The Effects of a Global Minimum Tax on Corporate Balance Sheets and Real Activities: Evidence from the Insurance Industry

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Abstract

How do global minimum taxes affect corporate balance sheets and real activities? I study this question using the introduction of the base erosion and anti-abuse tax (BEAT) on multinational insurance companies operating in the US. I find that the BEAT implementation significantly changed the internal capital allocation of insurers, increased global risk-sharing, and increased product prices in the US. I document three main sets of findings. First, the global minimum tax significantly changed the internal capital allocation of insurance companies and decreased the amount of transfer payments of US insurers to their foreign affiliates by 59%, or $30 billion per year. The changes in allocation were primarily driven by foreign-domiciled insurance groups and insurance groups which used foreign affiliates more extensively prior to the tax reform. Second, the tax increased global risk-sharing, inducing insurers to diversify more risk with external counterparties. Revealed-preference estimates suggest that the total increase in risk-sharing is worth $1.9 billion per year for insurers, equal to 2.9% of insurers' total net income. Third, insurance companies affected by the minimum tax increased policy prices by 1.03% relative to not-affected insurers.

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1 Introduction

Multinational corporations can transact with their affiliates in countries with different tax rates to shift profits and manage their tax liabilities. These transactions have come under increasing policy and academic attention over the past decade. In response, the US and other countries have proposed various legislative and policy instruments to revamp the global corporate tax system, such as an OECD global minimum tax agreement by over 130 countries in October 2021. Despite the legal and academic interests, there is limited evidence on the impacts of such tax policies. How do global minimum taxes affect corporate balance sheets and real economic activities?

This paper studies this question using the US implementation of the base erosion and anti-abuse tax (BEAT) in the insurance industry. The BEAT provision was a minimum tax introduced by the US federal government in 2017 that applied to certain transactions multinational firms conduct with foreign affiliates. The size and global nature of the insurance industry, combined with insurance groups' use of foreign affiliates, makes it a natural laboratory to study the effects of such tax policies on multinational firms. I focus on the property and casualty insurance industry, which underwrites over $700 billion in insurance premiums in the US annually. I find that the implementation of the BEAT minimum tax significantly changed the internal capital allocation of insurers, increased global risk-sharing, and affected downstream product markets in the US.

The analysis in this paper proceeds in four parts. First, I present a model of a multinational firm's profit maximization problem that highlights the effect of a global minimum tax. I focus on the case of insurance companies, which engage in real economic activities through selling insurance policies that facilitate risk-sharing. Importantly, insurance companies can either retain their insurance policy liabilities internally, such as with foreign or US affiliates, or outsource and diversify the risk externally with reinsurers. The insurance company trades off capturing tax benefits of internally transferring insurance policies to foreign affiliates against the risk-hedging benefits of sharing the risk externally with a reinsurer outside the insurance group. A global minimum tax decreases the relative tax benefit of using foreign affiliates, which decreases the use of foreign affiliates and induces an increase in the use of US affiliates and an increase in diversification of risks outside the insurance group. The external diversification, in particular, is potentially valuable if insurance groups are exposed to idiosyncratic shocks to the policies they underwrite, for example due to natural disasters or excess claims in the regions and lines of businesses they sell insurance in. In the product market, the global minimum tax increases the cost of selling insurance, plausibly leading insurance companies to increase prices.

I then empirically document the effects of the minimum tax. In the second part of the paper, I study how internal capital allocation of US property and casualty insurance companies changed in response to the tax. I find that insurance companies significantly adjusted their internal capital allocations after the global minimum corporate tax was implemented: insurers decreased their transfers of insurance premiums to foreign affiliates by 59%, from $51 billion annually to $21 billion annually. The estimates suggest that a 1% increase in the tax rate is associated with an approximately 7.9% decrease in the amount of liabilities allocated to foreign affiliates, corresponding to a semi-elasticity of capital flow with respect to the tax rate of -12.3. I also find that there is substantial heterogeneity in the use of foreign affiliates across insurers and that insurers that were more affected by the minimum tax, as proxied by greater use of foreign affiliates pre-BEAT, adjusted their internal capital allocation by more than insurers that were less affected. Turning to the insurers' domestic (US) affiliates, I find that insurers increased capital allocation to their domestic affiliates by 9%, suggesting that insurers substituted towards US affiliates in response to the tax. I further exploit the rich financial and operating data of insurance companies to show that tax incentives were a first-order determinant of internal capital allocation even before the BEAT provision. Overall, the evidence suggests that the minimum tax significantly changed insurers' internal capital allocations and that multinational firms' internal capital allocations are highly responsive to international tax policies.

Third, I show that insurers increased their external risk-sharing after the global minimum tax was implemented. External risk-sharing is valuable for property and casualty insurers given their significant exposures to natural and man-made shocks to their liabilities. Since insurers may face financing frictions such as agency costs and capital market imperfections, large liability shocks can deplete insurers' capital and cause financial constraints and distress, which can affect insurers' investments and product market decisions and lead to costly bankruptcies and liquidations (e.g. Ge and Weisbach (2019) and Ge (2020)). Despite their theoretical importance, the use of risk-sharing reinsurance has been relatively limited, and several explanations exist for why insurers may not use more external reinsurance, including frictions in the supply of reinsurance capital, high barriers to entry due to specialized expertise, and demand-side information asymmetries of which policies insurers choose to reinsure (e.g. Froot (2001)).

Insurers' use of foreign and US affiliates for tax and regulatory management suggests a complementary explanation for why insurers may not use more external risk-sharing: that insurers' private tax and regulatory benefits of using affiliates crowd out the use of external reinsurance. As such, insurers may forego hedging some of their liabilities if they can retain them on affiliates' balance sheets to capture private tax benefits, even if the external hedging may be otherwise valuable to the insurer. This trade-off implies that the global minimum tax, which decreases the tax benefits of using affiliates, would increase external risk-sharing.

Indeed, consistent with this prediction, I find that insurers increased external risk-sharing by 6.5% after the global minimum tax was implemented. I also find that insurers that were most affected by the minimum tax, as proxied by greater use of foreign affiliates pre-BEAT, increased their external risk-sharing by more than insurers that were less affected by the tax. I provide two additional sets of evidence that suggest that this increased risk-sharing was of substantial value to insurers. First, I use a revealed preference approach based on insurers' optimal liability allocation problem and estimate that the total increase in risk-sharing is worth $1.9 billion per year for all insurers, equivalent to 2.9% of their annual net income. Second, I show that US property and casualty insurers have significant exposures to idiosyncratic shocks to their liabilities, providing a primitive reason for why insurers would benefit from risk-hedging. Overall, the findings that the tax change increased risk-sharing and that this risk-sharing was valuable to insurers are consistent with the idea that insurers' private tax benefits of using foreign affiliates affect their decisions to diversify risks, potentially exposing insurers to shocks to their liabilