase in the promised return (in excess of non-defaultable bonds) from holding

USD-denomination corporate bonds.

Convenience yield differential (CYD). CYD is the difference between the non-U.S. government bonds' yield spread and U.S. Treasuries' yield spread relative to risk-free rates. An increase in CYD indicates a relative preference for safe USD assets, with a corresponding lower excess return on holding the U.S. Treasury.

Cross-currency basis (CCB). CCB is the difference between synthetic dollar funding cost $(y^{rf}_{e,t} + s_t - f_t)$ and the direct dollar funding cost $(y^{rf}_{\$,t})$. A positive value indicates that foreign investors are willing to pay a premium on obtaining dollar funding via the FX swap market, reflecting a scarcity of dollars and a high cost of obtaining dollar funding via FX markets.

As will be discussed in Section 2.3, we implement this three-way decomposition for each currency. Since it is well-documented in the literature on demand elasticity that asset prices respond more to demands at more aggregated levels (Chaudhary, Fu, and Li, 2023; Li and Lin, 2022), we expect shocks to the relative demand for risky and safe dollar assets to impact our measures of CSD and CYD respectively. Therefore it follows that variations in CSD and CYD are adequate at capturing these demand shocks. To be more specific, a decrease in CSD largely reflects a decrease in *unhedged* demand for risky dollar assets, which may be attributed to heightened risk aversion among bond investors (such as during the financial crisis period). Similarly, CYD measures the *unhedged* demand for safe dollar assets.

We note that our decomposition of the corporate basis differs from Liao (2020), in which the CSD is defined as $(y_{e,t} - y^{rf}_{e,t}) - (y_{\$,t} - y^{rf}_{\$,t})$, and is equivalent to the sum of our CSD and CYD in Eq. (3). By calculating credit spreads using government bond as the benchmark rate, our decomposition enables us to separate the components reflecting the demand for safe and risky dollar assets. Our measure is consistent with industry practice. For example, credit spreads quoted in the *Wall Street Journal* and major U.S. (investment-grade) corporate bond indices, such as Bloomberg Barclays, ICE BofA, and FTSE IG, are all calculated using government bond yields as a benchmark.[4]

2.2 Data

2.2.1 Corporate Bond Data

Bond issuer characteristics. We build our corporate bond data set on the bond issuance information as retrieved from the SDC Platinum Global New Issues database.

4. The option-adjusted spreads (OAS) in the three indices are all based on government bond rates, and the ICE BofA offer a separate variable named "LIBOR OAS" besides the standard "OAS" variable.

This database contains various characteristics of each issue, including the notional principal, maturity date, coupon structure, currency of denomination, the issuer's country of origin, and indicators for option-like features. We filter the bond data with the following criteria: (1) the bond is denominated in one of the seven major funding currencies: AUD, CAD, CHF, EUR, GBP, JPY or USD; (2) the ultimate parent of the issuer has outstanding bonds denominated in multiple currencies, and at least one of them is a USD bond; (3) the bond is unsecured, non-puttable, non-convertible, non-perpetual, and has fixed-rate coupons; (4) the issuer is not in a government-related industry such as City government or National Government or City agency; (5) the bond has an initial maturity of at least one year and a notional principal of at least $50 million.

The filtered sample of debt issues is then merged with the pricing data from the secondary market. Specifically, we obtain month-end price quotes from Bloomberg (BGN), a widely used data sources for studies on the international corporate bond markets (Valenzuela, 2016; Liao, 2020; Geng, 2021). We link price quotes to bond characteristics via ISIN. Owing to the relative sparseness of pricing observations before 2004, we focus on the sample period from January 2004 to March 2021. To each bond-month observation, we assign a credit rating by following Dick-Nielsen, Feldhütter, and Lando (2012): we first look up its credit rating in the Standard & Poor's Global Ratings database; if its rating in that month is missing, we turn to the Moody's Default & Recovery Database; if the rating information is still unavailable, we use the rating from other agencies as displayed in Bloomberg (e.g., Fitch and Dominion). Finally, we calculate yield-to-maturity and winsorize it at 1% at the currency-month level to remove outliers.

The final data set consists of 30,926 bonds issued by 3,376 entities with a total notional of $23.6 trillion. Following Liao (2020), we identify bond issuers by the borrower ultimate parent's 6-digit CUSIP. In other words, we link the 3,376 (residency-based) entities to their immediate parents by utilizing the UPCUSIP variable in the SDC database. Table 1 illustrates the monthly average of the number of bonds, the notional value in billion dollars, and the number of ultimate issuers by rating and maturity categories. On average, we have around 6,970 bonds with notional values of $5,282 billion issued by 929 firms each month. The A rating category and the maturity group of 3-7 years take the largest share in terms of both the number of issues and the outstanding notional. In particular, the average time to maturity over all bond-month observations is around five years, which motivates our focus on CYD and CCB at the five-year maturity in our analysis.

Cross-border Issuance. In our sample, USD-denominated corporate bonds constitute approximately 40% (2,798) of the total bonds, representing 47% ($2,508 billion) of the outstanding notional value. When ranked by currency, USD-denominated bonds are followed by those denominated in EUR, JPY, GBP, CAD, CHF, and AUD, respectively. Foreign firms issue more than 43% of USD-denominated bonds, collectively accounting for 47% of the notional value of all USD-denominated bonds.Notably, over 86% of CHF-denominated corporate bonds are issued by foreign companies, a trend likely driven by the presence of international corporations in Switzerland.

We also present a visual representation of cross-border bond issuance in Figure 2, based on cross-sectional observations of the outstanding amounts toward the end of our sample period (March 2021). Our analysis focuses on bond issuers located in the U.S., Euro Zone, UK, Switzerland, Canada, Australia, and Japan. The size of each purple circle is indicative of the aggregate notional value of bonds issued by firms domiciled in these regions, with U.S. firms unsurprisingly accounting for the largest share of bond issuance in global corporate bond markets. They are followed by issuers in the EU, Japan, and the UK.

The thickness of the arrows, exemplified by those bridging the EU to the US, reflects the volume of USD-denominated bonds issued by European firms. A more granular examination reveals that the most substantial cross-border bond issuance occurs between the EU and the U.S., as well as between the UK and the U.S. The darkness of the arrow from the EU to the U.S. signifies the proportion of foreign currency bonds issued by European firms that are denominated in USD. These findings highlight that USD-denominated bonds hold a dominant position in the foreign currency bond market across all countries surveyed, with the notable exception of Australia, where the issuance of USD- and EUR-denominated bonds is of comparable magnitude. Overall, USD-denominated bonds lead the global corporate bond market, closely followed by EUR-denominated bonds.

2.2.2 Default-Free Interest Rates and Exchange Rates

Government bond yields, fixed rates of interest rate swaps, cross-currency swap basis, which is calculated using LIBOR rates, and spot exchange rates are obtained from Bloomberg. We extract the data with tenors of 1, 2, 5, 7, 10, 12, 15, 20 and 30 years if available. The calculation of the CIP deviation x_t and convenience yield differential λ_t follows Eq. (3), which are consistent with Du, Tepper, and Verdelhan (2018) and Du, Im, and Schreger (2018).

One concern with using LIBOR swap rates is the associated credit risk, as LIBOR represents an unsecured lending rate.[5] In the U.S., LIBOR has been replaced by the Secured Overnight Financing Rate (SOFR), which reflects the cost of borrowing cash overnight, collateralized by U.S. Treasury securities, and thus minimizes credit risk. Similar re-

5. Additionally, the credibility of LIBOR was compromised by manipulation scandals in 2012, leading to its discontinuation for new transactions after December 31, 2021.

placements have occurred globally, with countries adopting their respective benchmarks akin to SOFR: Australia's AUD Overnight Index Average (AONIA), Canada's Canadian Overnight Repo Rate Average (CORRA), Switzerland's Swiss Average Rate Overnight (SARON), the Euro Area's Euro short-term rate (ESTR), the U.K.'s Sterling Overnight Index Average (SONIA), and Japan's Tokyo Overnight Average Rate (TONA). Although Bloomberg provides historical data for these rates back to before 2004, their longest maturity is currently only 12 months. Consequently, our baseline analysis employs 5-year LIBOR rates, while our robustness tests utilize the new benchmarks with a 1-year maturity.

2.2.3 Supplementary Data

Treasury International Capital (TIC). We utilize the TIC database to provide quantitative evidence on the demand for dollar-denominated assets, specifically through monthly net purchases of U.S. long-term securities by foreign residents. The TIC data consists of two components in the Treasury SLT filing: external liabilities and external claims. We extract data on the aggregate monthly purchases and sales of U.S. securities by foreign countries at the asset class level.

Historical data on net purchases of U.S. assets are obtained from *Securities (A): U.S. Transactions with Foreign-Residents in Long-Term Securities*. To estimate foreign investors' net purchases of USD corporate bonds, we refer to *Corporate Bonds: U.S. Corporate Bonds (Long-term), Net Purchases*. Similarly, for U.S. Treasuries, we use *Treasury Bonds and Notes, Net Purchases*.[6]

Bond illiquidity. To construct a measure of aggregate illiquidity for each corporate bond market, we supplement the fixed-income and currency market information with data from several other sources. We include all bonds covered by the ICE BofA Global Corporate Index and High Yield Index to gather a representative sample for each currency.[7] We use daily quoted prices to estimate the Hasbrouck (2009) measure for each bond-month and then aggregate them to the currency level.

Sentiment. We follow López-Salido, Stein, and Zakrajšek (2017) by quantifying bond yield spreads net of estimates of default risk and liquidity risk. Following Gilchrist and

6. Two limitations of the TIC data are noted in Bertaut and Judson (2014). First, the data records transactions based on the country of the initial cross-border counterparty, not the ultimate buyer, actual seller, or security issuer. Second, some types of cross-border securities flows that bypass standard broker-dealer and other TIC reporter channels are not captured. Despite these limitations, TIC data still offers valuable insights into the aggregate transactions of foreign investors in U.S. Treasuries and corporate bonds.

7. Huang, Nozawa, and Shi (2023) compare the BGN corporate bond data, our primary data source, with the ICE BofA data. For the bonds appearing in both databases, they find that the average credit spreads closely match each other regardless of currency denomination.

Zakrajšek (2012), we measure each issuer's default risk with the distance to default. To this end, we match month-end corporate bond prices from the ICE BofA database with their issuer's balance sheet data and equity data from Compustat NA (for the U.S. and Canada) and Compustat Global (for other countries).

Monetary policy surprises. We employ the methodology developed by Nakamura and Steinsson (2018) to construct U.S. monetary policy shocks. This approach involves analyzing the first principal component of changes in five interest rates: the Federal funds rate immediately following the FOMC meeting, the expected Federal funds rate after the next FOMC meeting, and the three-month Eurodollar rates for two, three, and four quarters ahead, specifically within a 30-minute window of scheduled FOMC announcements. Our high-frequency monetary policy shock measure is used in Acosta (2022), and we aggregate this data to a monthly frequency, with a default value of 0 during periods without scheduled monetary policy announcements.

2.3 Estimation of the corporate basis components

Corporate Basis. To estimate the corporate basis, we compare the promised returns on bonds while controlling for currency, maturity, and other characteristics. Following Liao (2020), we estimate the following cross-sectional regression:[8]

$$X_{i,t} = \alpha_{c,t} + \beta_{f,t} + \gamma_{m,t} + \delta_{r,t} + \epsilon_{i,t}, \tag{4}$$

where $X_{i,t}$ represents the corporate basis and is defined as follows:

$$X_{i,t} = \begin{cases} CS_{i,t} & \text{for USD,} \\ \\ CS_{i,t} + \text{CYD}_{c,t}^{(\tau)} + \text{CCB}_{c,t}^{(\tau)} & \text{for non-USD,} \end{cases} \tag{5}$$

where $CS_{i,t}$ is the corporate bond yield net of the government bond yield for bond i with the same maturity at time t, and τ denotes the bond's time to maturity. For non-USD currencies, the hedged yield spread additionally requires the inclusion of the CYD and CCB terms.

The specification includes firm-level fixed effects, $\beta_{f,t}$. Maturity-level fixed effects, $\gamma_{m,t}$, are controlled using four buckets: 1–3 years, 3–7 years, 7–10 years, and beyond 10 years. Rating fixed effects, $\delta_{r,t}$, are grouped into four categories: AAA & AA, A, BBB, and BB or below. Currency fixed effects, $\alpha_{c,t}$, capture the currency-specific component of the credit spreads after controlling for observable characteristics like maturity, credit

8. We exclude bond-month observations if the remaining maturity is less than one year or below 10% of the full maturity, to mitigate illiquidity concerns.

rating, and firm attributes.

The corporate basis at the aggregate level is then estimated as the difference in currency fixed effects derived from Eq. (4). Specifically, the corporate basis between currency c and the USD is expressed as $\Psi_{c,t} = \alpha_{c,t} - \alpha_{\text{USD},t}$.

Convenience yield differential (CYD). Following Jiang, Krishnamurthy, and Lustig (2021), we measure CYD using the difference between the yield spread of non-U.S. and U.S. government bonds. The yield spread of a government bond is the difference between its yield and the fixed rate of the maturity-matched interest rates swap (as the risk-free rate) denominated in the local currency.[9]

Cross-currency basis (CCB). Since we exclude corporate bonds with less than one year to maturity, CCB in our setting cannot be directly estimated from currency forward rates. Instead, we follow Du, Tepper, and Verdelhan (2018) by using spreads on LIBOR cross-currency basis swaps to quantify long-horizon CCB. The cross-currency swap involves a currency swap as well as exchanges of cash flow linked to floating interbank rates and thus offers a measure for long-term CIP deviations.

Credit spread differential (CSD). CSD measures the difference in corporate bond credit spread across currencies. We consider two approaches to estimating CSD. The first method involves calculating the CSD as a residual derived from our decomposition framework. Specifically, we utilize our estimates of the CYD and CCB

$$CSD^{Dec}_{c,t} = \Psi_{c,t} - \text{CYD}^{(5y)}_{c,t} - \text{CCB}^{(5y)}_{c,t}, \tag{6}$$

where we focus on the 5-year maturity to make the tenor of CSD aligned with the average maturity over all monthly corporate bond observations in our sample. The second approach estimates the following cross-sectional regression, which incorporates controls for bond-level characteristics,

$$CS_{i,t} = \alpha'_{c,t} + \beta'_{f,t} + \gamma'_{m,t} + \delta'_{r,t} + \epsilon'_{i,t}. \tag{7}$$

It follows that the CSD between currency c and USD can be calculated as $\text{CSD}^{Reg}_{c,t} = \alpha'_{c,t} - \alpha'_{USD,t}$.

Figure 3 serves as a robustness check for our CSD estimates by presenting alterna-

9. To ensure consistency in our analysis, we match the tenor of the CCB with the maturity of the corporate bonds using a linear interpolation method. This method applies to a range of maturities, specifically 1, 2, 5, 7, 10, 12, 15, 20, and 30 years. We employ the same interpolation technique to match the maturities between the CYD and corporate bonds. However, the selection of government bond maturities for interpolation depends on the actual data available. For instance, the maturities available for Australian government bonds are 1, 2, 3, 5, 7, 10, 20, and 30 years.

tive constructions of the CSD measure. The figure reveals a high degree of correlation, with coefficients ranging from 0.92 to 0.97, between the decomposition-based estimate (CSD^{Dec}) and the regression-based estimate (CSD^{Reg}) across all currency pairs. These results attest to the robustness of our CSD estimates.

In light of the consistency demonstrated by these findings, we opt to primarily employ the regression-based estimate (CSD^{Reg}) for our subsequent analyses. This decision is informed by the comprehensive control for bond-level characteristics that the regression-based approach affords, which enhances the accuracy of our estimates. However, we acknowledge that the decomposition-based method (CSD^{Dec}) also provides valuable insights and will be utilized where appropriate to validate our conclusions. Our approach ensures that our results are not unduly influenced by the choice of estimation technique.

2.3.1 Summary statistics

Figure 1 illustrates the monthly time series of the corporate basis for currency pairs involving USD and non-USD currencies (AUD, CAD, CHF, EUR, GBP, or JPY) from January 2004 to March 2021. The corporate basis represents the difference between the yield of non-U.S. corporate bonds and the hedged yield of U.S. corporate bonds. It exhibits negative spikes during two crisis periods (the GFC and Covid-19), suggesting either increasing hedging costs or reduced demand for risky dollar assets. Prior to the GFC, the basis was close to zero, but it deviated significantly and experienced significant fluctuations following the crisis.

Table 2 presents summary statistics of the three components of the corporate basis across different periods, including Pre-GFC from January 2004 to November 2007, the GFC from December 2007 to May 2009, and the post-GFC era from June 2009 to March 2021. These periods allow us to observe how the corporate basis components evolve over time in response to major financial events. The three components of the corporate basis are analyzed individually in Figure 4.

First, the CSD, which reflects the demand for risky dollar assets, saw a sharp decline during the GFC, indicating a reduced appetite for risk due to heightened FX risk and rising hedging costs. Among the currencies, JPY and CHF experienced the most significant negative shifts in CSD, followed by EUR, GBP, CAD, and AUD. Second, the CYD exhibited a general downward trend after the GFC, suggesting a diminished uniqueness of U.S. safe assets. Notably, the positive CYD spikes during the GFC signaled a flight to safe USD assets, while the less pronounced rise during the Covid-19 period reflects the observed dash for dollars as opposed to an increased demand for U.S. Treasuries, a trend consistent with findings from Ma, Xiao, and Zeng (2022), He, Nagel, and Song (2022), and Cesa-Bianchi, Robert, and Eguren-Martin (2023). Finally, the CCB, indicative of dollar liquidity stress in global financial markets, remained near zero before the GFC but has been persistently elevated since.

Table 3 shows the results from our variance decomposition analysis of the corporate basis, focusing on contributions from CSD, CYD, and CCB. The variance of CSD emerges as the primary driver of fluctuations in the corporate basis, with an average ratio of $\frac{\text{var(CSD)}}{\text{var}(\Psi)}$ equal to 1.36. In contrast, the variances of CCB and CYD have considerably smaller impacts on the corporate basis. A notable finding is the negative covariance between CSD and CYD, averaging -0.65, which stands out as the second most significant factor influencing corporate basis variance. While there is also a negative co-movement between CSD and CCB, its effect is less pronounced. Overall, the combined variances of CYD and CCB contribute relatively little to the total variation in the corporate basis. Thus, the negative covariance between CSD and CYD emerges as a key driver of fluctuations in the corporate basis during our sample period, reflecting the substitution between demand for risky and safe dollar assets.

3 Empirical Evidence

3.1 Substitution effect between safe and risky dollar assets

3.1.1 Holdings-Level Evidence

We begin our analysis with holding-level data to illustrate a substitution effect between the demand for safe and risky dollar assets among foreign investors. To obtain comprehensive information on foreign investors' overall transactions in U.S. assets, we rely on the TIC S-form data. Our focus is on the holdings of U.S. corporate bonds and Treasuries by foreign private investors during two significant crisis periods: the 2008 financial crisis and the 2011-2012 European debt crisis.

We present our findings in Figure 5. Here, net purchases of U.S. assets are normalized by one standard deviation of the monthly net purchases from January 2004 to March 2021, with the inclusion of the VIX to indicate financial market stress. The top panel of the figure clearly shows a substitution effect in the demand patterns of foreign private investors during the 2008 financial crisis. In March 2008, corresponding with Bear Stearns' collapse due to significant mortgage-related losses, foreign investors reduced their holdings of U.S. corporate bonds while concurrently increasing their investments in U.S. Treasury bonds. This trend intensified from July 2008 to November 2008, as the financial crisis peaked and the VIX surged, with foreign private investors further decreasing their corporate bond holdings and increasing their Treasury bond investments.

Next, we focus on the European debt crisis period, as illustrated in the bottom panel of Figure 5. During this time, foreign investors significantly increased their holdings of U.S. Treasury bonds, concurrently reducing their holdings in U.S. corporate bonds.

Particularly from August 2011 to September 2011, amid ongoing financial market stress, there was a notable and consistent flow of foreign investment towards U.S. Treasuries, coupled with a decrease in investments in U.S. corporate bonds.

This pattern provides clear evidence of a substitution effect at the holding level, where foreign investors shifted from risky to safe dollar assets by simultaneously acquiring U.S. Treasuries and divesting from U.S. corporate bonds.

3.1.2 Decomposition of corporate basis

We demonstrate the substitution effect between the demand for safe and risky dollar assets through our decomposition of the corporate basis. In the top panel of Figure 6, we present a time-series plot of the cross-currency mean of the CYD and CSD from January 2004 to March 2021. The correlation between CSD and CYD is strongly negative across the entire sample, with a correlation of -0.48 for levels and -0.46 for monthly changes, highlighting a robust substitution effect.

During the GFC, this negative correlation intensifies, reaching -0.82 for levels and -0.57 for monthly changes, reflecting a pronounced *flight to safety* among global investors. This behavior is characterized by a decrease in CSD and an increase in CYD. A similar pattern emerges during the Covid-19 pandemic, where we observe a significant drop in CSD and a more moderate rise in CYD. This modest increase in CYD suggests a reduced specialness of U.S. Treasuries during the pandemic (Cesa-Bianchi, Robert, and Eguren-Martin, 2023; Ma, Xiao, and Zeng, 2022; He, Nagel, and Song, 2022).

The robustness of the substitution effect remains apparent even after excluding the periods of the GFC and the Covid-19 pandemic from our analysis. When these periods are omitted, a statistically significant correlation of -0.33 is observed between the monthly changes in CSD and CYD, significant at the 1% level. This pattern persists across all currencies analyzed.

Further evidence is provided in the subsequent panels of Figure 6, which display the time-series for CSD and CYD for each of the six non-USD currencies included in our study. Across all these currencies, we consistently observe a negative co-movement between CSD and CYD, reinforcing the presence of the substitution effect.

3.1.3 SVAR: Baseline Estimation

To examine the simultaneous dynamics of the CSD, CYD and CCB, we estimate a SVAR model, as specified in Eq. (8):

$$AY_t = A_0 + \sum_{j=1}^{N} A_j Y_{t-j} + \epsilon_t, \tag{8}$$

where $Y_t = [CSD_t; CYD_t; CCB_t]'$ is the vector of endogenous variables, and ϵ_t represents a vector of orthogonal structural innovations, each with a mean of zero.

The parameter N is set to one, as determined by the Bayesian Information Criterion (BIC) for model selection. The structural shock vector ϵ_t includes shocks to the demand for risky (ϵ_t^{CSD}) and safe (ϵ_t^{CYD}) dollar assets, as well as shocks to cross-border dollar liquidity (ϵ_t^{CCB}). By applying the inverse of matrix A, denoted as A^{-1}, to both sides of Eq. (8), we derive the reduced-form representation shown in Eq. (9):

$$Y_t = C_0 + CY_{t-1} + B\epsilon_t \tag{9}$$

In Eq. (9), matrix B is the inverse of A, C_0 is computed as $A^{-1}A_0$, and C is derived as $A^{-1}A_1$, allowing us to analyze the effects of structural shocks on the endogenous variables.

In our baseline estimations, we assume a causal framework where the CSD impacts both the CYD and CCB contemporaneously, and CYD contemporaneously affects CCB. Figure 7 illustrates the impulse response function (IRF) following a one-unit shock to each variable, based on their average values across all sampled currencies. The IRF, estimated through 1,000 bootstraps, supports the existence of a substitution effect between safe and risky dollar assets, indicated by a negative co-movement between CSD and CYD following shocks to CSD.[10]

Quantitatively, a one standard deviation increase in CSD (18.2 basis points) results in a 4.2 basis point reduction in CYD. Additionally, positive shocks to both CSD and CYD lead to contemporaneous reductions in CCB. Specifically, a one standard deviation increase in both CSD (18.2 basis points) and CYD (18 basis points) results in decreases in CCB of 2.46 and 2.50 basis points, respectively.

3.1.4 SVAR-IV Estimation

A notable limitation of the unrestricted SVAR estimation is its inherent assumption of causality flowing from the CSD to both the CYD and CCB. To robustly identify the causal effects of each corporate basis component, we adopt an alternative specification by incorporating external instruments that uniquely identify shocks to these components.

For instrument validity, the instruments Z_t^{CSD} and Z_t^{CYD} must meet the criteria of relevance and exclusion. Specifically, an instrument for CSD should be associated with fluctuations in the demand for risky dollar assets and plausibly exogenous to factors influencing the demand for safe dollar assets and the scarcity of dollars in cross-border markets. Formally, we require Z_t^{CSD} to correlate with ϵ_t^{CSD} but remain orthogonal to other shocks, as specified in Eq. (10):

10. While the IRFs for CSD, CYD, and CCB at the individual currency level also affirm these findings, they are omitted from this paper due to space constraints.

$$E[Z_t^{CSD}\epsilon_t^{\text{CSD}}] = \phi; \quad E[Z_t^{CSD}\epsilon_t^{\text{CYD}}] = 0; \quad \text{and} \quad E[Z_t^{CSD}\epsilon_t^{\text{CCB}}] = 0. \tag{10}$$

Similarly, an instrument for CYD must be connected to variations determining the demand for safe dollar assets, yet be exogenous to the elements affecting risky dollar asset demand and dollar scarcity in international markets. Formally, Z_t^{CYD} should correlate with ϵ_t^{CYD} while being orthogonal to other shocks, detailed in Eq. (11):

$$E[Z_t^{CYD}\epsilon_t^{\text{CSD}}] = 0; \quad E[Z_t^{CYD}\epsilon_t^{\text{CYD}}] = \phi; \quad \text{and} \quad E[Z_t^{CYD}\epsilon_t^{\text{CCB}}] = 0. \tag{11}$$

We employ three specific instruments in our analysis to identify structural shocks. Credit market illiquidity and sentiment serve as instruments for shocks to the CSD, capturing time-series variation in the demand for risky dollar assets. Conversely, monetary policy surprises are utilized as an instrument for shocks to CYD, reflecting changes in the demand for safe dollar assets. For additional information on our estimation method, readers are directed to Appendix A.

Credit-Market Illiquidity. We construct an instrument based on the differential illiquidity between USD and non-USD corporate bonds. Our approach is informed by the insights of Bretscher et al. (2022), who document a pronounced preference among active investors (e.g., mutual funds) for bonds with higher liquidity. Further support comes from studies like Goldstein, Jiang, and Ng (2017) and Cai et al. (2019), which suggest that bond illiquidity amplifies mutual funds' fragility by exacerbating the sensitivity of fund performance to flows and magnifying the price impact of herding by mutual funds. Consequently, we posit that the relative liquidity of USD versus non-USD corporate bonds, as proxied by our IV, is likely to influence the demand for USD corporate bonds, which is captured by the CSD. Moreover, we argue that this liquidity differential is exogenous to the shocks that influence the demand for safe dollar assets (CYD).

Following Hasbrouck (2009), we infer effective transaction costs in both USD and non-USD corporate bond markets using Eq. (12):

$$r_{i,u} = c_{i,t} \cdot \Delta D_{i,u} + \beta r_{i,u}^M + \epsilon_{i,u}, \tag{12}$$

where $r_{i,u}$ and r_u^M are the returns on bond i and the corporate bond market, respectively, on day u in month t, D is a sell side indicator, and c represents half the effective bid-ask spread. We employ Gibbs sampling to infer the latent D_u, thereby overcoming the limitations of the Roll (1984) model. Monthly estimation of Eq. (12) provides $Gibbs_{i,t} = 2\hat{c_{i,t}}$, an estimate of effective transaction costs.[11]

11. There are alternative corporate bond liquidity measures, however we use the Hasbrouck (2009) measure of illiquidity for two reasons. First, unlike the U.S. corporate bond market, there is very limited

In alignment with Bao, Pan, and Wang (2011), we aggregate $Gibbs_{i,t}$ at the currency level each month and denote it by $Gibbs_{c,t}$.[12] Figure 8a illustrates the time-series of the aggregate illiquidity measure for each currency. Consistent with Huang, Nozawa, and Shi (2023), the U.S. corporate bond market generally exhibits higher levels of illiquidity compared to other currencies throughout our sample period. Notably, large spikes in illiquidity measures occur for all currencies during the GFC and the Covid-19 pandemic, with transaction costs of USD bonds escalating more significantly than those of other currencies, particularly during the Covid-19 crisis.[13]

We define a non-USD liquidity proxy by averaging the currency-level illiquidity measures, capturing liquidity variations in the international corporate bond market. We finalize the construction of our illiquidity IV by calculating the difference between $Gibbs_{usd,t}$ and $Gibbs_{non-usd,t}$, which represents the relative illiquidity of international versus U.S. corporate bond markets. An increase in this IV indicates greater transaction costs for non-USD corporate bonds relative to USD-denominated ones, suggesting a positive shock to the demand for risky dollar assets.

Sentiment. We develop an instrument to capture credit market sentiment of corporate bonds. Periods of high sentiment are marked by reduced returns required by investors to bear credit risk, reflecting a change in their effective risk appetite concerning default probabilities and bond illiquidity.

To construct our IV, we adapt the regression model from López-Salido, Stein, and Zakrajšek (2017), incorporating an additional variable to account for liquidity risk at the security level:

$$\log CS_{i,t} = \alpha_i + \beta_1 DFT_{i,t} + \beta_2 ILLQ_{i,t} + \gamma' Z_{i,t} + \epsilon_{i,t}, \tag{13}$$

where DFT and $ILLQ$ represent default risk and debt illiquidity measures, respectively. The vector Z includes controls for bond-specific characteristics. We employ distance to default, following Gilchrist and Zakrajšek (2012), as a proxy for default risk and utilize the previously discussed illiquidity measure for bond illiquidity.

We estimate Eq. (13) across all currencies using investment-grade bond yield spreads from the ICE BofA database. By aggregating the observed and fitted yield spreads at the currency level, we derive a proxy for credit market sentiment, denoted as $Senti_{c,t}$, by

regulatory requirements for reporting OTC-market bond transactions outside the U.S. until recent years. Second, Schestag, Schuster, and Uhrig-Homburg (2016) have shown that this illiquidity measure has the best performance after empirically comparing various low-frequency measures of corporate bond liquidity based on daily pricing data in the U.S. market.

12. We include a currency-month in our IV only if there are at least 10 security-level observations for that currency in the month.

13. This pattern is supported by studies documenting a sharp deterioration in U.S. corporate bond liquidity following the Covid-19 outbreak (Gilchrist et al., 2024; Haddad, Moreira, and Muir, 2021; Kargar et al., 2021; O'Hara and Zhou, 2021).

calculating the difference between them.

Figure 8b displays the time-series of the sentiment measure. In contrast to the liquidity proxies, there is no significant divergence between USD and non-USD bonds in terms of sentiment. The U.S. market sentiment proxy, $Senti_{usd,t}$, remains aligned with that of other currencies, even during the Covid-19 period, indicating that liquidity risk is well-controlled in our sentiment estimation. Following a similar approach to the bond illiquidity IV construction, we aggregate $Senti_{c,t}$ for all non-USD currencies and compute the sentiment-based IV by taking the difference between the non-USD and USD sentiment proxies. An increase in this IV signals that investors exhibit more positive sentiment towards USD-denominated bonds, as they demand higher risk compensation for non-USD corporate bonds relative to USD-denominated ones. This suggests a positive shock to the demand for risky dollar assets.

Further, we construct shock series for both the bond illiquidity and sentiment IVs by extracting innovations from the differences between the corresponding non-USD and USD measures through an AR(1) model. Within the SVAR framework, these derived shocks are introduced as separate external instruments for CSD. Figure 8c illustrates the time series of both shock IVs.

Monetary Policy. We construct an instrument for CYD using high-frequency identification of monetary policy surprises around scheduled Federal Open Market Committee (FOMC) announcements, as detailed by Nakamura and Steinsson (2018). We posit that the foreign demand for safe dollar assets is directly influenced by U.S. monetary policy. Specifically, when U.S. monetary policy tightens, the resultant higher yields on U.S. Treasuries become more appealing to unlevered international investors, such as pension funds in the UK, who may find these low-risk assets sufficient for meeting their nominal return targets. This leads to an increased demand for safe dollar assets. Conversely, an easing of U.S. monetary policy tends to divert these investors towards alternative asset classes in pursuit of yield. To capture the impact of these dynamics on the demand for safe dollar assets, we utilize the identified monetary policy shocks as an external instrument. Figure 9 displays the time series of the monetary policy shock series.

3.1.5 SVAR-IV results

The results of our SVAR-IV estimation using all three instruments are displayed in Figure 10. Figure 10a explores the impact of CSD on CYD, employing the IRF derived from a negative shock to CSD using the illiquidity shock IV. The first stage F-statistic is 48, with an R^2 of 0.19, indicating a robust instrument. The positive first-stage coefficient aligns with our hypothesis that an increase in the relative illiquidity of the USD corporate bond market (CSD $\downarrow$) correlates with higher U.S. corporate bond spreads relative to non-U.S.

spreads. This shift suggests a substitution effect where global investors move towards safer dollar assets (CYD $\uparrow$), and an increase in the premium for borrowing dollars in FX swap markets (CCB $\uparrow$). Quantitatively, a one standard deviation decrease in CSD (18.2 basis points) corresponds to increases of 3.56 basis points in CYD and 1.65 basis points in CCB.[14]

Figure 10b details the results using corporate bond sentiment as an IV. The robust first stage F-statistic of 263 and an R^2 of 0.56 confirm the strength of the instrument. The positive first-stage coefficient indicates that lower sentiment in the USD corporate bond market, relative to the global market, leads to higher expected returns for USD corporate bonds than for global bonds, thus increasing U.S. corporate bond spreads (CSD $\downarrow$). This effect, similar to the illiquidity shock, promotes a shift towards safer dollar assets and an increase in the dollar borrowing premium (CCB $\uparrow$). A one standard deviation decrease in CSD (18.2 basis points) induced by the sentiment shock leads to a 1.70 basis point increase in CYD and a 2.36 basis point increase in CCB.

Figure 10c presents the results from using a monetary policy surprise as an IV for a CYD shock. The first stage F-statistic of 17 and an R^2 of 0.08 indicate a suitable instrument. Consistent with a positive first-stage coefficient, a tightening of U.S. monetary policy increases the demand for U.S. Treasuries (CYD $\uparrow$), which decreases the demand for risky dollar assets (CSD $\downarrow$). Quantitatively, a one standard deviation increase in CYD (18 basis points) leads to a 11.18 basis point decrease in CSD. Additionally, the effects on CCB are found to be insignificant both in the short and long run, and is consistent with the observed weak correlation between CYD and CCB across the sample.

3.1.6 Robustness Tests

We conduct several robustness tests to confirm the validity of our main findings, with detailed results presented in Appendix B, and summarize the tests below.

Supply effects. We address the potential confound of supply-side dynamics in the corporate bond market on CSD. This is important as our narrative interprets CSD shocks as impacting the demand for risky assets, holding supply constant. To address this concern, we first examine the correlation between the relative changes in notional amounts outstanding for non-USD versus USD corporate bonds and changes in CSD. The correlation coefficient, a negligible -0.03, suggests that the CSD, which encapsulates pricing discrepancies between USD and non-USD currencies, is not systematically affected by the supply of corporate bonds. To further control for supply-side factors, we explicitly incorporate variables indicative of the relative outstanding amounts of non-USD to USD

14. Unreported results, including tests of the substitution effect by excluding the GFC period and using illiquidity shock IVs derived only from firms that have issued both USD and non-USD corporate bonds, confirm the robustness of these findings.

corporate bonds into our SVAR model. Controlling for changes in issuance, our SVAR analysis reveals a robust demand-driven substitution effect between risky and safe dollar assets.

Time-varying substitution between CSD and CYD. A potential concern is that we are interpreting shocks to CSD and CYD as changes in the relative demand for risky and safe dollar assets, respectively. However, these results may not necessarily be driven by changes in investor demand (e.g., quantities), but rather by variation in the substitutability between safe and risky dollar assets. To address cross-sectional variation in our substitutability between safe and risky assets, we re-estimate the CSD separately for corporate bonds rated AAA and BBB. Given that AAA-rated bonds tend to be more substitutable with safe assets, our findings confirm that the substitution effect is present for both ratings categories.

Next, we control for time-variation in substitutability by employing a measure of substitution elasticity between safe and risky bonds developed in Nenova (2024), based on global fund holdings.[15] Our analysis reveals that, while controlling for time-varying substitutability leads to a marginal attenuation of the substitution effect, it remains robust and consistent with our baseline findings.

Alternative measures of risk-free rates. Another concern pertains to the credit risk embedded in the London Interbank Offered Rate (LIBOR), an unsecured lending rate, and its correlation with interest rate swap (IRS) rates. To address this, we investigate alternative benchmark interest rates that carry minimal credit risk, such as the Secured Overnight Financing Rate (SOFR), which reflects the cost of collateralized borrowing in OTC markets. Our SVAR findings remain robust when substituting LIBOR with SOFR rates, demonstrating that a negative shock to risky dollar asset demand leads to a shift towards safe dollar assets and an associated widening of CIP deviations.

Regression-based estimates of CSD. We explore various methods to estimate the corporate basis and CSD beyond our primary cross-sectional regression approach. By employing different default-free benchmarks to calculate the CSD, while sticking to uniform benchmark rates for the (CYD), we mitigate concerns about a mechanically induced negative correlation between CSD and CYD. Moreover, we develop a bottom-up measure of CSD to confirm that our core results are not contingent on the specific estimation technique used. This involves generating regression-based estimates of firm-level CSD and aggregating these to the currency level.

15. The measure used in our analysis is denoted as *Xleast* in Nenova (2024) and was kindly provided by the author.

CSD based on matched bonds. Lastly, our analysis includes a subset of issuers that have both EUR and USD denominated bonds with matched maturities. We find that the CSD estimates derived from these matched bond pairs closely align with our regression-based estimates, reinforcing the robustness of our approach.

3.2 Spillovers to financial markets and real economic activity

3.2.1 FX Market

The relationship between foreign demand for U.S. assets and cross-border liquidity is linked to the FX market. In this analysis, we decompose the impact of each component of the corporate basis on the U.S. dollar. We commence with a simple OLS regression, where the dependent variable is the monthly change in the log of the real spot dollar value against a basket of currencies.[16] Our primary independent variables are the first differences in the corporate basis components. Market risk is controlled by incorporating the VIX.

The regression results are presented in Table 4. We observe that the corporate basis negatively influences the strength of the USD. Specifically, a one standard deviation (13.5 basis points) decrease in the corporate basis is associated with a 0.91% (91 basis points) appreciation of the USD, as detailed in column (1). Notably, this effect is predominantly driven by CSD, as evidenced in columns (3), (5), and (6), where a one standard deviation (18.2 basis points) decrease in CSD results in a 1.21% appreciation of the USD.

The Treasury premium, defined as the aggregate of CYD and CCB, positively affects dollar appreciation. A one standard deviation (14.8 basis points) increase in the Treasury premium corresponds to a 2.34% rise in dollar value, with a coefficient of 15.84 reported in column (2). Decomposing the U.S. Treasury premium further, both CYD and CCB contribute to USD appreciation: a one standard deviation increase (18 basis points) in CYD and a one standard deviation (10.7 basis points) increase in CCB each lead to a 2.37% appreciation in the USD.

To further investigate the effects of CSD and CYD shocks, we extend our SVAR analysis to include the real spot value of the USD against our currency basket. Figure 11a illustrates that a shock reflecting increased illiquidity in the USD corporate bond market relative to the global market reduces the demand for risky dollar assets, prompts a shift towards safer dollar assets, and results in a widening of CCB. This scenario, indicative of USD scarcity in funding markets, reveals that a one standard deviation negative shock to CSD leads to a 1.94% USD appreciation against the basket. This finding is consistent with results obtained using the sentiment shock IV for CSD, as shown in Figure 11b.

Figure 11c demonstrates that a positive shock to the demand for safe dollar assets,

16. The basket includes AUD, CAD, CHF, EUR, GBP, and JPY.

triggered by our monetary policy shock IV, also results in USD appreciation. This appreciation is accompanied by a widening of CCB and excess returns on the dollar. Collectively, our findings suggest that an increase in the demand for safe dollar assets, as evidenced by a rise in the Treasury premium, leads to a medium-term appreciation of the USD, supporting evidence in Jiang, Krishnamurthy, and Lustig (2021).

3.2.2 Equity and Commodity Markets

In addition to the FX market, we examine shocks to risky dollar asset demand on equity and commodity markets. We hypothesize that increased illiquidity in the USD corporate bond market relative to the global market would have a persistent negative impact on other asset classes, reflecting a diminished risk-bearing capacity of investors. We investigate the spillover effects of shocks to the CSD on the S&P 500 index (SPX), a composite non-U.S. stock index, and the Bloomberg Commodity Index (BCOM). The non-U.S. stock index is a composite measure comprising the Austrian Traded Index, S&P/TSX Composite Index, Swiss Market Index, Euronext 100 Index, FTSE 100 Index, and Nikkei 225 Index, tracking overall stock market performance across these six economies.

Figure 12a displays the results, indicating that a one standard deviation decrease in CSD (18.2 basis points) leads to declines of 7.8%, 9%, and 7.1% in the SPX, the non-U.S. stock index, and BCOM respectively. Given that the monthly return standard deviation for these indices is 4.19%, 4.16%, and 4.77%, these spillover effects are economically significant. These findings are consistent across different instruments, including the sentiment shock IV for CSD, as shown in Figure 12b.

3.2.3 Economic Activities

We further hypothesize that fluctuations in the demand for risky dollar assets impact macroeconomic activity. Our analysis incorporates macroeconomic variables such as the Consumer Price Index (CPI), industrial production, unemployment rate, real GDP, real investment, and real consumption. While CPI, industrial production, and unemployment rate data are monthly, real GDP and other variables are observed quarterly. Figure 13 demonstrates the impulse response functions (IRF) of a negative CSD shock on U.S. economic activity, using both the illiquidity and sentiment shock IVs. The results indicate substantial spillovers, characterized by declines in inflation, industrial production, real investment, real consumption, and real GDP, alongside an increase in the unemployment rate. These findings are complementary to previous research that examines the impact of financial shocks on economic activities (Gilchrist and Zakrajšek, 2012; Gertler and Karadi, 2015).

In Appendix C, significant spillovers to the economic activities of other economies in our sample, including Canada, Japan, the Euro Area, the UK, Switzerland, and Australia, are documented. For some countries, like Switzerland and Australia, we only have quarterly data for industrial production, and for Australia, CPI data is also quarterly. We harmonize these quarterly observations by matching them to the last values of CSD, CYD, and CCB each quarter. For the IVs, we derive the innovation based on an AR(1) model using the quarterly-level variables. All variables, except for the unemployment rate, which is in percentage terms, are expressed in log terms. Consistent with the U.S. findings, a negative shock to the demand for risky dollar assets leads to a contemporaneous and subsequent deterioration in economic activities across these nations, marked by a decline in CPI, industrial production, real GDP, real investment, real consumption, and a rise in the unemployment rate.

4 Conclusion

Deviations from the law of one price are a pervasive phenomenon across various segments of the financial markets. In the global credit market, this deviation is captured by the corporate basis, which is close to zero if corporate bond yields are equalized across currencies with exchange rate risks being hedged. Since the global financial crisis, the corporate basis has shown substantial time variation. Our study aims to understand the economic forces that drive this variation, with a particular focus on the demand for both risky and safe dollar-denominated assets.

By exploiting detailed issuance and pricing data of 30,926 corporate bonds issued in major funding currencies, we introduce a novel decomposition of the corporate basis into elements measuring the demand for risky and safe dollar assets as well as the scarcity of dollars in cross-border funding. We employ an instrumental variable framework to ascertain the causal effects of shocks to corporate basis components. With this approach, we uncover a substitution effect between risky and safe dollar assets. Finally, we examine the ripple effects of shocks to the demand for risky dollar assets on both financial markets and the broader economy. We find that a contraction in the demand for risky dollar assets, as evidenced by a relative increase in dollar credit spreads, precipitates a strengthening of the US dollar, a downturn in equity and commodity prices, and a decline in real economic activity indicators.

Our findings not only enhance our understanding of the U.S. dollar's role in international finance but also underscore the implications that shifts in the demand for risky and safe dollar assets can have on financial markets and the real economy. The empirical evidence calls for future works on the complex interplay between currency markets, asset demand, and economic stability.

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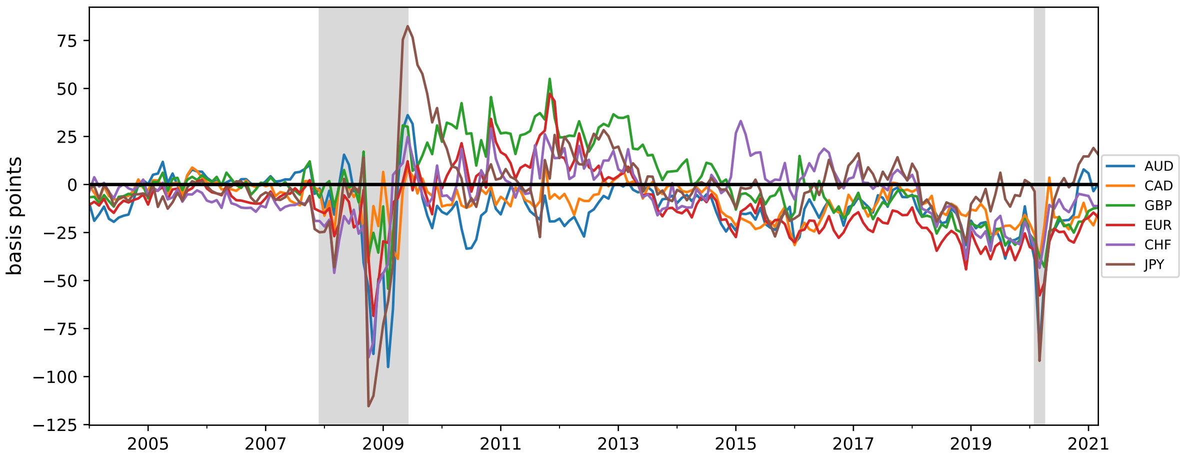
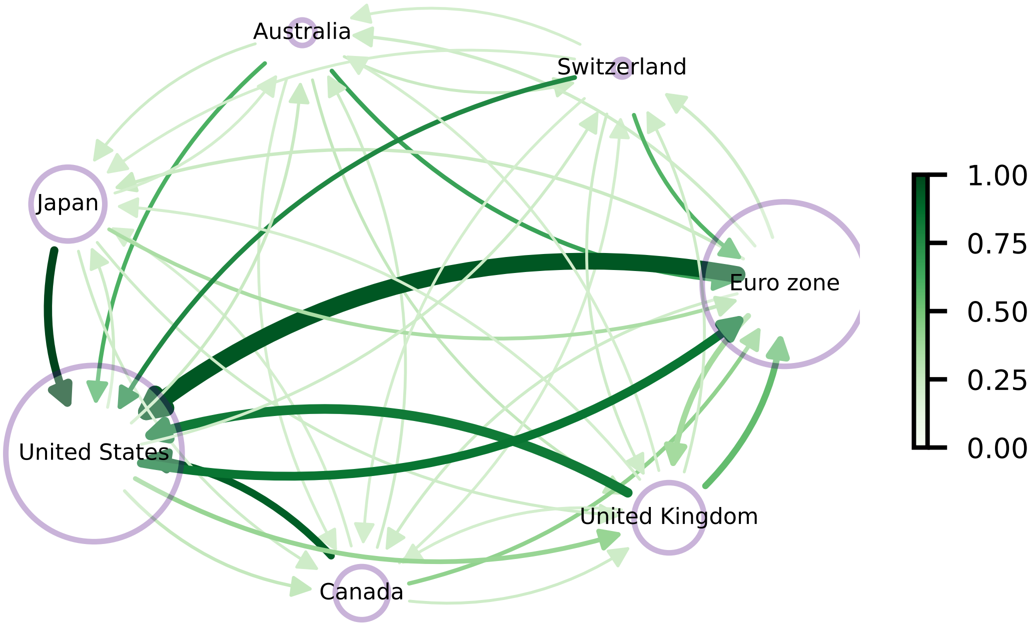
Figure 1: The Corporate Basis



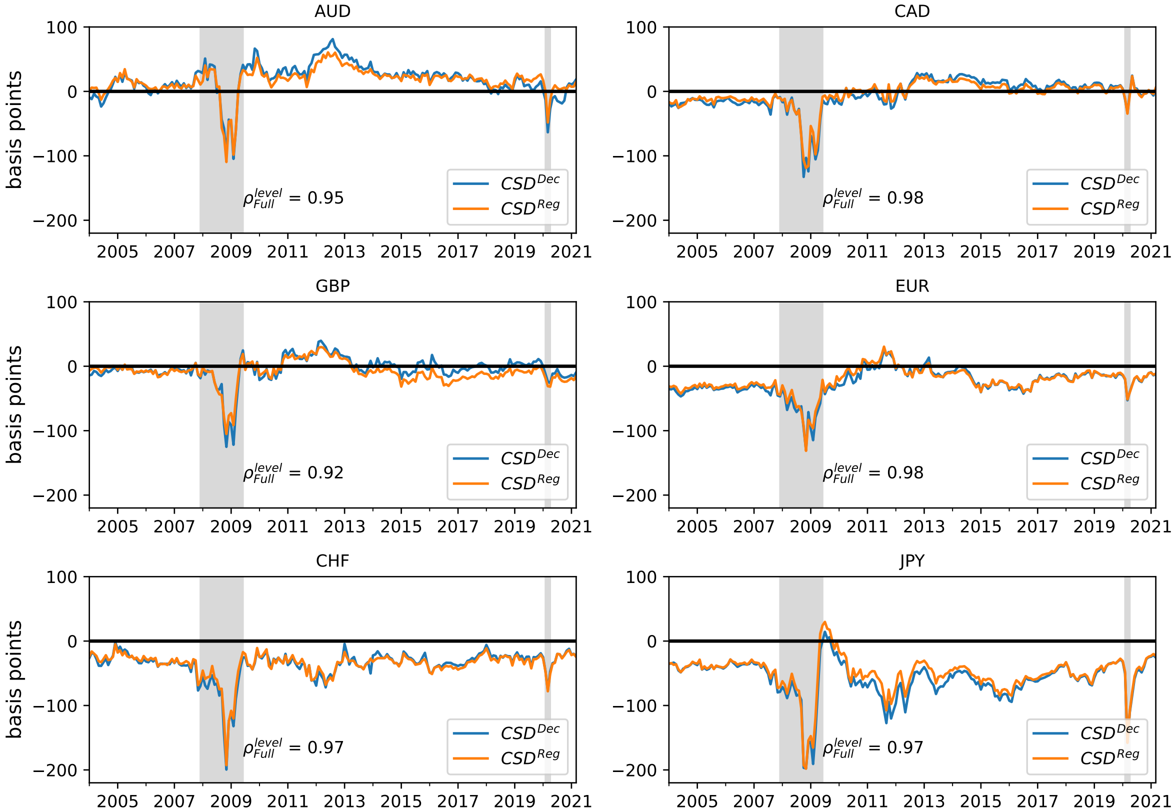
This figure presents the time series of corporate basis by currency. Corporate bases are estimated with cross-sectional regressions in Eq. (4). The sample period ranges from January 2004 to March 2021. Shaded bars denote months designated as recessions by the National Bureau of Economic Research.

Figure 2: Cross-border Bond Issuance



This figure presents the cross-border issuance of corporate bonds with currency denominations in AUD, CAD, CHF, EUR, GBP, JPY, and USD, based on the bond outstanding data in March 2021. Purple circles depicts the total notional principal of outstanding bonds issued by the domestic firms. Green arrows from country/region A to B represents bonds that are issued by firm in L and denominated in the fiat currency of K: their size reflects the absolute amount of bonds in that category, and their color depth indicates the proportion of A's foreign currency bonds that are denominated in the currency of country/region B.

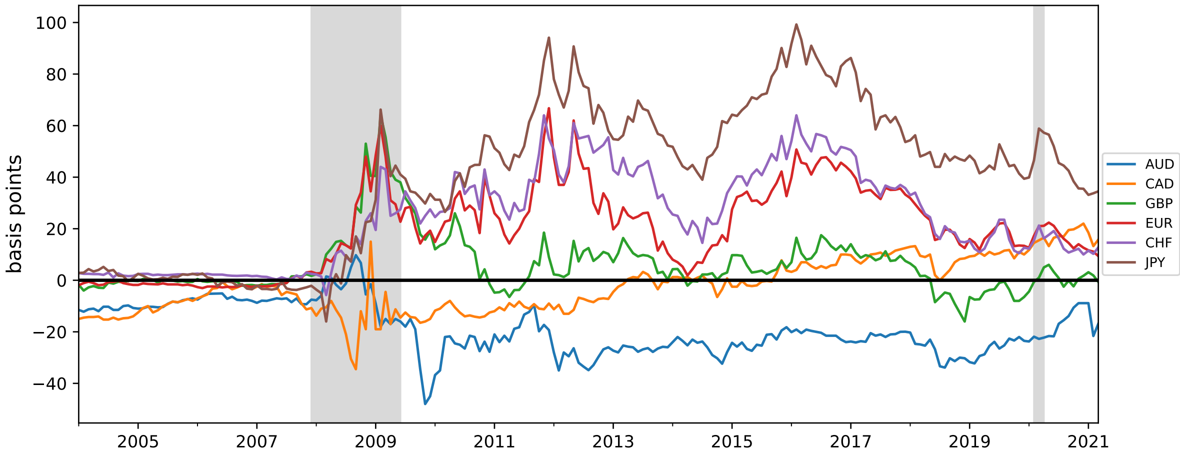
Figure 3: Alternative Estimates of Credit Spread Differential



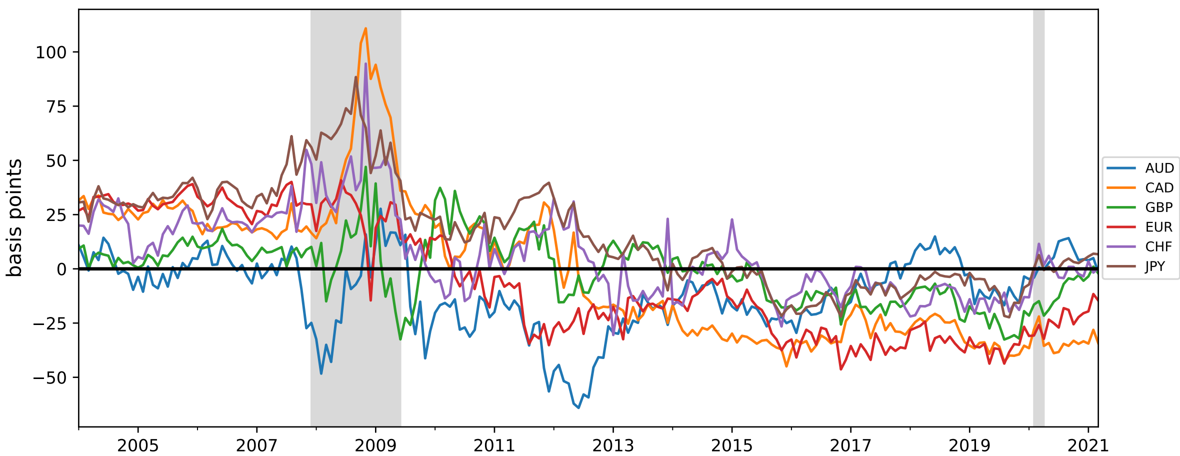
This figure compares the decomposition-based estimate of CDS (CSD^{Dec}) and regression-based estimate (CSD^{Reg}). CSD^{Dec} is derived from the decomposition as presented in Eq. (3) and thus involves the estimate of corporate basis, CYD and CCB. CSD^{Reg} is directly estimated from the cross-sectional regression of Eq. (7). The sample period ranges from January 2004 to March 2021. Shaded bars denote months designated as recessions by the National Bureau of Economic Research.

Figure 4: The Decomposition of Corporate Basis

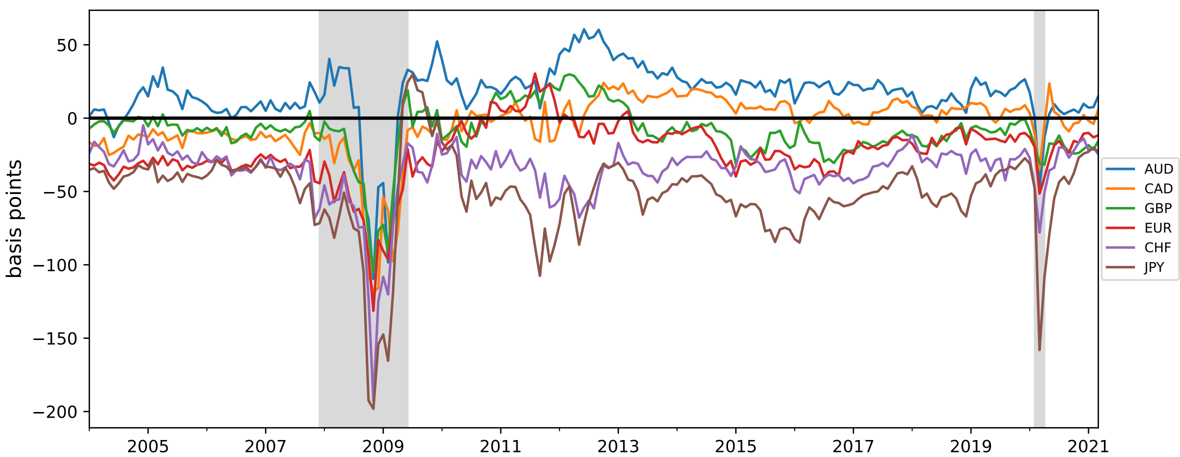
(a) Cross-currency Basis (CCB, 5-year)



(b) Convenience Yields Differential (CYD, 5-year)



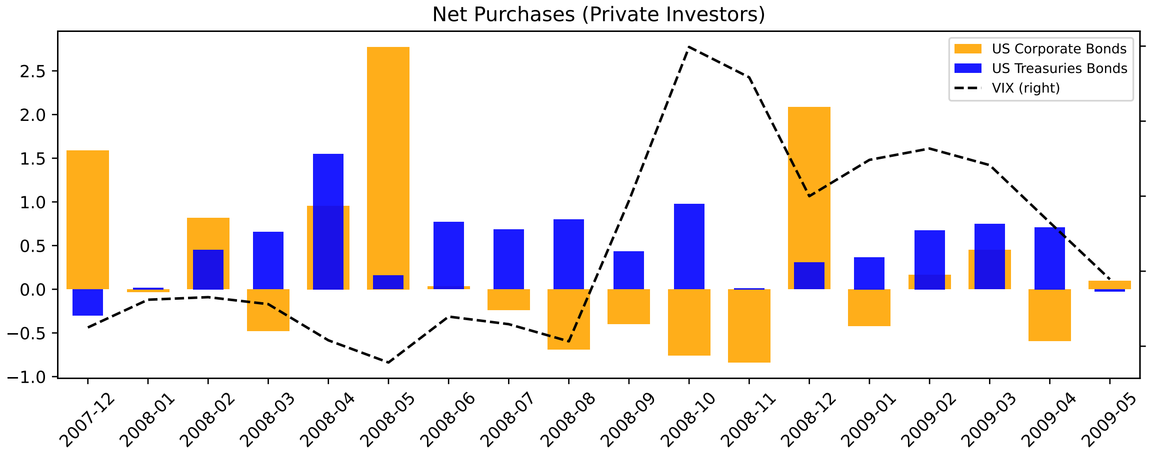
(c) Credit Spread Differential (CSD)



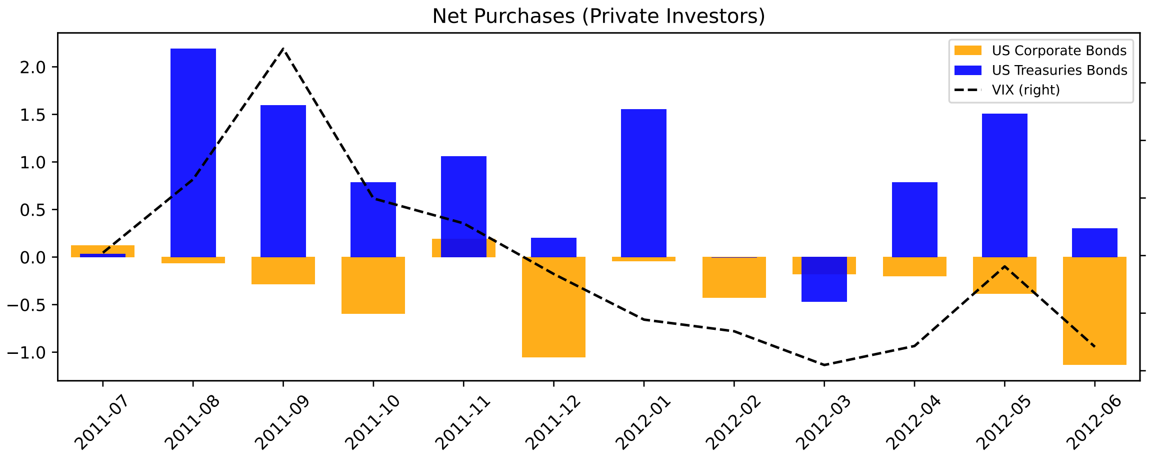
This figure presents the time series of corporate basis components: CSD, CYD (5-year maturity) and CCB (5-year maturity). The sample period ranges from January 2004 to March 2021. Shaded bars denote months designated as recessions by the National Bureau of Economic Research.

Figure 5: Holding Level Evidence

(a) Foreign Investors' Net Purchases of U.S. Assets

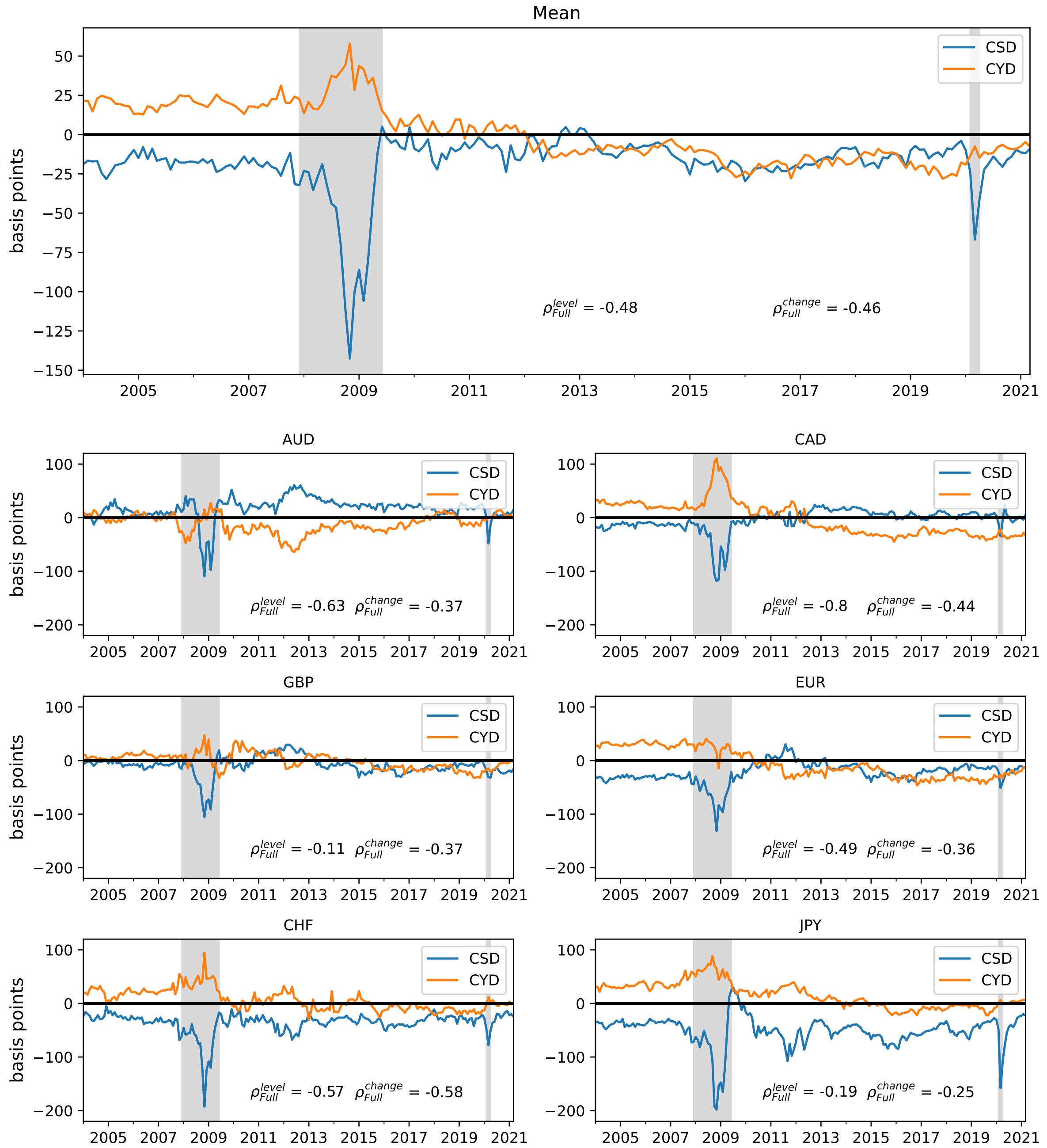


(b) Foreign Investors' Net Purchases of U.S. Assets



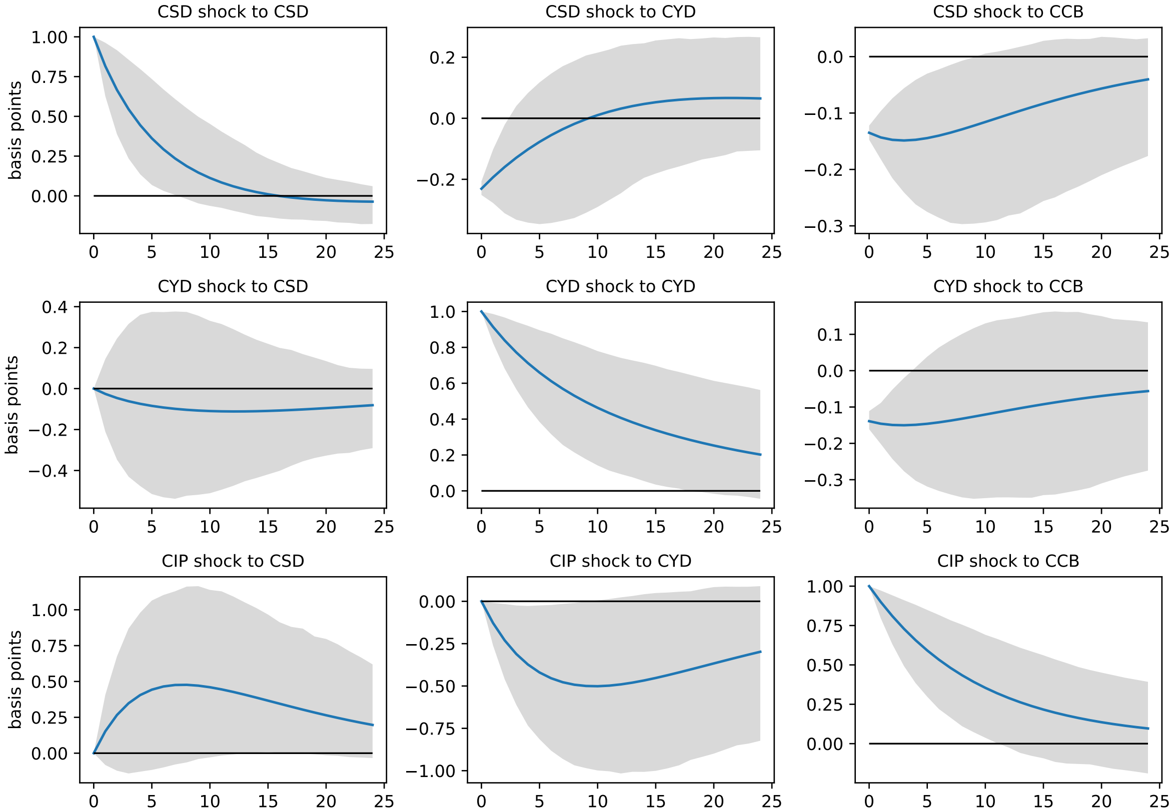
The top figure shows the foreign investors' net purchases of U.S. assets during the 2008 Global Financial Crisis, while the bottom figure presents these purchases during the European Debt Crisis period. The net purchases are scaled by one standard deviation of the monthly net purchases from January 2004 to March 2021. Data is sourced from the TIC S Form - Securities (A): U.S. Transactions with Foreign Residents in Long-Term Securities. Additionally, the VIX values are included in each figure, with the corresponding values shown on the right y-axis.

Figure 6: A Substitution Effect Between Safe and Risky Dollar Assets



This figure depicts the co-movement between our estimates of CSD and CYD from January 2004 to March 2021. The top panel plots the average across currencies, and the lower panels display the CSD and CYD for each currency. Correlation coefficients are reported for both the levels and changes of these two variables. Shaded bars denote months designated as recessions by the National Bureau of Economic Research.

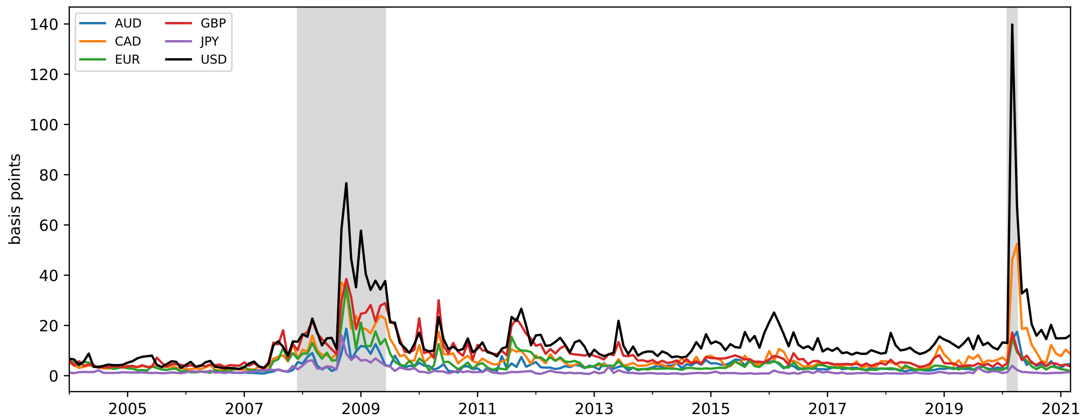
Figure 7: IRF of the Unrestricted SVAR Model (Mean)



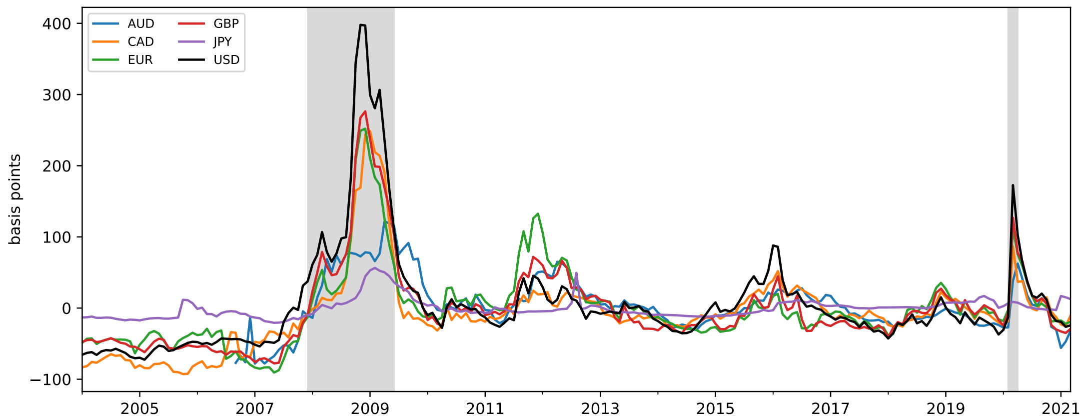
This figure presents the impulse response function (IRF) of one unit corresponding shock to each variable in the corporate basis decomposition. The plots are based on 1,000 wild bootstraps. The solid lines are the mean value of IRF, and the shaded areas are 95% confidence bands. The monthly sample is from January 2004 to March 2021 with the cross-currency mean of CSD, CYD and CCB.

Figure 8: Instrumental Variables for CSD

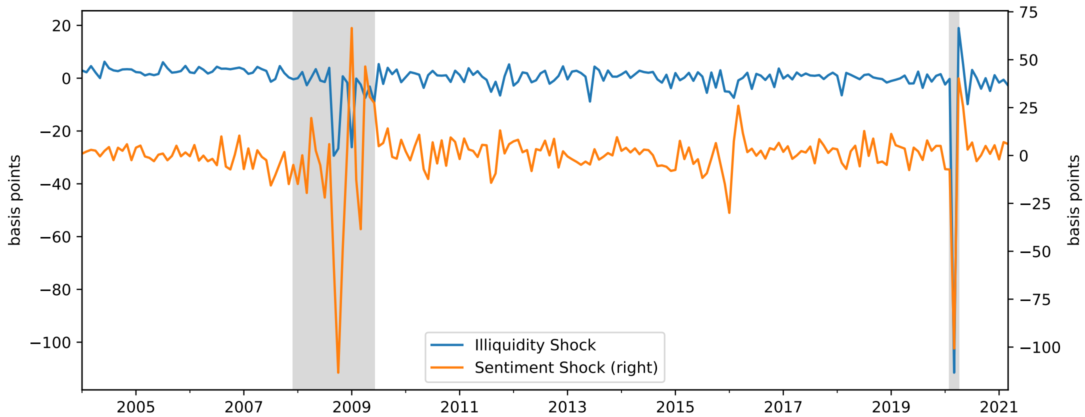
(a) Illiquidity Measure (*Gibbs*)



(b) Sentiment Measure (*Senti*)

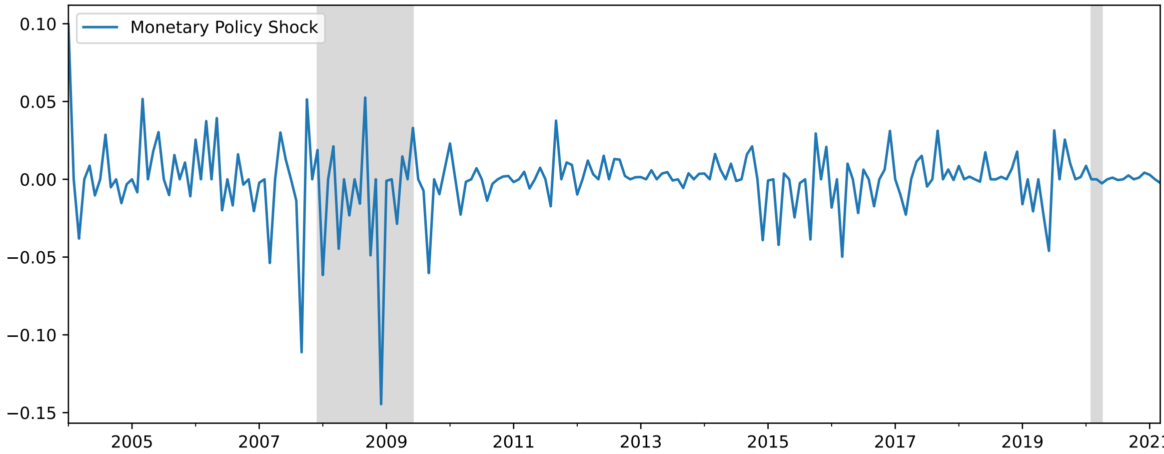


(c) Instrumental Variables



This figure presents the time series of instrumental variables for CSD. Panel (A) presents the corporate bond illiquidity aggregated at the currency level, with security-level illiquidity quantified by the Hasbrouck's (2009) Gibbs measure. Panel (B) presents the time variation in sentiment for each corporate bond market, where bond market sentiment is measured using the methodology of López-Salido, Stein, and Zakrajšek (2017). Panel (C) displays the time series of the instruments for illiquidity shocks and sentiment shocks. These instruments are constructed by first aggregating the currency-specific measures to a non-USD one. The innovation from the difference between the non-USD and the USD measures is then derived from a AR(1) model. The sample period ranges from January 2004 to March 2021. Shaded bars denote months designated as recessions by the National Bureau of Economic Research.

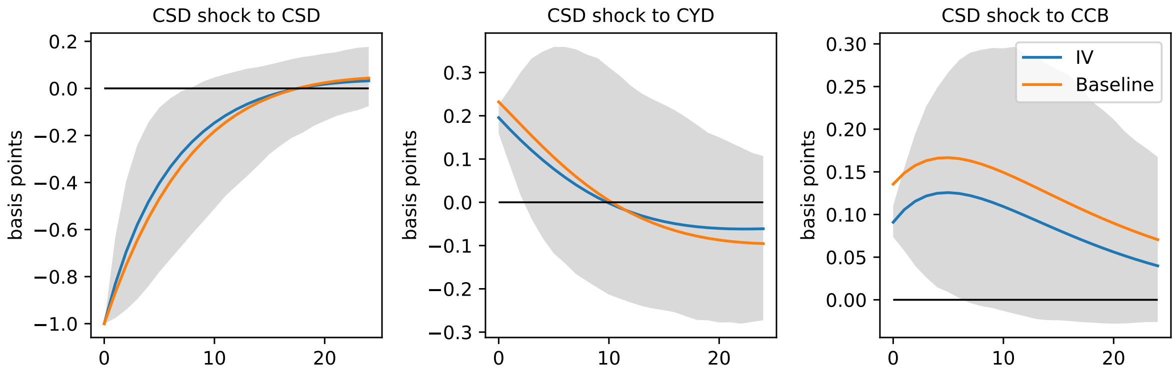
Figure 9: Instrumental Variables for CYD: Monetary Policy Shock



This figure presents the time series of monetary policy shock, following the method proposed by Nakamura and Steinsson (2018). The sample period ranges from January 2004 to March 2021. Shaded bars denote months designated as recessions by the National Bureau of Economic Research.

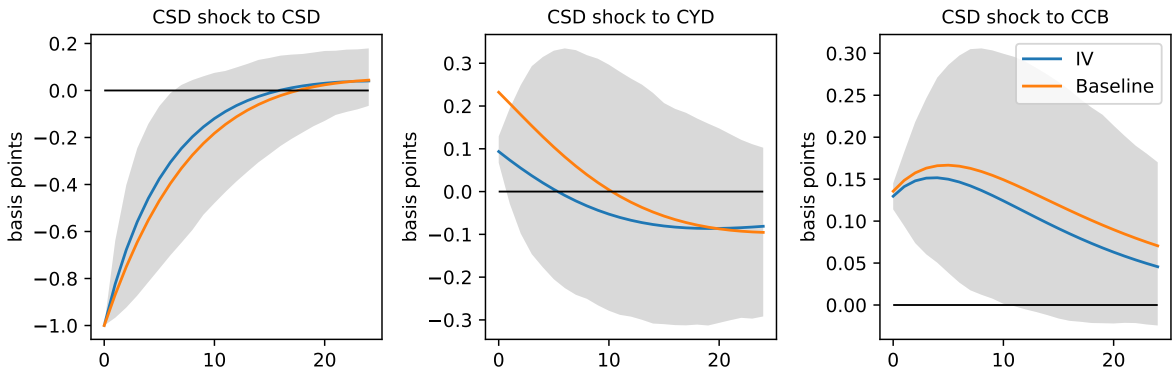
Figure 10: IRF of the SVAR Model with Instrumental Variables

(a) IRF of the CSD Shock with Illiquidity IV (Mean)



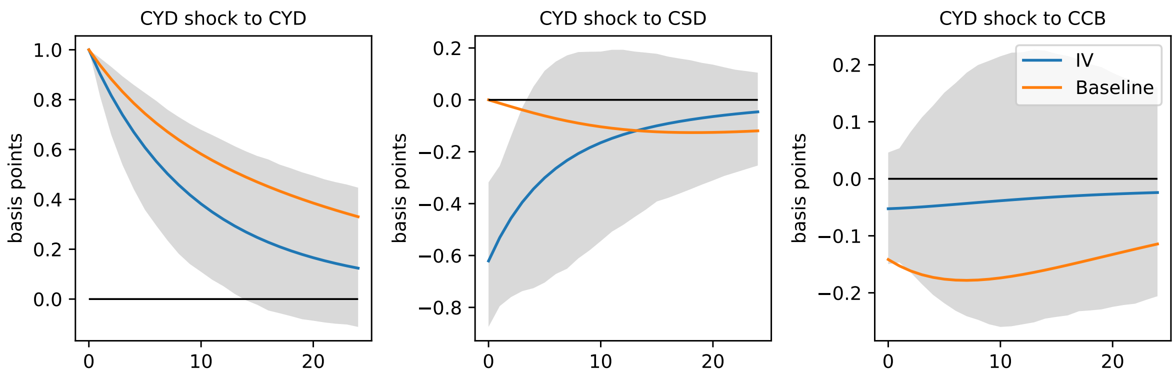
First-stage regression: Coefficient: 0.42; F-statistics: 48; R^2: 0.19.

(b) IRF of the CSD Shock with Sentiment IV (Mean)



First-stage regression: Coefficient: 0.42; F-statistics: 263; R^2: 0.56.

(c) IRF of the CYD Shock with Monetary Policy IV (Mean)

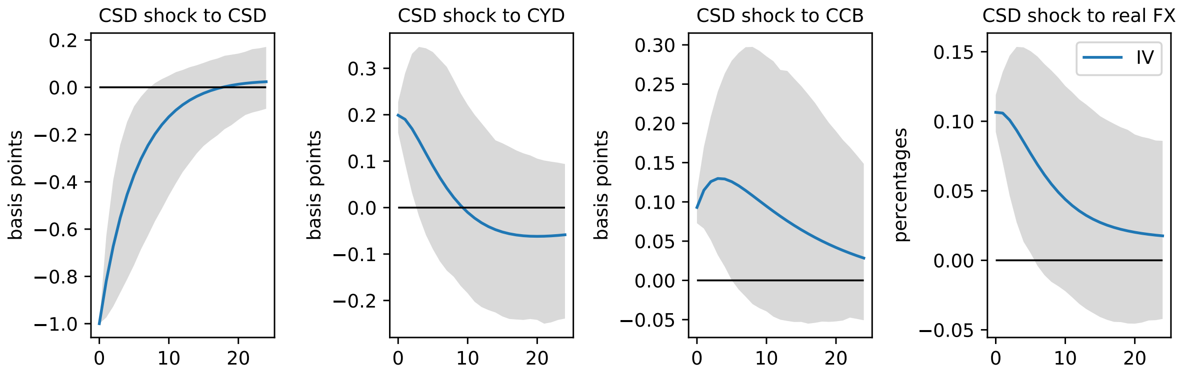


First-stage regression: Coefficient: 59.60; F-statistics: 17; R^2: 0.08.

This figure presents the impulse response function (IRF) of one negative/positive unit CSD shock (Panel A and B)/CYD shock (Panel C) to each variable in the corporate basis decomposition. Panels A, B and C are based on 1,000 wild bootstraps with the illiquidity shock IV, sentiment shock IV and monetary policy shock IV, respectively. The solid lines are the mean value of IRF, and the shaded areas are 95% confidence bands. The monthly sample is from January 2004 to March 2021 with the cross-currency mean of CSD, CYD and CCB.

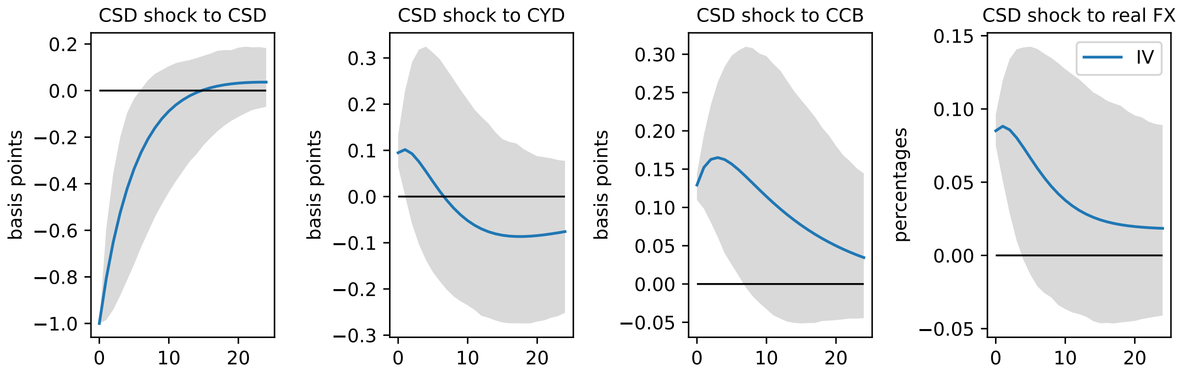
Figure 11: IRF of SVAR Model Incorporating the FX Market

(a) IRF of the CSD Shock with Illiquidity IV (Mean)



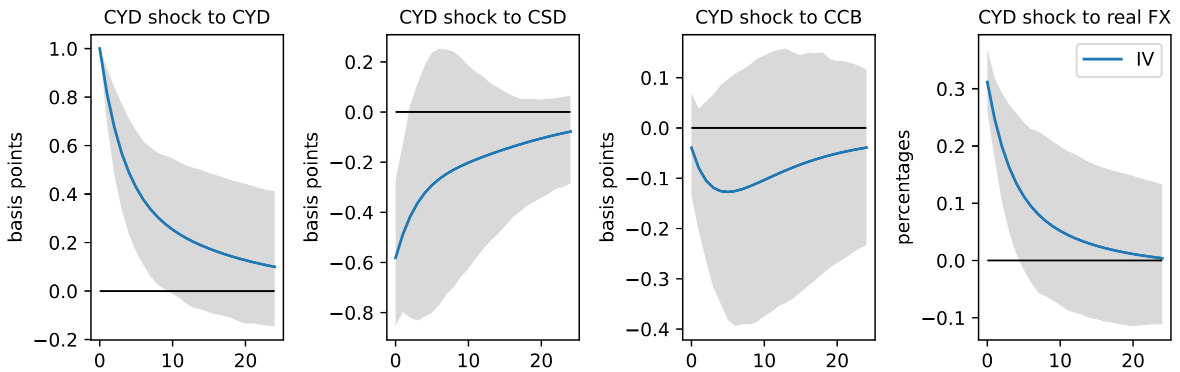
First stage regression: Coefficient: 0.42; F-statistics: 48; R^2: 0.19.

(b) IRF of the CSD Shock with Sentiment IV (Mean)



First stage regression: Coefficient: 0.42; F-statistics: 263; R^2: 0.56.

(c) IRF of the CYD Shock with Monetary Policy IV (Mean)

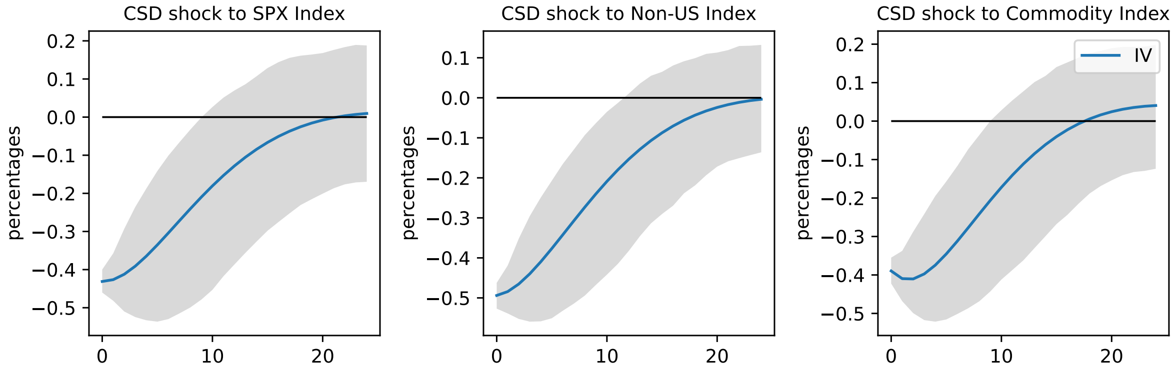


First stage regression: Coefficient: 61.56; F-statistics: 19; R^2: 0.09.

This figure presents the impulse response function (IRF) of one negative/positive unit CSD shock (Panel A and B)/CYD shock (Panel C) to the real USD exchange rate as well as the corporate basis components. Panels A, B and C are based on 1,000 wild bootstraps with the illiquidity shock IV, sentiment shock IV and monetary policy shock IV, respectively. The solid lines are the mean value of IRF, and the shaded areas are 95% confidence bands. The monthly sample is from January 2004 to March 2021 with the cross-currency mean of CSD, CYD, CCB, and logarithm of the real spot USD exchange rate.

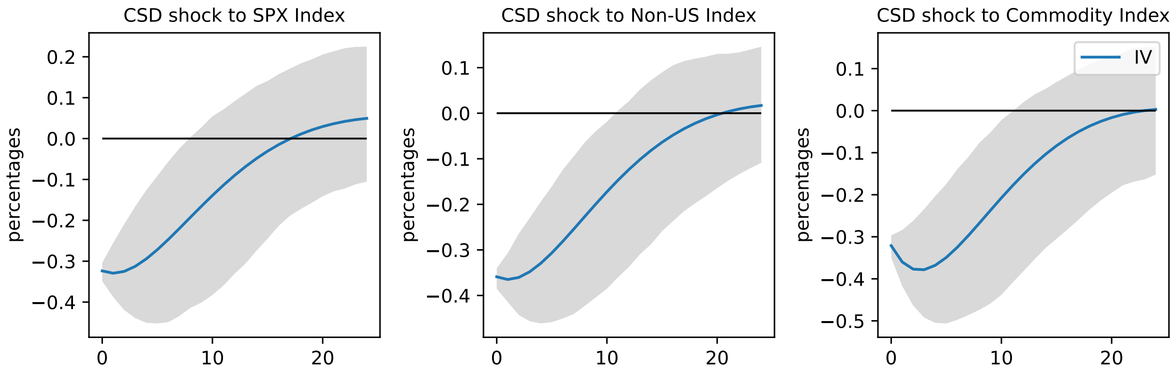
Figure 12: IRF of the CSD Shock with the Other Assets Classes (Mean)

(a) IRF of the CSD Shock with Illiquidity IV (Mean)



First stage regression: Coefficient: 0.42; F-statistics: 49; R^2: 0.19.

(b) IRF of the CSD Shock with Sentiment IV (Mean)

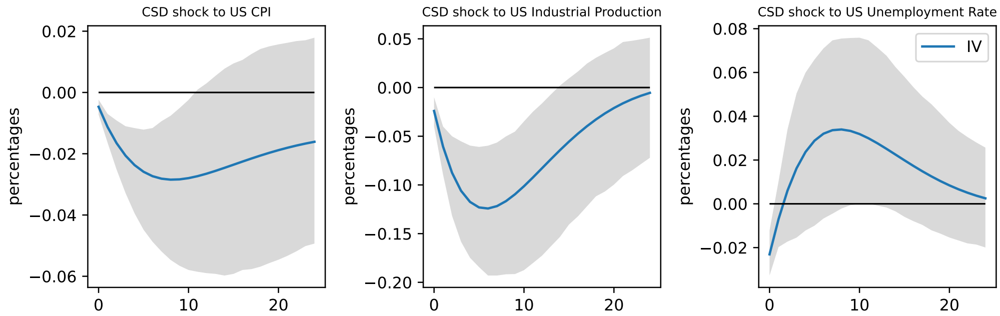


First stage regression: Coefficient: 0.39; F-statistics: 215; R^2: 0.51.

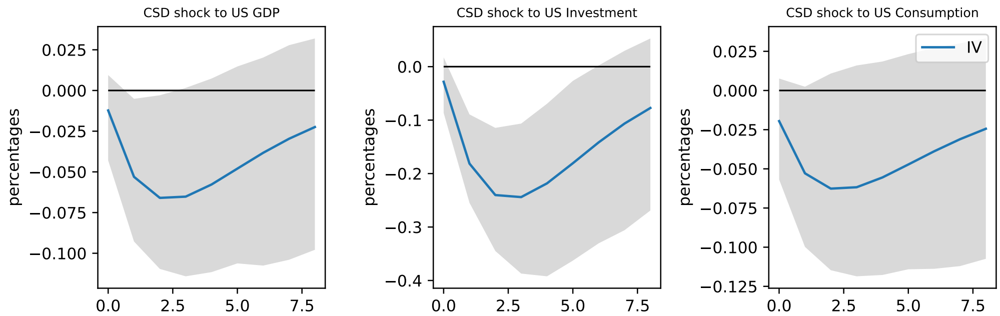
This figure presents the impulse response function (IRF) of one negative unit CSD shock (Panel A and B) to indices of the equity and commodity sectors. Panels A and B are based on 1,000 wild bootstraps with the illiquidity shock IV and sentiment shock IV, respectively. The solid lines are the mean value of IRF, and the shaded areas are 95% confidence bands. The monthly sample spans from January 2004 to March 2021 with the cross-currency mean of CSD, CYD, CCB, the logarithm of SPX (S&P 500) index, the logarithm of international market indices (Austrian Traded Index, S&P/TSX Composite Index, Swiss Market Index, EURONEXT 100, FTSE 100 and Nikkei 225) and the logarithm of the Bloomberg commodity index.

Figure 13: IRF of the CSD Shock with the U.S. Macroeconomic Activity (Mean)

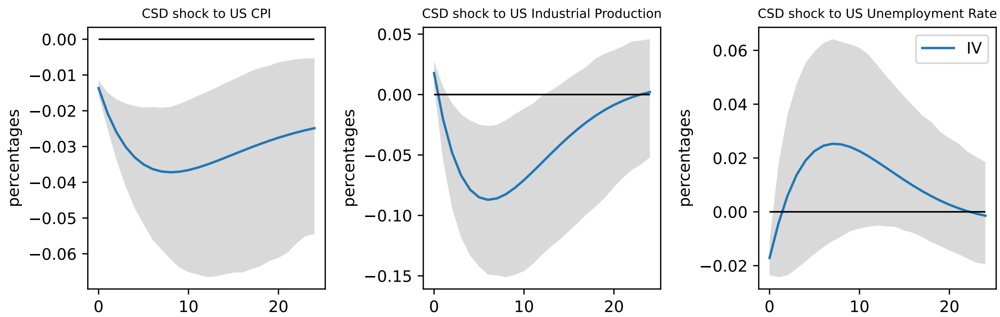
(a) IRF of the CSD Shock with Illiquidity IV: Monthly Variables



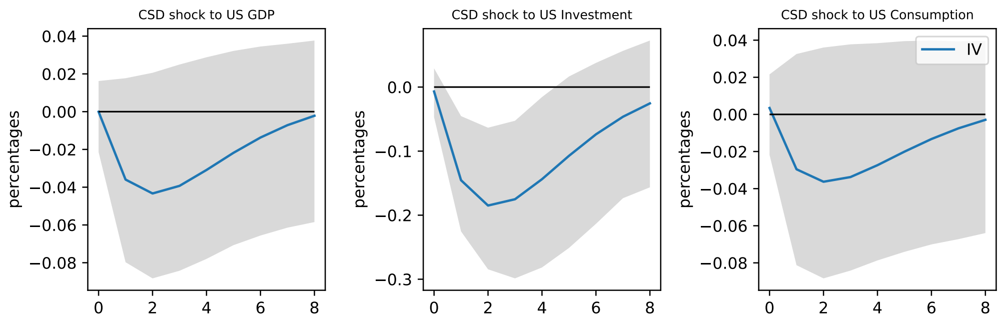
(b) IRF of the CSD Shock with Illiquidity IV: Quarterly Variables



(c) IRF of the CSD Shock with Sentiment IV: Monthly Variables



(d) IRF of the CSD Shock with Sentiment IV: Quarterly Variables



This figure presents the impulse response function (IRF) of one negative unit CSD shock (Panel A through D) to measures of real economic activities. Panels A through D are based on 1,000 wild bootstraps with the illiquidity shock IV and sentiment shock IV, respectively. The solid lines are the mean value of IRF, and the shaded areas are 95% confidence bands. The monthly sample spans from January 2004 to March 2021 with the cross-currency mean of CSD, CYD, CCB, as well as the U.S. CPI, the U.S. Industrial Production, U.S. Unemployment Rate, U.S. Real GDP, U.S. Real Investment and U.S. Real Consumption. The monthly and quarterly variables are estimated in the SVAR model separately.

Table 1: Corporate Bond Information - Currency Level

	Issues	Notional	Firms		Issues	Notional	Firms
All				**USD**			
Total	6,969.6	5,281.7	929.1	Total	2,798.0	2,508.0	587.1
Rating				**Rating**			
AAA&AA	2,066.9	1,792.2	166.1	AAA&AA	641.0	748.8	102.8
A	2,780.5	1,933.6	347.4	A	1,032.5	884.6	199.0
BBB	1,694.4	1,248.0	357.5	BBB	852.3	677.5	220.7
HY (BB and below)	427.9	307.9	159.3	HY (BB and below)	272.2	197.1	115.3
Maturity				**Maturity**			
1-3 yrs	1,742.5	1,414.8	522.8	1-3 yrs	725.3	687.1	306.3
3-7 yrs	2,744.1	2,196.3	703.8	3-7 yrs	1061.7	972.6	420.4
7-10 yrs	1,194.9	893.1	468.7	7-10 yrs	499.3	444.8	278.0
10+ yrs	1,288.1	777.5	340.0	10+ yrs	511.7	403.5	184.3
% by Foreign Firms				**% by Foreign Firms**	43.5%	47.0%	55.4%
AUD				**CAD**			
Total	230.6	69.9	72.7	Total	259.9	108.7	75.6
Rating				**Rating**			
AAA&AA	147.3	50.2	30.7	AAA&AA	66.4	32.5	22.7
A	58.7	14.0	28.7	A	93.6	40.3	27.6
BBB	23.5	5.4	14.5	BBB	95.4	34.6	25.1
HY (BB and below)	1.2	0.2	0.9	HY (BB and below)	4.5	1.3	2.9
Maturity				**Maturity**			
1-3 yrs	81.5	23.2	41.9	1-3 yrs	70.2	32.5	39.6
3-7 yrs	102.6	33.3	49.1	3-7 yrs	96.4	48.5	49.4
7-10 yrs	36.7	10.6	20.6	7-10 yrs	31.6	12.0	21.8
10+ yrs	9.9	2.8	5.6	10+ yrs	61.7	15.6	22.4
% by Foreign Firms	69.2%	56.7%	72.2%	**% by Foreign Firms**	35.3%	28.9%	48.2%
CHF				**EUR**			
Total	287.8	68.3	105.6	Total	1,679.7	1,900.0	386.2
Rating				**Rating**			
AAA&AA	150.3	34.0	42.5	AAA&AA	491.1	718.1	83.7
A	95.7	23.3	41.5	A	650.3	682.8	151.5
BBB	37.4	9.7	23.7	BBB	435.1	411.6	125.0
HY (BB and below)	4.4	1.3	3.2	HY (BB and below)	103.3	87.5	54.6
Maturity				**Maturity**			
1-3 yrs	83.5	21.1	58.3	1-3 yrs	428.1	517.5	206.5
3-7 yrs	136.5	32.9	72.4	3-7 yrs	778.1	904.8	292.0
7-10 yrs	41.0	9.4	29.0	7-10 yrs	287.4	318.7	149.9
10+ yrs	26.8	4.8	16.3	10+ yrs	186.2	158.9	89.9
% by Foreign Firms	86.7%	79.2%	86.4%	**% by Foreign Firms**	34.0%	31.5%	51.2%

Continued on next page

Table 1. (Continued)

	Issues	Notional	Firms		Issues	Notional	Firms
GBP				**JPY**			
Total	456.5	289.5	195.1	Total	1,257.1	337.6	113.5
Rating				**Rating**			
AAA&AA	157.1	88.1	55.1	AAA&AA	413.7	120.6	33.9
A	158.5	112.2	73.4	A	691.1	176.4	57.3
BBB	124.7	80.3	67.5	BBB	126.0	28.9	23.1
HY (BB and below)	16.1	8.9	11.1	HY (BB and below)	26.2	11.6	4.8
Maturity				**Maturity**			
1-3 yrs	86.3	49.1	61.4	1-3 yrs	267.6	84.2	74.1
3-7 yrs	131.6	77.3	91.0	3-7 yrs	437.2	126.9	86.2
7-10 yrs	60.1	39.7	52.1	7-10 yrs	238.9	57.9	55.9
10+ yrs	178.5	123.3	94.1	10+ yrs	313.4	68.6	30.7
% by Foreign Firms	65.0%	65.0%	65.0%	**% by Foreign Firms**	9.1%	10.9%	39.1%

This table summarizes the corporate bond sample at the currency level. It details monthly averages for the number of bonds, notional principal in billions of dollars, and number of issuing firms, segmented by issuance currency, credit rating, years to maturity, and percentage of bonds issued by foreign firms. The data covers the period from January 2004 to March 2021.

Table 2: Summary Statistics of CCB, CYD and CSD

		Full Sample **Jan 04 to Mar 21**	**Pre-GFC** **Jan 04 to Nov 07**	**GFC** **Dec 07 to May 09**	**Post-GFC** **Jun 09 to Mar 21**
			CCB		
AUD	Mean	-18.91***	-8.72***	-4.71**	-24.09***
	SEs	(0.66)	(0.29)	(1.91)	(0.51)
CAD	Mean	-2.29***	-8.22***	-14.04***	1.15
	SEs	(0.73)	(0.71)	(2.45)	(0.83)
GBP	Mean	5.89***	-0.75***	26.40***	5.49***
	SEs	(0.79)	(0.18)	(4.65)	(0.72)
EUR	Mean	19.82***	-1.49***	24.30***	26.31***
	SEs	(1.14)	(0.17)	(4.34)	(1.05)
CHF	Mean	24.51***	1.95***	15.50***	33.12***
	SEs	(1.26)	(0.09)	(3.26)	(1.2)
JPY	Mean	40.60***	0.22	16.51***	57.02***
	SEs	(2.02)	(0.38)	(5.34)	(1.42)
Average	Mean	11.60***	-2.84***	10.66***	16.50***
	SEs	(0.74)	(0.12)	(2.71)	(0.64)
			CYD		
AUD	Mean	-11.11***	0.66	-8.7	-15.31***
	SEs	(1.19)	(1.1)	(5.39)	(1.41)
CAD	Mean	-1.69	23.48***	56.78***	-17.43***
	SEs	(2.21)	(0.81)	(7.61)	(1.77)
GBP	Mean	-0.74	7.58***	8.65**	-4.69***
	SEs	(1.03)	(0.61)	(4.2)	(1.27)
EUR	Mean	-5.55***	30.67***	25.60***	-21.49***
	SEs	(1.87)	(0.61)	(2.84)	(1.22)
CHF	Mean	6.56***	21.83***	43.47***	-3.17***
	SEs	(1.35)	(1.28)	(3.65)	(1.02)
JPY	Mean	15.81***	35.08***	61.13***	3.69***
	SEs	(1.63)	(1.14)	(2.65)	(1.28)
Average	Mean	0.55	19.88***	31.16***	-9.73***
	SEs	(1.25)	(0.55)	(2.83)	(0.83)
			CSD		
AUD	Mean	16.56***	9.46***	-14.11	22.79***
	SEs	(1.51)	(1.27)	(11.53)	(1.19)
CAD	Mean	-4.54***	-13.58***	-51.67***	4.43***
	SEs	(1.48)	(0.69)	(8.9)	(0.81)
GBP	Mean	-9.35***	-6.30***	-37.93***	-6.73***
	SEs	(1.26)	(0.67)	(8.13)	(1.23)
EUR	Mean	-22.92***	-31.42***	-65.21***	-14.75***
	SEs	(1.4)	(0.61)	(6.06)	(1.15)
CHF	Mean	-35.94***	-28.58***	-77.85***	-33.06***
	SEs	(1.42)	(1.34)	(9.6)	(0.95)
JPY	Mean	-51.36***	-38.75***	-96.80***	-49.78***
	SEs	(2.05)	(1.11)	(13.02)	(2.0)
Average	Mean	-17.92***	-18.19***	-57.26***	-12.85***
	SEs	(1.27)	(0.66)	(9.0)	(0.74)

This table summarizes the estimate of CSD (CSD^{Reg}), CYD (5-year maturity) and CCB (5-year maturity). The reported statistics include the average value in basis point (Mean), heteroscedasticity-robust standard errors (SEs), and number of monthly observations (N). The sample period spans from January 2004 to March 2021. The sub-periods are Pre-GFC (Jan 2004 to November 2007), GFC (December 2007 to May 2009) and post-GFC (June 2009 to March 2021). *** denotes significance at the 1% level, ** at the 5% level, and * at the 10% level.

Table 3: Variance Decomposition of Corporate Basis Movement

	$\frac{var(CSD)}{var(\Psi)}$	$\frac{var(CYD)}{var(\Psi)}$	$\frac{var(CCB)}{var(\Psi)}$	$\frac{2cov(CSD,CYD)}{var(\Psi)}$	$\frac{2cov(CSD,CCB)}{var(\Psi)}$	$\frac{2cov(CCB,CYD)}{var(\Psi)}$
AUD	1.27	0.50	0.09	-0.58	0.01	-0.04
CAD	1.71	0.67	0.34	-0.93	-0.53	-0.15
GBP	0.72	0.63	0.21	-0.50	-0.21	0.00
EUR	1.05	0.59	0.42	-0.58	-0.37	-0.05
CHF	1.43	0.94	0.24	-1.36	-0.32	0.18
JPY	1.09	0.14	0.14	-0.20	-0.24	0.06
Average	1.36	0.37	0.15	-0.65	-0.34	0.01

This table reports the variance decomposition results. For each currency, the variance of its corporate basis is decomposed into the variances of CSD, CYD and CCB, as well as their pairwise covariances. The data sample is composed of monthly observations from January 2004 to March 2021.

Table 4: Effects on the FX Market: Evidence of OLS Regressions

	(1)	(2)	(3)	(4)	(5)	(6)
$\Delta\Psi$	-6.71***					
	(2.55)					
ΔU.S. Treasury Premium		15.84***	9.60***			
		(2.55)	(3.35)			
ΔCSD			-6.66***		-6.46***	-5.26**
			(2.32)		(2.42)	(2.52)
ΔCYD				13.15***	7.53*	7.31*
				(3.58)	(4.12)	(3.97)
ΔCCB				22.14***	15.09***	14.41***
				(3.54)	(4.27)	(4.10)
Δlog(VIX)						0.01**
						(0.01)
constant	6.20	7.45	7.29	6.67	6.63	6.49
	(14.29)	(13.36)	(12.95)	(13.28)	(12.95)	(12.81)
R^2	0.06	0.18	0.24	0.19	0.24	0.26

The table reports the regression results in which the dependent variable is the monthly change in the logarithm of the real spot USD exchange rate against a basket. The independent variables include the corporate basis (Ψ), U.S. Treasury premium, CSD, CYD and CCB in Mean, as well as the logarithm of VIX. We use the simple change as the innovation. The input data is in basis points. Statistics in parentheses are the White heteroscedasticity-robust standard errors. The sample period spans from January 2004 to March 2021. *** denotes significance at the 1% level, ** at the 5% level, and * at the 10% level.

Appendix

A SVAR-IV estimation

We follow the SVAR-IV method in Gertler and Karadi (2015). In our setting, the reduced-form VAR representation is given by:

$$\begin{bmatrix} CSD_t \\ CYD_t \\ CCB_t \end{bmatrix} = \begin{bmatrix} c_{10} \\ c_{20} \\ c_{30} \end{bmatrix} + \begin{bmatrix} c_{11} & c_{12} & c_{13} \\ c_{21} & c_{22} & c_{23} \\ c_{31} & c_{32} & c_{33} \end{bmatrix} \begin{bmatrix} CSD_{t-1} \\ CYD_{t-1} \\ CCB_{t-1} \end{bmatrix} + \begin{bmatrix} b_{11} & b_{12} & b_{13} \\ b_{21} & b_{22} & b_{23} \\ b_{31} & b_{32} & b_{33} \end{bmatrix} \begin{bmatrix} \epsilon_t^{\text{CSD}} \\ \epsilon_t^{\text{CYD}} \\ \epsilon_t^{\text{CCB}} \end{bmatrix}. \tag{14}$$

A.1 IV-CSD

First stage regression. Let u^{CSD}, u^{CYD} and u^{CCB} be the reduced form residual for the CSD, CYD and CCB, respectively. The first stage extracts the variation in the u^{CSD} that is due to the IV. We estimate β as $cov(b_{11}\epsilon_t^{\text{CSD shock}}, Z_t^{CSD})/var(Z_t^{CSD})$ based on the assumption of external instrumentals as specified by Eq. (10):

$$u_t^{CSD} = \beta Z_t^{CSD} + w_t. \tag{15}$$

Second stage regression. To identify the effect of the instrument on CYD and CCB, we need to estimate the ratio b_{21}/b_{11} and b_{31}/b_{11} from the two stage least squares regression of u_t^{CYD} and u_t^{CCB} on $\widehat{u_t^{CSD}}$, where $\widehat{u_t^{CSD}}$ is fitted value from the first stage regression. We estimate $\gamma_1 = b_{21}/b_{11}$ and $\gamma_2 = b_{31}/b_{11}$ under the identifying assumption that shocks to CYD and CCB are transmitted through the instrument's effect on CSD:[17]

$$\begin{aligned} u_t^{CYD} &= \gamma_1 \widehat{u_t^{CSD}} + w_t \\ u_t^{CCB} &= \gamma_2 \widehat{u_t^{CSD}} + w_t \end{aligned} \tag{16}$$

Lastly, we normalize b_{11} to 1. Parameters b_{21} and b_{31} are therefore equal to γ_1 and γ_2, respectively.

17. Proofs:
$\gamma_1 = cov(u_t^{CYD}\widehat{u_t^{CSD}})/var(\widehat{u_t^{CSD}})$
$cov(u_t^{CYD}, \widehat{u_t^{CSD}}) = cov(b_{21}\epsilon_t^{\text{CSD}}, \beta Z_t^{CSD}) = b_{21}\beta cov(\epsilon_t^{\text{CSD}}, Z_t^{CSD})$
$var(\widehat{u_t^{CSD}}) = \beta^2 var(Z_t^{CSD})$

$$\gamma_1 = \frac{b_{21}\beta cov(\epsilon_t^{\text{CSD}}, Z_t^{CSD})}{\beta^2 var(Z_t^{CSD})} = \frac{b_{21} cov(\epsilon_t^{\text{CSD}}, Z_t^{CSD})}{\beta var(Z_t^{CSD})}$$

Replacing $\beta = cov(b_{11}\epsilon_t^{\text{CSD}}, Z_t^{CSD})/var(Z_t^{CSD})$ We can get $\gamma_1 = b_{21}/b_{11}$. Under the same procedure, we also can get $\gamma_2 = b_{31}/b_{11}$.

A.2 IV-CYD

Our application of the monetary policy shock as an IV for CYD follows a similar two-stage procedure.

First stage regression. The first stage captures the variation in u^{CYD} that can be attributed to the IV. We estimate β as $cov(b_{22}\epsilon_t^{\text{CYD}}, Z_t^{CYD})/var(Z_t^{CYD})$.

$$u_t^{CYD} = \beta Z_t^{CYD} + w_t.$$

Second stage regression. To identify the effect of the instrument on CSD and CCB, we need to estimate the ratio b_{12}/b_{22} and b_{32}/b_{22} from the two stage least squares regression of u_t^{CSD} and u_t^{CCB} on $\widehat{u_t^{CYD}}$, where $\widehat{u_t^{CYD}}$ is fitted value from the first stage regression. We estimate $\gamma_1 = b_{12}/b_{22}$ and $\gamma_2 = b_{32}/b_{22}$ under the identifying assumption that shocks to CSD and CCB are transmitted through the instrument's effect on CYD.

$$u_t^{CSD} = \gamma_1 \widehat{u_t^{CYD}} + w_t$$
$$u_t^{CCB} = \gamma_2 \widehat{u_t^{CYD}} + w_t$$

Lastly, we normalize b_{22} to 1. Parameters b_{12} and b_{32} are therefore equal to γ_1 and γ_2, respectively.

B Robustness Tests

B.1 Supply Effects

Our measures of CSD examine the pricing effect of currency on corporate bonds, focusing on the demand side. By employing IVs that are only associated with demand, we establish a robust demand channel. However, a valid concern is the extent to which our baseline results are influenced by changes in the supply of corporate bonds. To address this concern, we further examine the impact of the supply effect on CSD by constructing a time-series of corporate bond notional amounts outstanding for each currency, using issuance-level data from the SDC New Issues database. We calculate the log changes in these amounts for each currency, and take the difference between non-USD and USD log changes, and then average these differences to measure the relative changes in overall notional amounts outstanding between non-USD and USD corporate bonds.

We start by calculating the correlation between the relative changes in notional amounts and changes in CSD. With a correlation of only -0.03, which is highly insignificant, we find no direct link between the supply effect and CSD. This suggests that the supply effect does not influence the currency effect on bond pricing. We then incorporate the difference in log notional amounts between non-USD and USD bonds into our baseline SVAR models. Figure A1 presents these results, confirming that the substitution effect persists even when controlling for bond supply. Furthermore, Figure A1c illustrates that a positive shock in demand for safe dollar assets leads to a negative demand shock for risky dollar assets, which then increases the relative supply of non-USD corporate bonds compared to USD corporate bonds.

B.2 Time-varying Substitutability Between CSD and CYD

A potential concern is that we are interpreting shocks to CSD and CYD as changes in the relative demand for risky and safe dollar assets, respectively. However, these results may not necessarily be driven by changes in investor demand (e.g., quantities), but rather by variation in the substitutability between safe and risky dollar assets.

First, to control for cross-sectional variation, we estimate the CSD for corporate bonds rated AAA and BBB, referred to as CSD (AAA) and CSD (BBB), respectively. This allows us to analyze the effect of cross-sectional substitutability. We hypothesize that AAA-rated corporate bonds, due to their higher liquidity and lower risk, are better substitutes for government bonds compared to BBB-rated corporate bonds. Figure A2a displays the IRF of CYD on both CSD (AAA) and CSD (BBB). To facilitate a more meaningful comparison of the substitution effects, we standardize CYD, CSD (AAA), CSD (BBB), and CCB by their respective standard deviations. As anticipated, AAA-rated bonds demonstrate more pronounced substitutability with safe dollar assets. Specifically, a one standard deviation increase in CYD leads to a decrease of 0.84 standard deviations in CSD (AAA) compared to just a 0.65 standard deviation decrease in CSD (BBB).

Second, we examine the impact of the time-series variation in substitutability. We include *Xleast* into our Structural Vector Autoregression (SVAR) model as a control variable.*Xleast*, developed by Nenova (2024), which measures the substitution elasticity between safe and risky bonds based on global fund holding data. Adding this variable to our analysis controls for time variation in substitutability.[18]

We adjusted our measures of CSD, CYD, and CCB to match the quarterly frequency and the respective sample period of Xleast. Figures A2b and A2c present the IRF of a CSD shock on CYD, both with and without Xleast. Although the substitution effect decreases slightly with the inclusion of Xleast, it remains robust.

B.3 Alternative Measures of Risk-free Rates

We use the LIBOR interest rates as the risk-free benchmark in our baseline analysis. Since LIBOR might contain a credit risk component relating to banks' creditworthiness,

18. Tsvetelina Nenova kindly provided us with the Xleast data, which spans quarterly from 2000 to 2020.

we test the robustness of our findings using alternative measures of risk-free rates. To be more specific, we use the Secured Overnight Financing Rate (SOFR), Canadian Overnight Repo Rate Average (CORRA), Euro Short-Term Rate (ESTR), Sterling Overnight Index Average (SONIA), Tokyo Overnight Average Rate (TONA) as the alternative risk-free rates for the U.S., Canada, Euro Area, the UK and Japan, respectively. These rates serve as the new benchmark rates to replace LIBOR in the bank lending and derivative markets and have negligible credit risk. For example, SOFR is the cost of borrowing cash overnight using U.S. Treasury securities as collateral. Owing to the data availability, we only include the currency of CAD, EUR, GBP and JPY in this robustness tests. For the same reason, the corporate basis components are estimated only for the one-year maturity.

Figure A3a reports the stylized fact for the basis components estimated using the alternative risk-free rates. Consistent with our baseline results, the correlation between the monthly changes of CSD and CYD is -0.34, negative and statistically significant at the 1% level. The correlation between the levels of CSD and CYD decreases to -0.04, still negative but no longer statistically significant. Figures A3b and A3c plot the IRF to a CSD shock using the illiquidity shock IV and Sentiment shock IV, respectively. A negative shock to risky dollar asset demand results in a substitution toward safe dollar assets and a widening of CCB. In summary, the estimation results based on alternative risk free rates are consistent with our key empirical findings on the dynamics of CSD, CYD and CCB, confirming the robustness of our baseline results.

B.4 Regression-Based Estimates of CSD

We examine the robustness of our CSD estimates using several alternative regression specifications. First, we include several extra controls into Eq. (7) to mitigate the potential omitting variables biases. The additional controls are the interaction terms between maturity buckets and rating buckets. We denote this CSD as “CSD with M*R”. Second, we perform the tests on the sub-sample of non-U.S. firms, which enables us to examine the validity of the USD-denomination effect for bonds issued only by foreign firms. We denote this CSD as “CSD with non-U.S.”. Third, we construct a bottom-up measure of CSD: we estimate the firm-specific CSDs in the first step and then aggregate them to obtain the currency-specific CSD. We denote this CSD as “Bottom-up CSD”’.

Fourth, we replace the government bond yield with the AAA corporate bond yield for the corresponding currency in calculating credit spreads (Chen, Collin-Dufresne, and Goldstein, 2009). For example, we use as the benchmark rate for the USD denominated corporate bonds the effective yields of the ICE BofA AAA U.S. Corporate indices with maturity buckets of 1-3 years, 3-5 years, 5-7 years, 7-10 years and 10+ years.[19] We denote

19. Due to the data availability, we drop the sample with CHF-denominated bonds.

this alternative measure of CSD as “CSD with AAA Yield”. Fifth, we replace the government bond yield with the maturity-matched LIBOR interest rates when calculating credit spreads. This is in line with Liao (2020)'s CSD, based on the two-way decomposition. We denote this CSD as “CSD with LIBOR-based”. The use of AAA yields and LIBOR rates addresses the concern that, given both CSD and CYD depend on the government yield, the variation in government bond yield may drive a mechanical substitution effect.

Sixth, considering that firms have cost advantages in issuing local currency bonds, we exclude all such bonds and further require firms to have issued bonds in at least two different currencies, of which one is USD. We denote this as “CSD without LocalCurrency”. Finally, we categorize bonds into two types. A bond is classified as “offshore issued” if the market in which it was issued is different from the parent firm's nationality. Otherwise, the bond is classified as “onshore issued”. Then, we denote these CSDs based on these two types, as “CSD Offshore Issued” and “CSD Onshore Issued”, respectively.

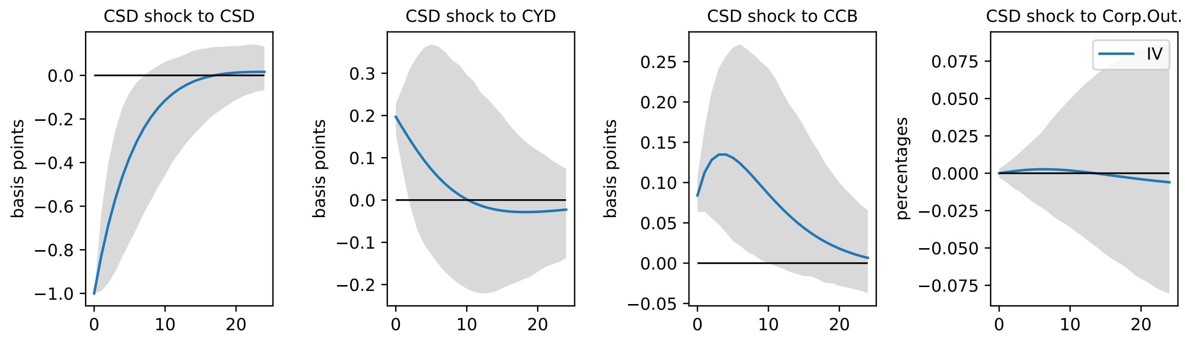
As shown in Figure A4a, the CSD estimated with alternative approaches moves closely with our baseline CSD. We further examine the substitution effect using the alternative CSD measures and report the IRF of one negative unit of CSD shock to CYD in Figure A4b. All results are consistent with the baseline results and support the substitution effect between safe and risky dollar assets.

B.5 CSD Based on Matched Bonds

We provide some anecdotal examples to provide some additional insights on our estimation of CSD. For several matched EUR and USD denominated bonds issued by the same issuer, we calculate the CSD as the credit spread difference between the EUR and USD denominated bonds with similar remaining maturity and duration. Figure A5 compares the CSD based on the matched bond pairs with the CSD we estimated based on the cross-sectional regressions specified by Eq. (7). The baseline CSD we used in the paper is quite close to the CSD estimated based on matched bond pairs. Therefore, its robustness is further validated with these model-free CSD estimates, which do not rely cross-sectional regressions to control the maturity effect.

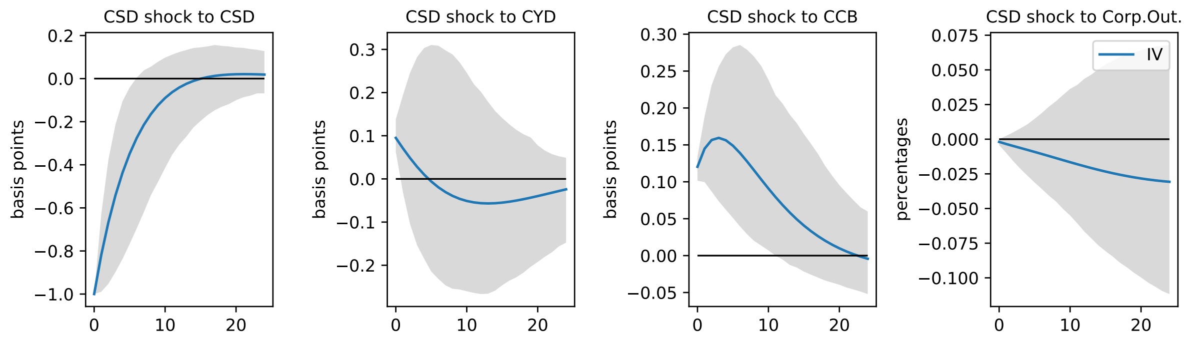
Figure A1: IRF of SVAR Model Incorporating Bond supply

(a) IRF of the CSD Shock with Illiquidity IV (Mean)



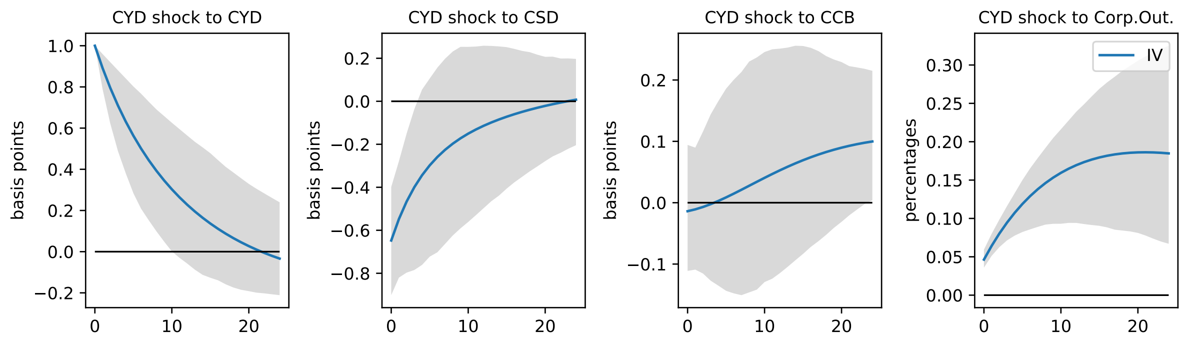
First stage regression: Coefficient: 0.42; F-statistics: 48; R^2: 0.19.

(b) IRF of the CSD Shock with Sentiment IV (Mean)



First stage regression: Coefficient: 0.42; F-statistics: 258; R^2: 0.56.

(c) IRF of the CYD Shock with Monetary Policy IV (Mean)

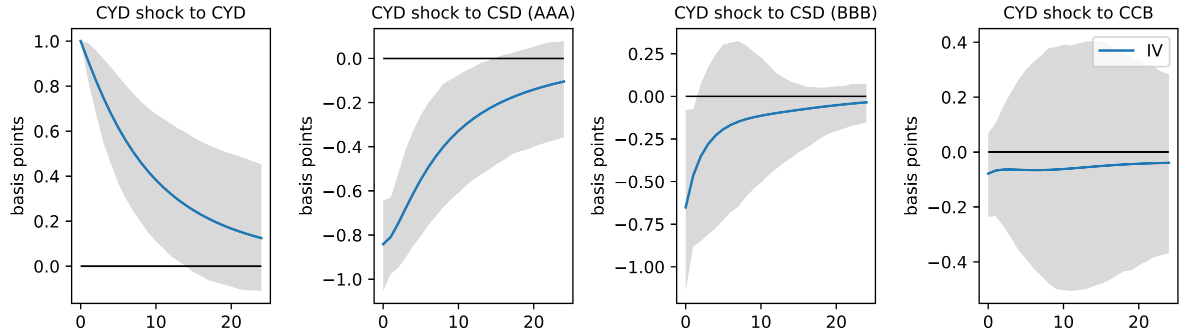


First stage regression: Coefficient: 59.47; F-statistics: 17; R^2: 0.08.

This figure presents the impulse response function (IRF) of one negative/positive unit CSD shock (Panel A and B)/CYD shock (Panel C) to the bond supply as well as the corporate basis components. Panels A, B and C are based on 1,000 wild bootstraps with the illiquidity shock IV, sentiment shock IV and monetary policy shock IV, respectively. The solid lines are the mean value of IRF, and the shaded areas are 95% confidence bands. The monthly sample is from January 2004 to March 2021 with the cross-currency mean of CSD, CYD, CCB, and the mean difference of the logarithm of corporate bonds outstanding denominated in non-USD and USD..

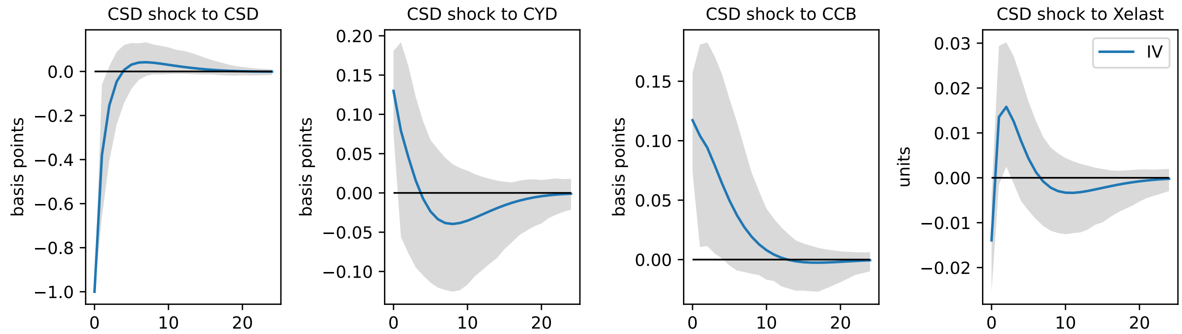
Figure A2: IRF of the SVAR Model with Instrumental Variables

(a) Cross-sectional Analysis: IRF of the CYD Shock with Monetary Policy IV (Mean)



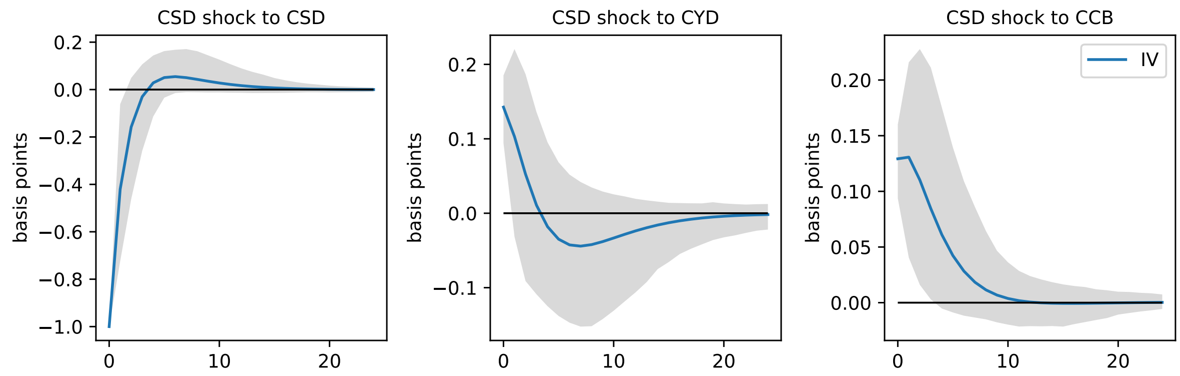
First-stage regression: Coefficient: 3.44 F-statistics: 18.89; R^2: 0.08.

(b) Time-series Analysis: IRF of the CSD Shock with Illiquidity IV (Mean)



First-stage regression: Coefficient: 0.53; F-statistics: 23.59; R^2: 0.31.

(c) Time-series Analysis: IRF of the CSD Shock with Illiquidity IV (Mean)

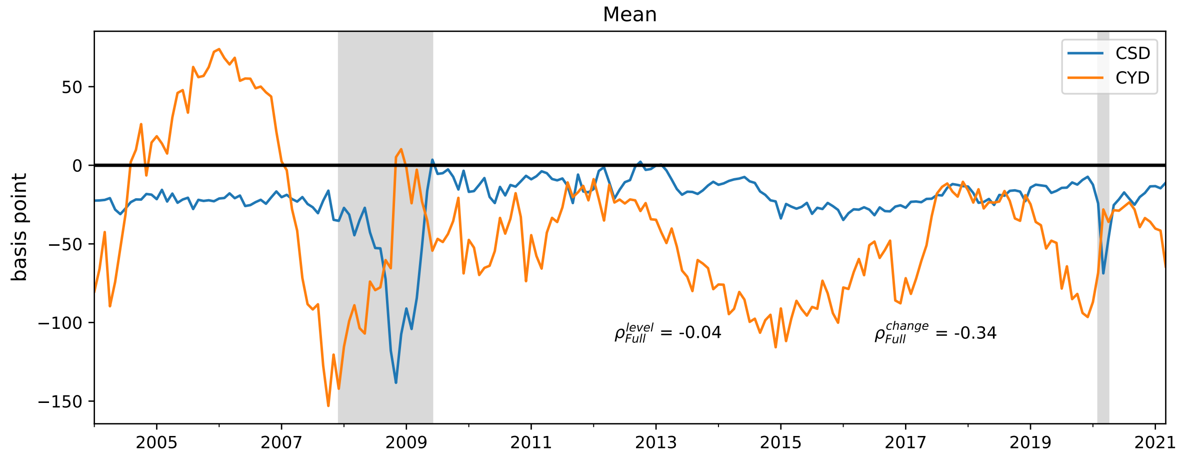


First-stage regression: Coefficient: 0.55; F-statistics: 25.52; R^2: 0.33.

Panel A presents the impulse response function (IRF) of one positive standard deviation CYD shock to CSD (AAA), CSD (BBB), and CCB, scaled by their standard deviations. Panel A is based on 1,000 wild bootstraps with the monetary policy shock IV, using monthly data from January 2004 to March 2021. Panels B and C present the IRF of one negative unit CSD shock to CYD, CCB, and Xleast (substitution elasticity between safe and risky bonds constructed by Nenova (2024)). Panels B and C are based on 1,000 wild bootstraps with the illiquidity shock IV, using the quarterly sample from 2007 to 2020. The solid lines are the mean value of IRF, and the shaded areas are 95% confidence bands.

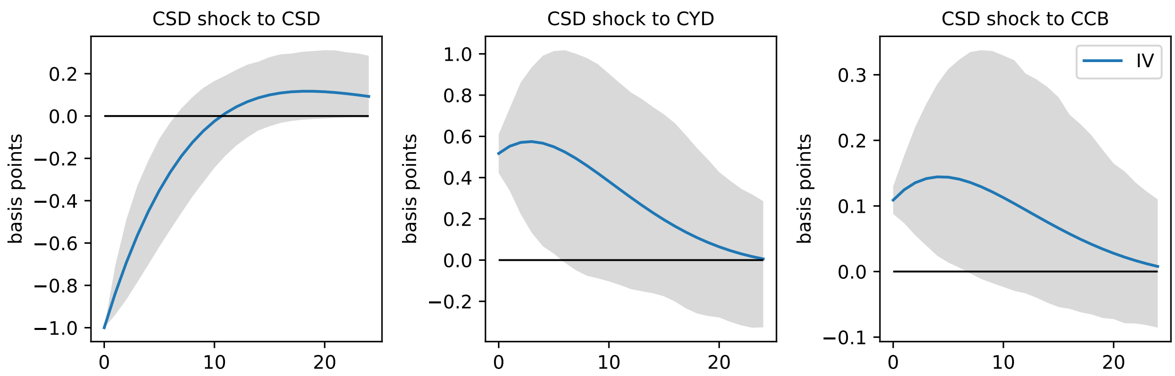
Figure A3: Robustness check using Alternative Risk-Free Rates (ARR)

(a) Substitution Effect using Alternative Risk-Free Rates (ARR)



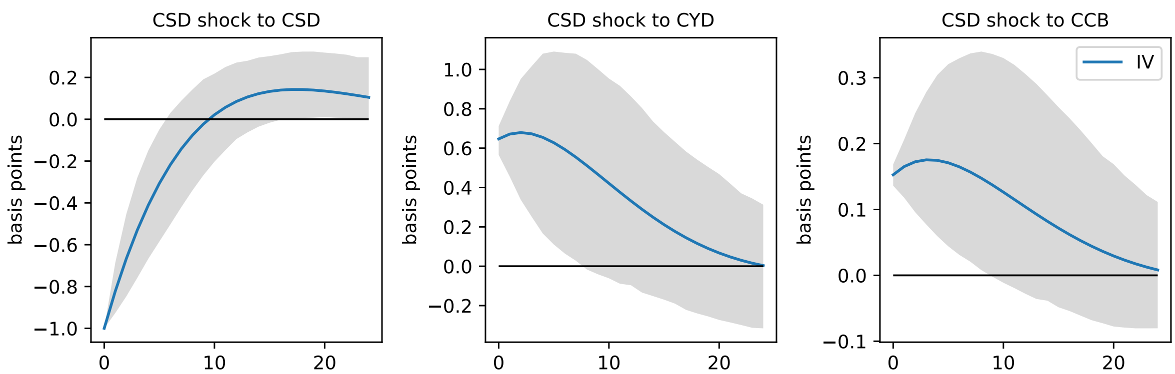
SVAR Model Analysis using Alternative Risk-Free Rates (ARR) (Mean)

(b) IRF of the CSD Shock with Illiquidity IV



First stage regression: Coefficient: 0.40; F-statistics: 52; R^2: 0.20.

(c) IRF of the CSD Shock with Sentiment IV

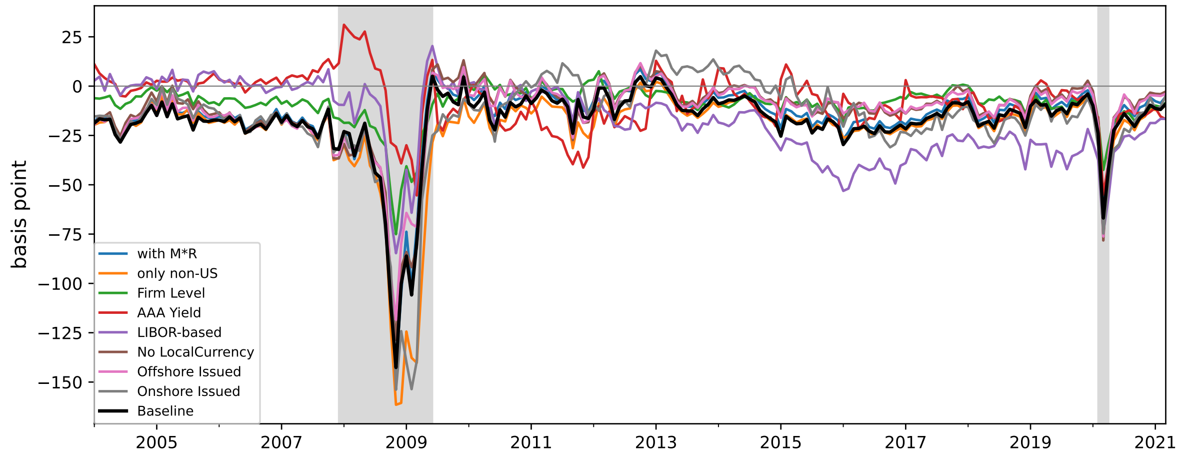


First stage regression: Coefficient: 0.39; F-statistics: 264; R^2: 0.56.

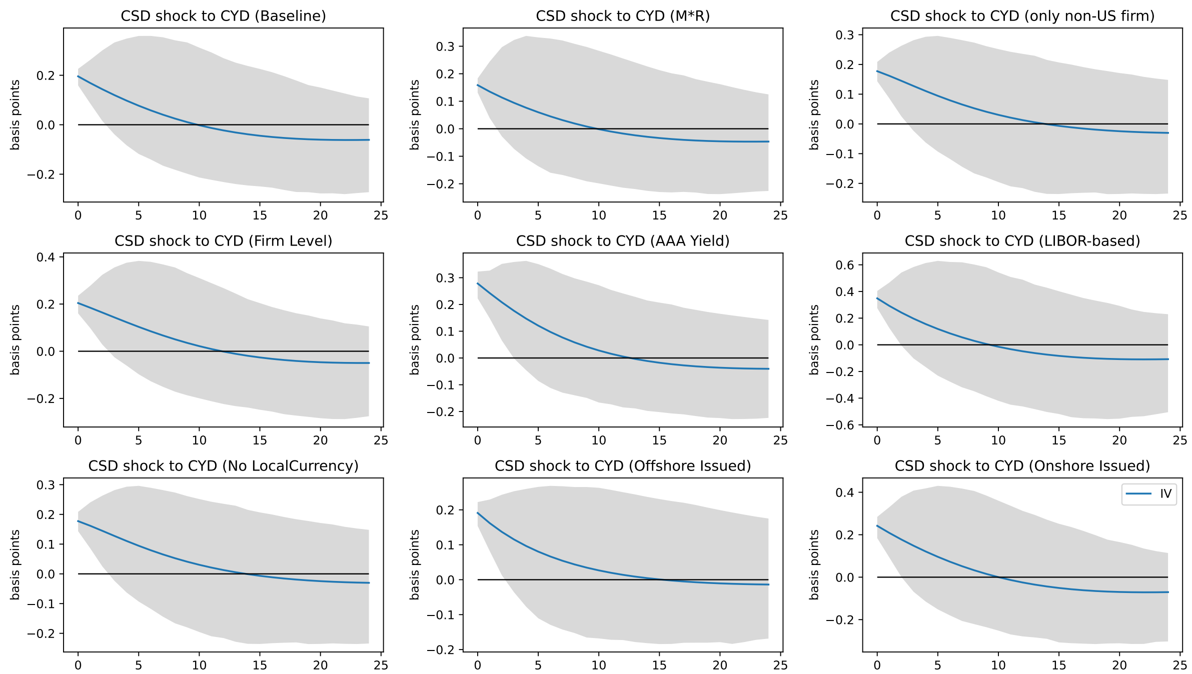
The top figure redraws the substitution effect with the CSD and CYD_{ARR}. The bottom figure redraws the SVAR model analysis with the ARR. The IVs are the illiquidity shock IV and sentiment shock IV for CSD shock, respectively. The sample is from January 2004 to March 2021 with the currency of CAD, EUR, GBP and JPY. The shadow areas indicate the recession period of the GFC and Covid-19 based on NBER business cycle dates, respectively.

Figure A4: Alternative Measures of CSD

(a) Alternative Measurement

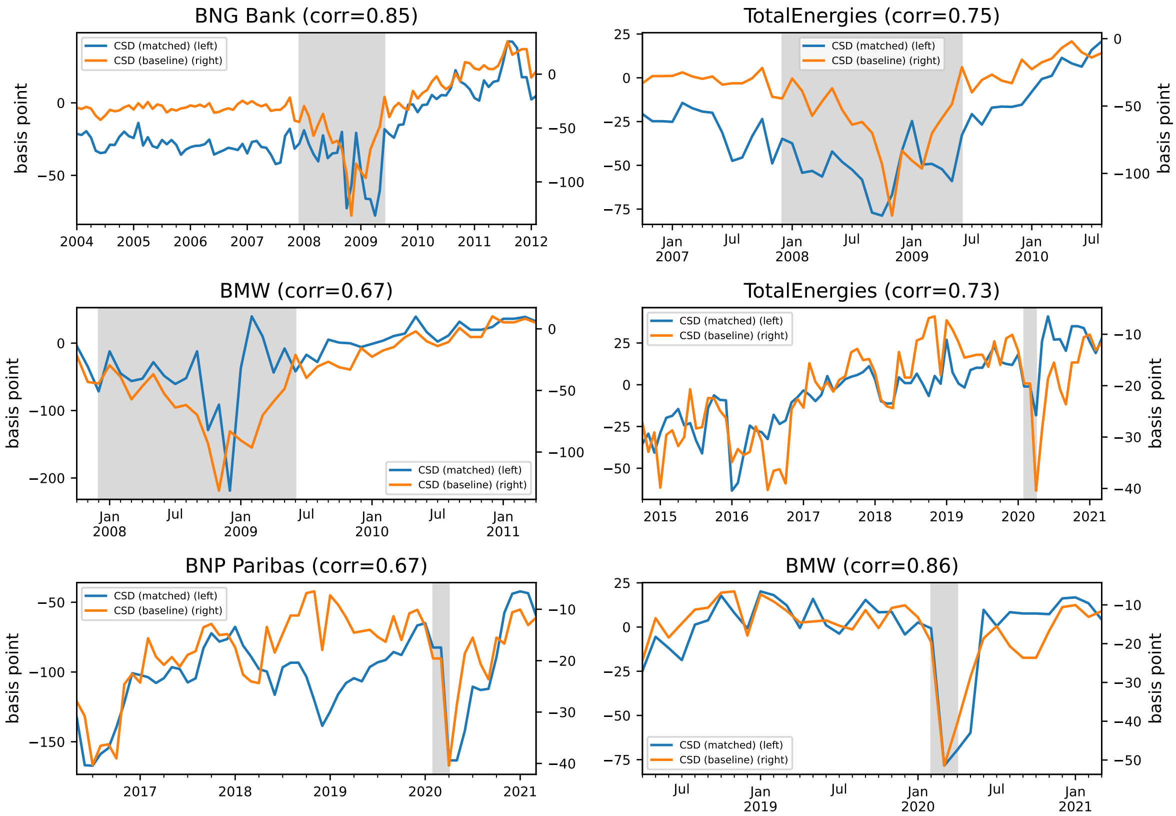


(b) SVAR Model Analysis with Illiquidity IV (Mean)



The top figure compares the baseline CSD with eight alternative measures. The baseline CSD is the black line. The label *with M*R* line shows the alternative CSD, which adds the interaction terms between maturity buckets and rating buckets into cross-section regression. The label *only non-US* line shows the alternative CSD, which only uses the non-US firms' sample. The label *Firm Level* line shows the CSD, which takes the mean value of firm-level CSD. The label *AAA yield* line shows the CSD, which calculates the corporate bond credit spread as the bond yield net of the AAA bond yield. The label *LIBOR-based* line shows the CSD, which calculates the corporate bond credit spread as the bond yield net of the maturity-matched LIBOR rates. The label *No LocalCurrency* line represents the CSD that excludes firms' local currency bonds. The label *Offshore Issued* line denotes the CSD that includes bonds issued in a market different from the parent firm's nationality. The label *Onshore Issued* line refers to the CSD that includes bonds issued in the same market as the parent firm's nationality. The bottom figure compares the substitution effect between CSD and CYD when using the baseline and alternative CSD. Each sub-figure shows the impulse response functions (IRF) of one negative unit CSD shock to CYD. The plots are based on 1,000 wild bootstraps with the Illiquidity shock IV. The monthly sample is from January 2004 to March 2021. Shaded bars in the top figure denote months designated as recessions by the National Bureau of Economic Research.

Figure A5: Credit Spread Differential Based on Matched Pairs of Bond



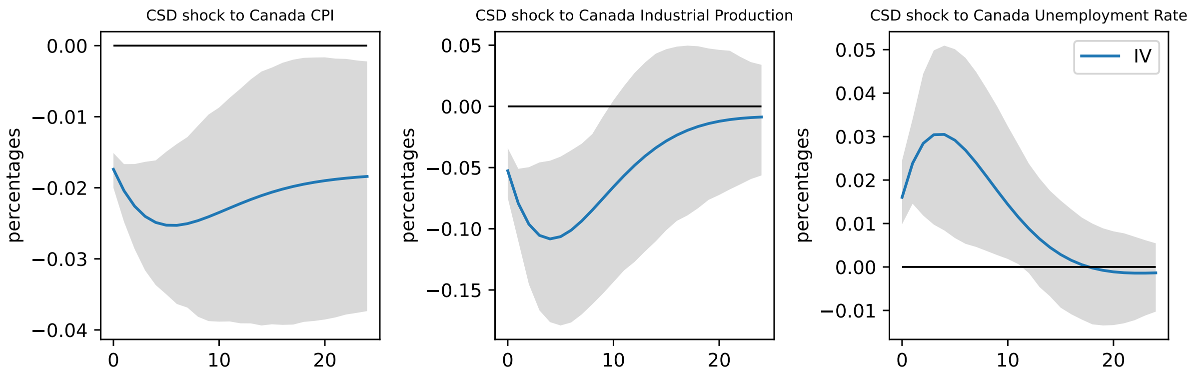
This figure presents the CSD at the bond pair-level. The bond pair-level (matched) CSD is the credit spread difference between a EUR-denomination bond and a USD-denomination bond issued by the same firm with similar remaining maturity and duration. The sub-figure title shows the parent firm's name and the correlation between CSD (matched) and the EUR-USD pair' CSD (baseline). Shaded bars denote months designated as recessions by the National Bureau of Economic Research.

C Macroeconomic effects on other countries

C.1 SVAR with Illiquidity IV

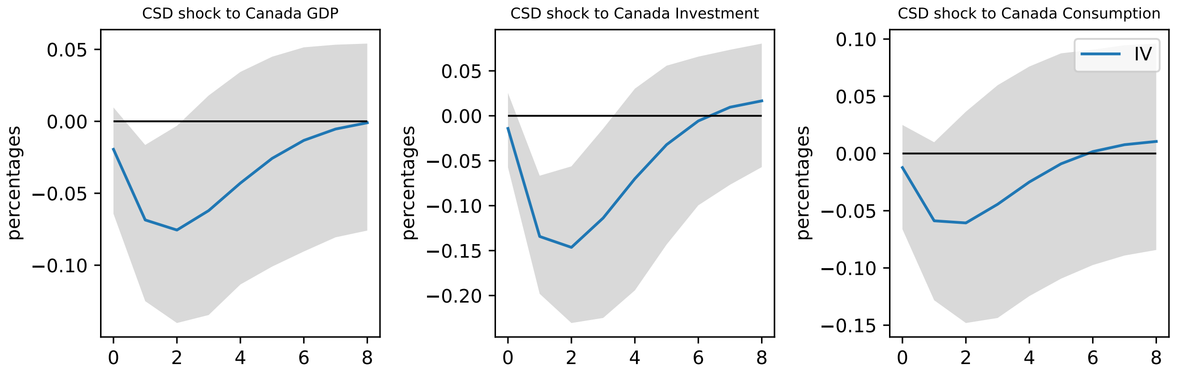
Figure A6: IRF of the CSD Shock with the Canada Macroeconomic Activity

(a) Monthly Variables



First stage regression: Coefficient: 0.38; F-statistics: 41; R^2: 0.17.

(b) Quarterly Variables

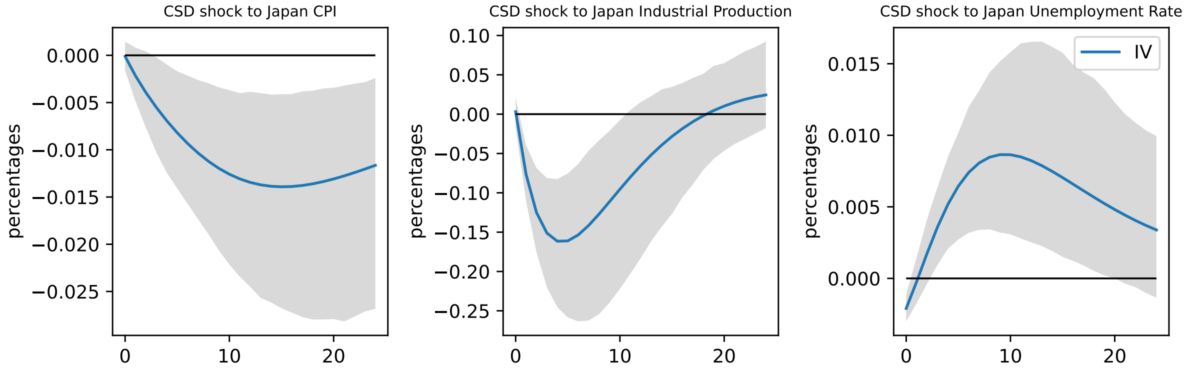


First stage regression: Coefficient: 0.51; F-statistics: 27; R^2: 0.29.

This figure presents the impulse response function (IRF) of one negative unit CSD shock to each variable. The plots are based on 1,000 wild bootstraps with the Gibbs shock IV. The solid lines are the mean value of IRF, and the shaded areas are 95% confidence bands. The monthly sample is from January 2004 to March 2021 with the CAD data of CSD, CYD, CCB, Canada CPI, Canada Industrial Production, Canada Unemployment Rate, Canada Real GDP, Canada Real Investment and Canada Real Consumption. The monthly and quarterly variables are estimated in the SVAR model separately.

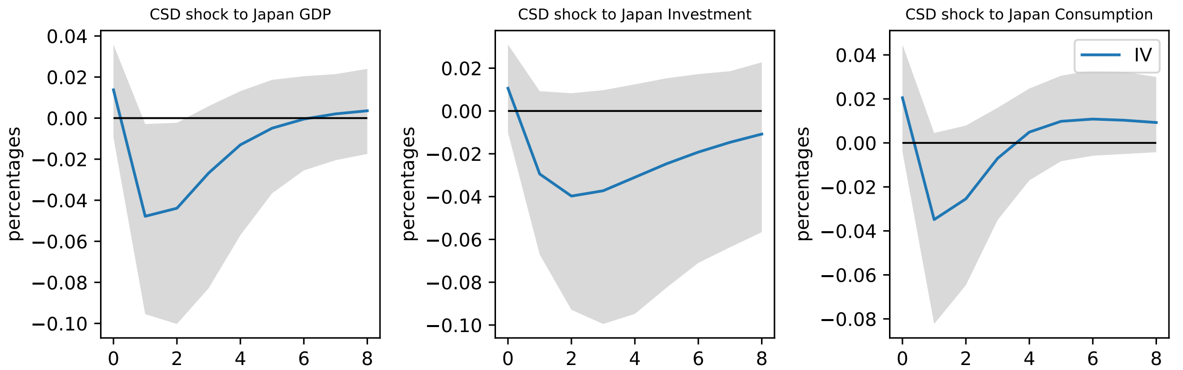
Figure A7: IRF of the CSD Shock with the Japan Macroeconomic Activity

(a) Monthly Variables



First stage regression: Coefficient: 0.41; F-statistics: 49; R^2: 0.19.

(b) Quarterly Variables

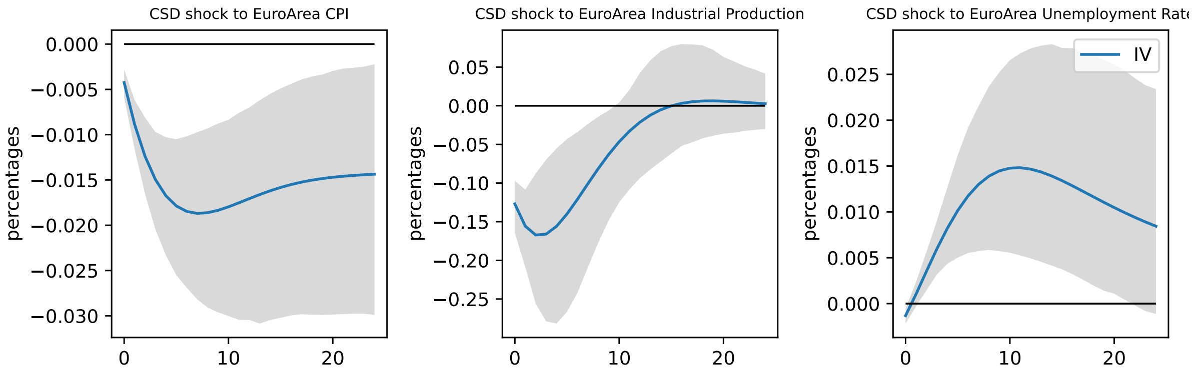


First stage regression: Coefficient: 0.50; F-statistics: 30; R^2: 0.31.

This figure presents the impulse response function (IRF) of one negative unit CSD shock to each variable. The plots are based on 1,000 wild bootstraps with the Gibbs shock IV. The solid lines are the mean value of IRF, and the shaded areas are 95% confidence bands. The monthly sample is from January 2004 to March 2021 with the JPY data of CSD, CYD, CCB, Japan CPI, Japan Industrial Production, Japan Unemployment Rate, Japan Real GDP, Japan Real Investment and Japan Real Consumption. The monthly and quarterly variables are estimated in the SVAR model separately.

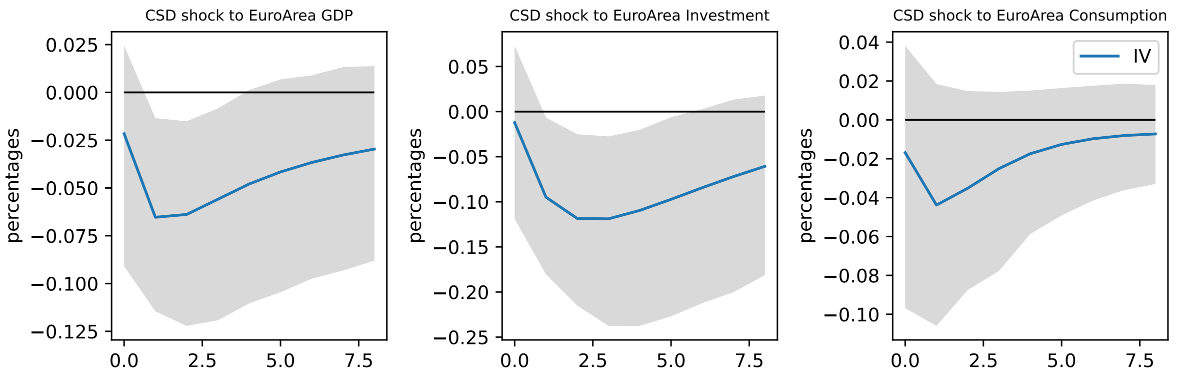
Figure A8: IRF of the CSD Shock with the Euro Area Macroeconomic Activity

(a) Monthly Variables



First stage regression: Coefficient: 0.40; F-statistics: 46; R^2: 0.18.

(b) Quarterly Variables

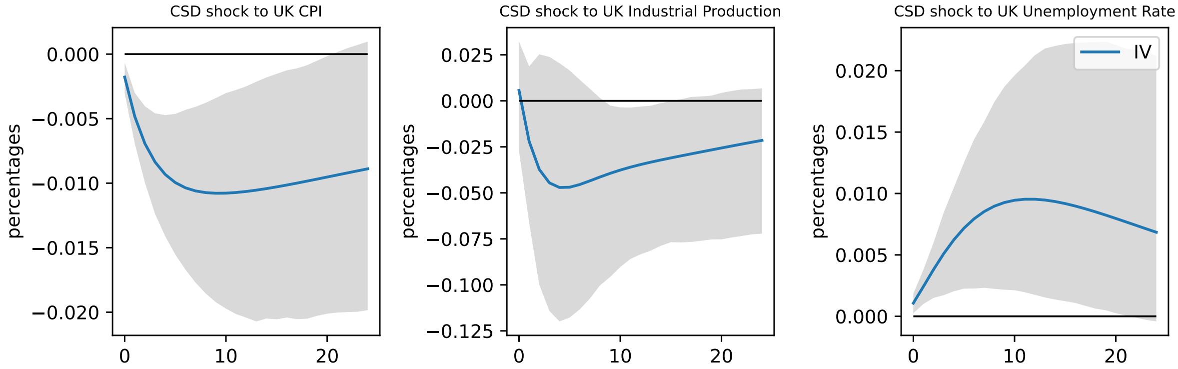


First stage regression: Coefficient: 0.49; F-statistics: 26; R^2: 0.28.

This figure presents the impulse response function (IRF) of one negative unit CSD shock to each variable. The plots are based on 1,000 wild bootstraps with the Gibbs shock IV. The solid lines are the mean value of IRF, and the shaded areas are 95% confidence bands. The monthly sample is from January 2004 to March 2021 with the EUR data of CSD, CYD, CCB, Euro Area CPI, Euro Area Industrial Production, Euro Area Unemployment Rate, Euro Area Real GDP, Euro Area Real Investment and Euro Area Real Consumption. The monthly and quarterly variables are estimated in the SVAR model separately.

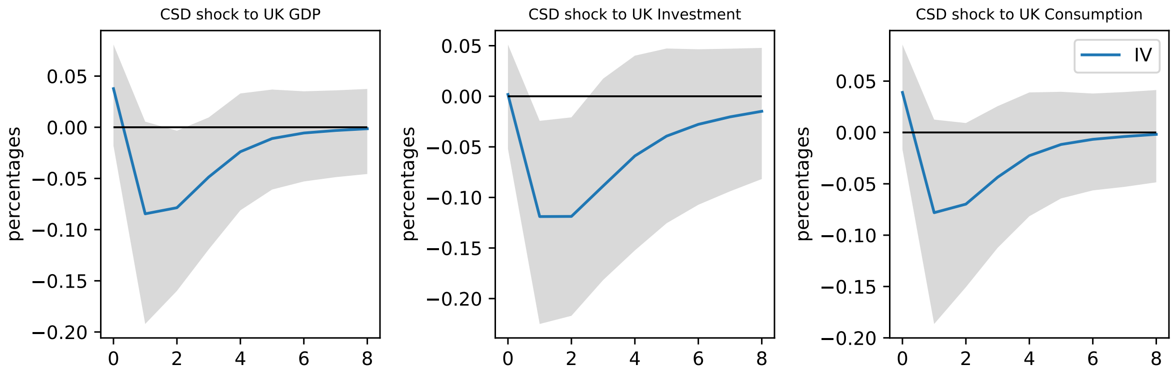
Figure A9: IRF of the CSD Shock with the UK Macroeconomic Activity

(a) Monthly Variables



First stage regression: Coefficient: 0.40; F-statistics: 43; R^2: 0.17.

(b) Quarterly Variables

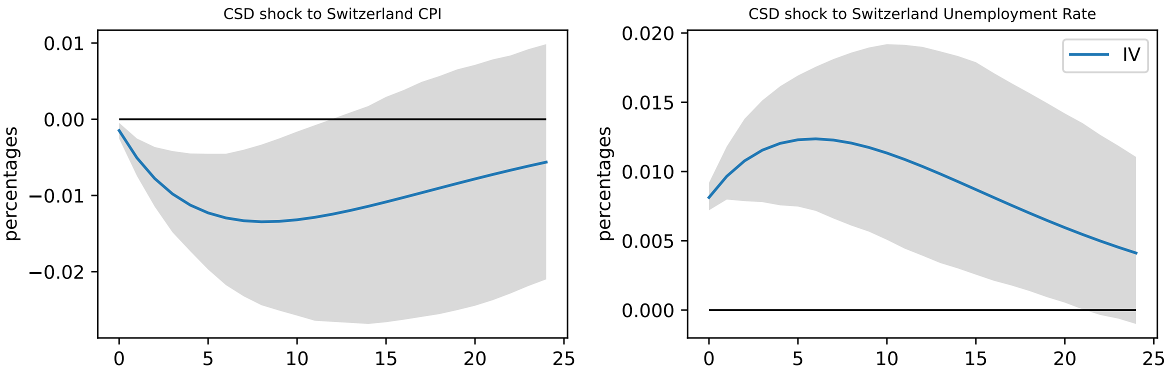


First stage regression: Coefficient: 0.51; F-statistics: 29; R^2: 0.30.

This figure presents the impulse response function (IRF) of one negative unit CSD shock to each variable. The plots are based on 1,000 wild bootstraps with the Gibbs shock IV. The solid lines are the mean value of IRF, and the shaded areas are 95% confidence bands. The monthly sample is from January 2004 to March 2021 with the GBP data of CSD, CYD, CCB, UK CPI, UK Industrial Production, UK Unemployment Rate, UK Real GDP, UK Real Investment and UK Real Consumption. The monthly and quarterly variables are estimated in the SVAR model separately.

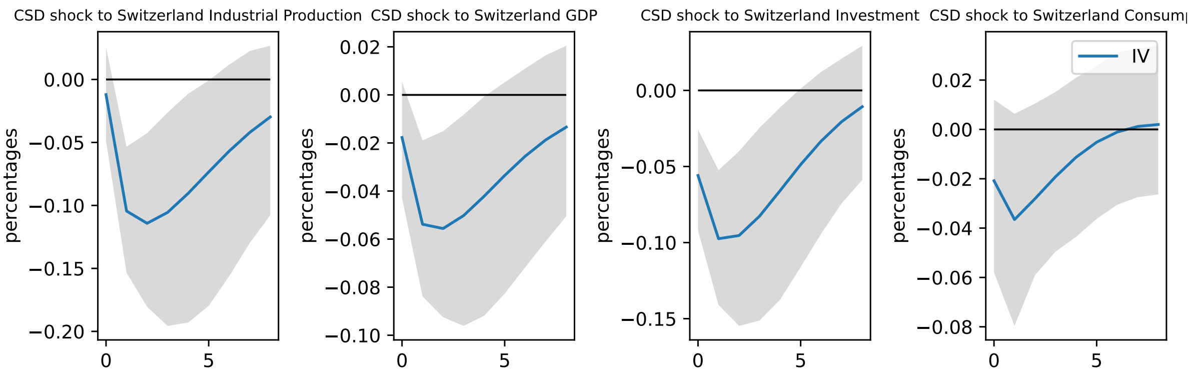
Figure A10: IRF of the CSD Shock with the Switzerland Macroeconomic Activity

(a) Monthly Variables



First stage regression: Coefficient: 0.39; F-statistics: 42; R^2: 0.17.

(b) Quarterly Variables

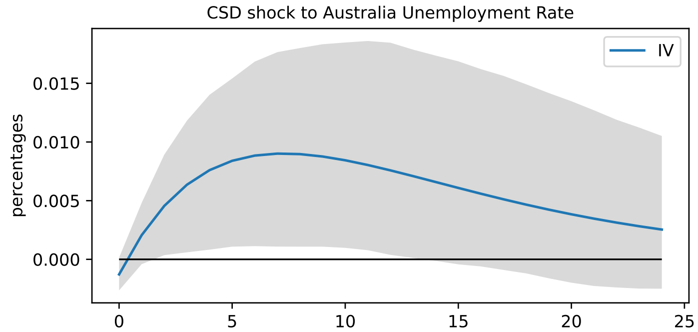


First stage regression: Coefficient: 0.48; F-statistics: 27; R^2: 0.29.

This figure presents the impulse response function (IRF) of one negative unit CSD shock to each variable. The plots are based on 1,000 wild bootstraps with the Gibbs shock IV. The solid lines are the mean value of IRF, and the shaded areas are 95% confidence bands. The monthly sample is from January 2004 to March 2021 with the CHF data of CSD, CYD, CCB, Switzerland CPI, Switzerland Industrial Production, Switzerland Unemployment Rate, Switzerland Real GDP, Switzerland Real Investment and Switzerland Real Consumption. The monthly and quarterly variables are estimated in the SVAR model separately.

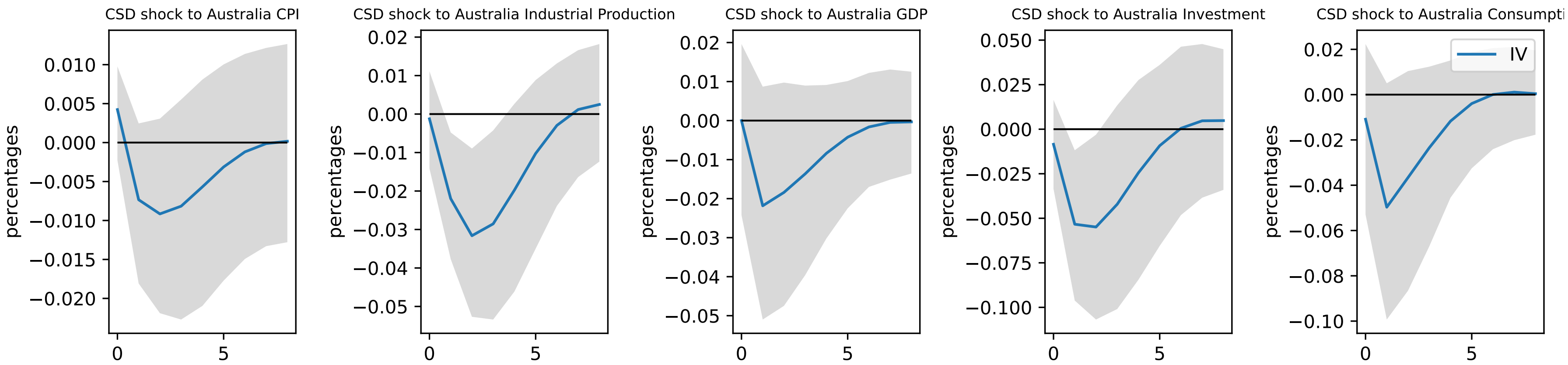
Figure A11: IRF of the CSD Shock with the Australia Macroeconomic Activity

(a) Monthly Variables



First stage regression: Coefficient: 0.41; F-statistics: 47; R^2: 0.19.

(b) Quarterly Variables



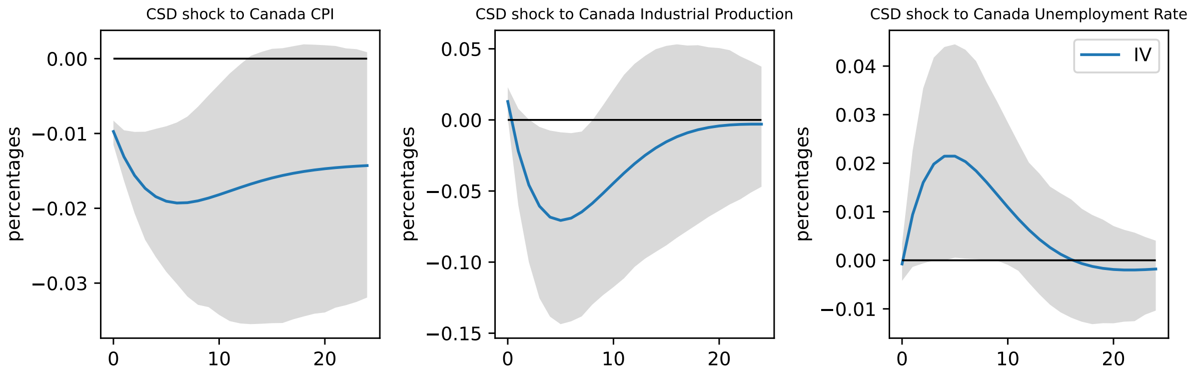
First stage regression: Coefficient: 0.49; F-statistics: 30; R^2: 0.32.

This figure presents the impulse response function (IRF) of one negative unit CSD shock to each variable. The plots are based on 1,000 wild bootstraps with the Gibbs shock IV. The solid lines are the mean value of IRF, and the shaded areas are 95% confidence bands. The monthly sample is from January 2004 to March 2021 with the AUD data of CSD, CYD, CCB, Australia CPI, Australia Industrial Production, Australia Unemployment Rate, Australia Real GDP, Australia Real Investment and Australia Real Consumption. The monthly and quarterly variables are estimated in the SVAR model separately.

C.2 SVAR with Sentiment IV

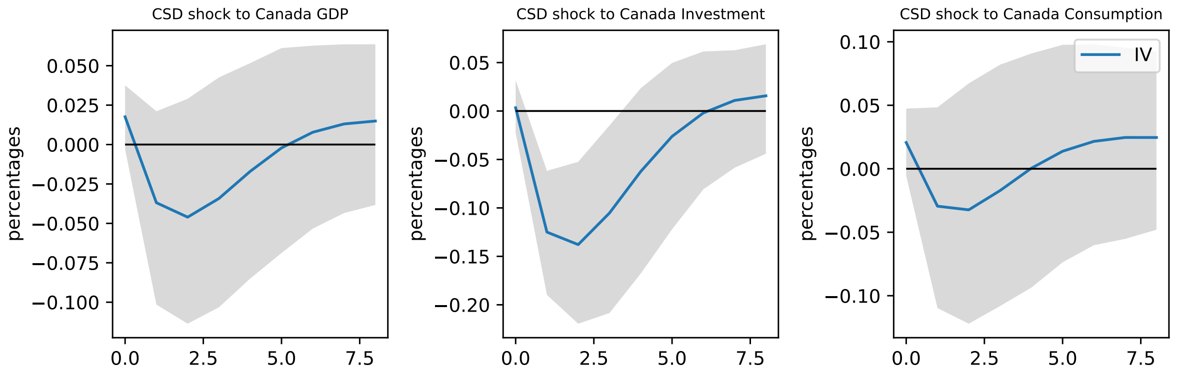
Figure A12: IRF of the CSD Shock with the Canada Macroeconomic Activity

(a) Monthly Variables



First stage regression: Coefficient: 0.38; F-statistics: 197; R^2: 0.49.

(b) Quarterly Variables

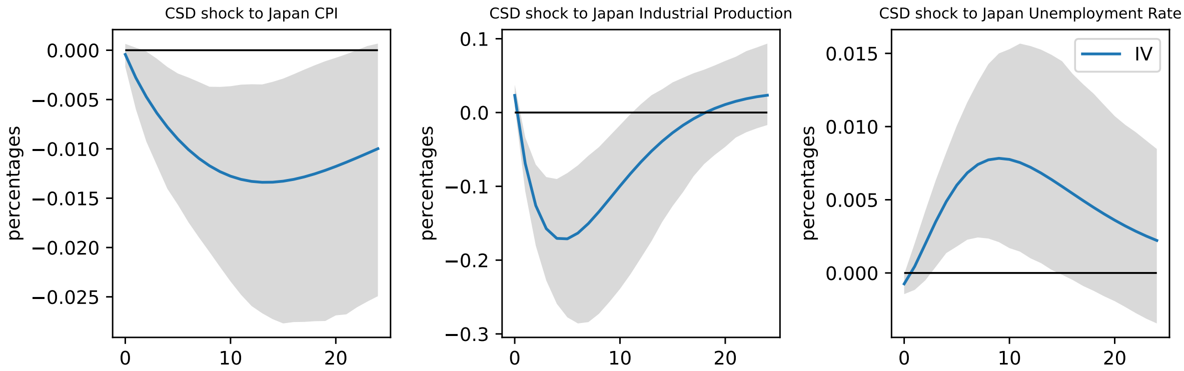


First stage regression: Coefficient: 0.39; F-statistics: 128; R^2: 0.66.

This figure presents the impulse response function (IRF) of one negative unit CSD shock to each variable. The plots are based on 1,000 wild bootstraps with the EBP shock IV. The solid lines are the mean value of IRF, and the shaded areas are 95% confidence bands. The monthly sample is from January 2004 to March 2021 with the CAD data of CSD, CYD, CCB, Canada CPI, Canada Industrial Production, Canada Unemployment Rate, Canada Real GDP, Canada Real Investment and Canada Real Consumption. The monthly and quarterly variables are estimated in the SVAR model separately.

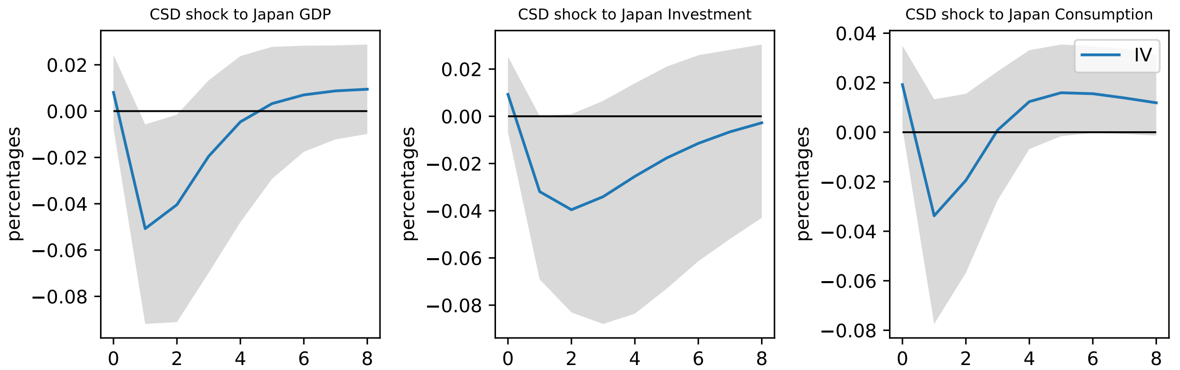
Figure A13: IRF of the CSD Shock with the Japan Macroeconomic Activity

(a) Monthly Variables



First stage regression: Coefficient: 0.38; F-statistics: 210; R^2: 0.51.

(b) Quarterly Variables

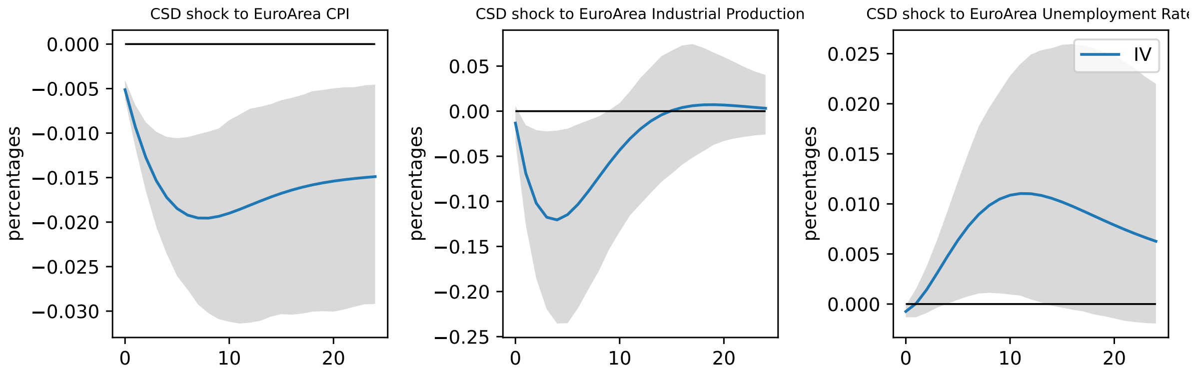


First stage regression: Coefficient: 0.36; F-statistics: 118; R^2: 0.64.

This figure presents the impulse response function (IRF) of one negative unit CSD shock to each variable. The plots are based on 1,000 wild bootstraps with the EBP shock IV. The solid lines are the mean value of IRF, and the shaded areas are 95% confidence bands. The monthly sample is from January 2004 to March 2021 with the JPY data of CSD, CYD, CCB, Japan CPI, Japan Industrial Production, Japan Unemployment Rate, Japan Real GDP, Japan Real Investment and Japan Real Consumption. The monthly and quarterly variables are estimated in the SVAR model separately.

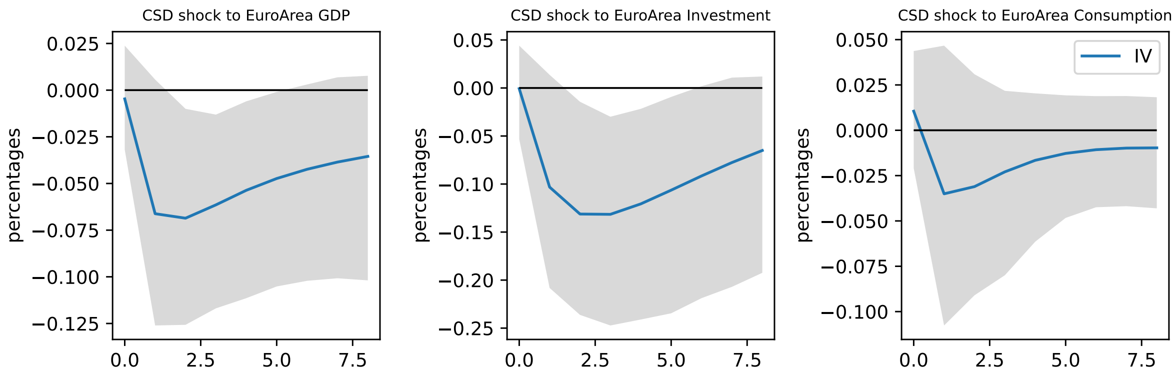
Figure A14: IRF of the CSD Shock with the Euro Area Macroeconomic Activity

(a) Monthly Variables



First stage regression: Coefficient: 0.37; F-statistics: 185; R^2: 0.48.

(b) Quarterly Variables

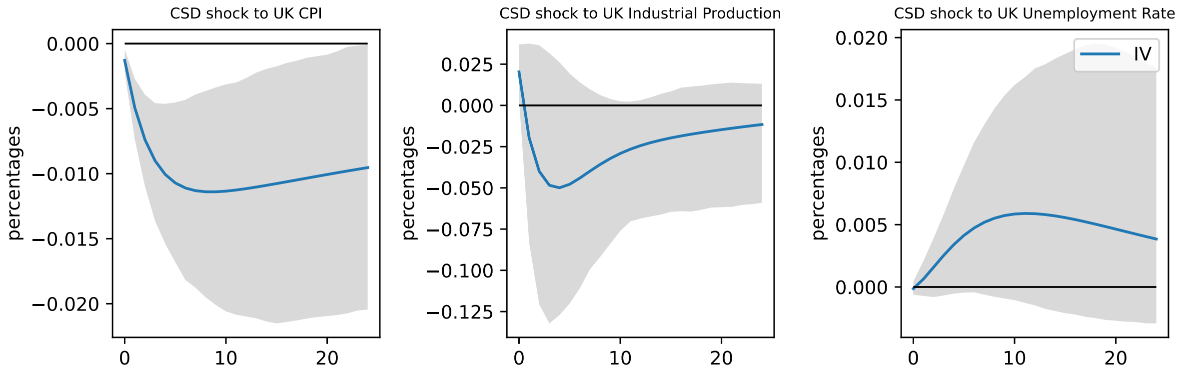


First stage regression: Coefficient: 0.38; F-statistics: 121; R^2: 0.65.

This figure presents the impulse response function (IRF) of one negative unit CSD shock to each variable. The plots are based on 1,000 wild bootstraps with the EBP shock IV. The solid lines are the mean value of IRF, and the shaded areas are 95% confidence bands. The monthly sample is from January 2004 to March 2021 with the EUR data of CSD, CYD, CCB, Euro Area CPI, Euro Area Industrial Production, Euro Area Unemployment Rate, Euro Area Real GDP, Euro Area Real Investment and Euro Area Real Consumption. The monthly and quarterly variables are estimated in the SVAR model separately.

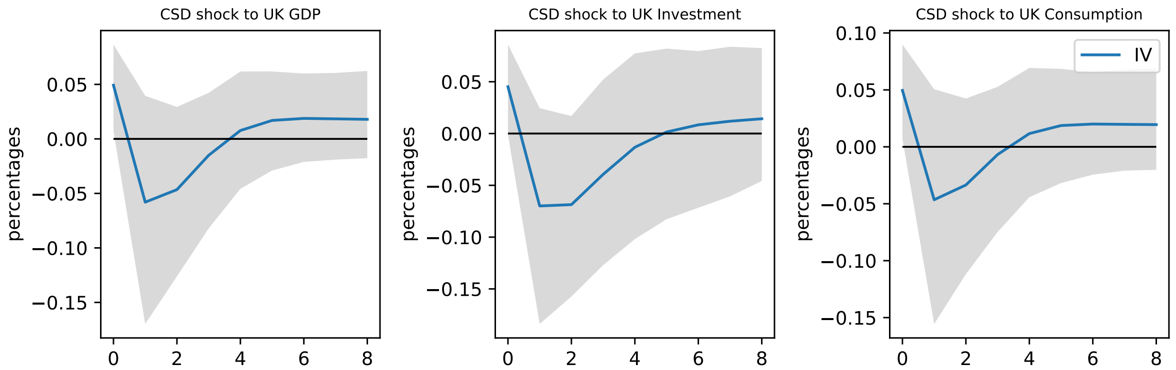
Figure A15: IRF of the CSD Shock with the UK Macroeconomic Activity

(a) Monthly Variables



First stage regression: Coefficient: 0.41; F-statistics: 241; R^2: 0.54.

(b) Quarterly Variables

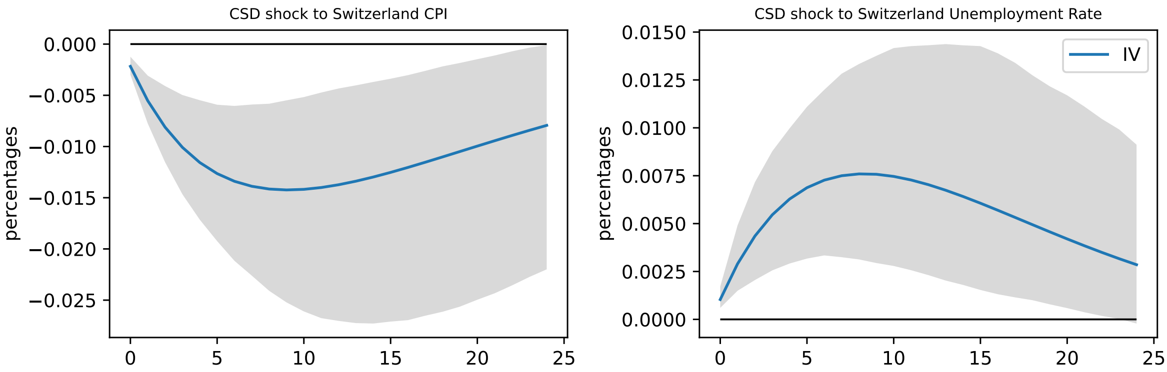


First stage regression: Coefficient: 0.38; F-statistics: 129; R^2: 0.66.

This figure presents the impulse response function (IRF) of one negative unit CSD shock to each variable. The plots are based on 1,000 wild bootstraps with the EBP shock IV. The solid lines are the mean value of IRF, and the shaded areas are 95% confidence bands. The monthly sample is from January 2004 to March 2021 with the GBP data of CSD, CYD, CCB, UK CPI, UK Industrial Production, UK Unemployment Rate, UK Real GDP, UK Real Investment and UK Real Consumption. The monthly and quarterly variables are estimated in the SVAR model separately.

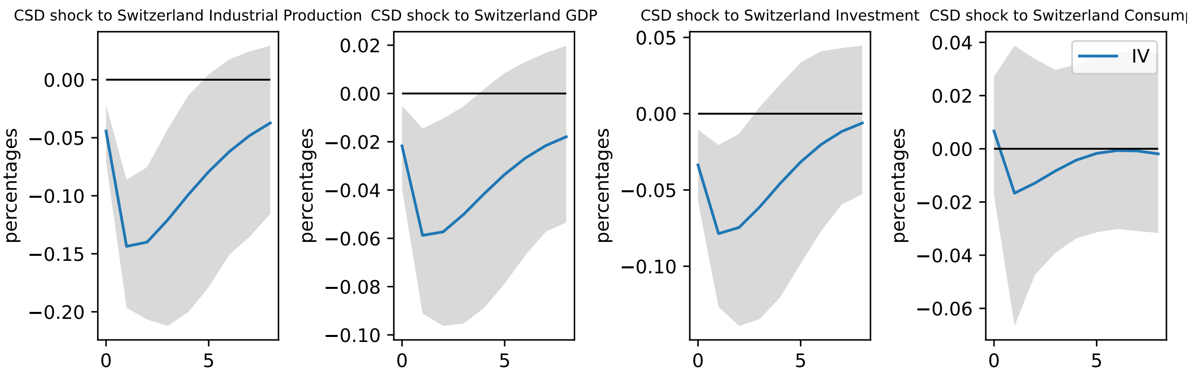
Figure A16: IRF of the CSD Shock with the Switzerland Macroeconomic Activity

(a) Monthly Variables



First stage regression: Coefficient: 0.40; F-statistics: 221; R^2: 0.52.

(b) Quarterly Variables

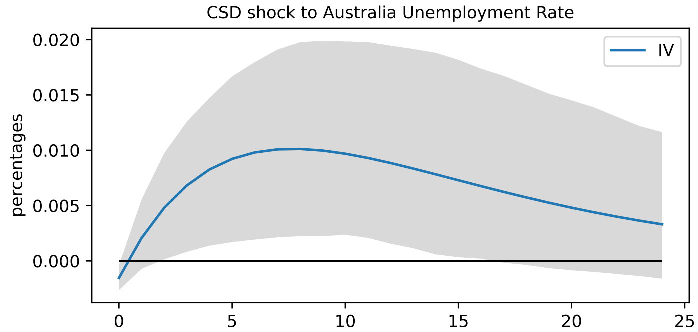


First stage regression: Coefficient: 0.35; F-statistics: 103; R^2: 0.61.

This figure presents the impulse response function (IRF) of one negative unit CSD shock to each variable. The plots are based on 1,000 wild bootstraps with the EBP shock IV. The solid lines are the mean value of IRF, and the shaded areas are 95% confidence bands. The monthly sample is from January 2004 to March 2021 with the CHF data of CSD, CYD, CCB, Switzerland CPI, Switzerland Industrial Production, Switzerland Unemployment Rate, Switzerland Real GDP, Switzerland Real Investment and Switzerland Real Consumption. The monthly and quarterly variables are estimated in the SVAR model separately.

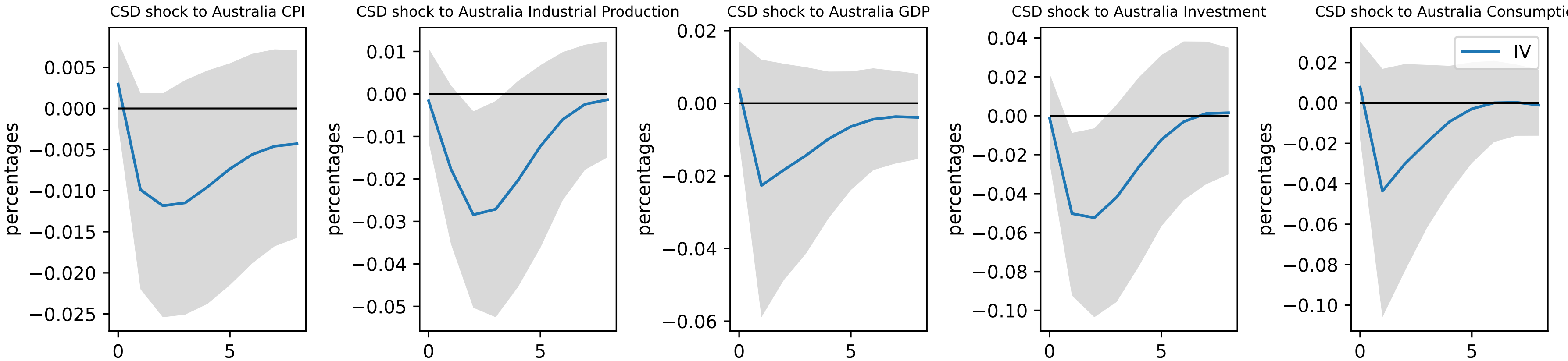
Figure A17: IRF of the CSD Shock with the Australia Macroeconomic Activity

(a) Monthly Variables



First stage regression: Coefficient: 0.41; F-statistics: 244; R^2: 0.54.

(b) Quarterly Variables



First stage regression: Coefficient: 0.33; F-statistics: 87; R^2: 0.57.

This figure presents the impulse response function (IRF) of one negative unit CSD shock to each variable. The plots are based on 1,000 wild bootstraps with the EBP shock IV. The solid lines are the mean value of IRF, and the shaded areas are 95% confidence bands. The monthly sample is from January 2004 to March 2021 with the AUD data of CSD, CYD, CCB, Australia CPI, Australia Industrial Production, Australia Unemployment Rate, Australia Real GDP, Australia Real Investment and Australia Real Consumption. The monthly and quarterly variables are estimated in the SVAR model separately.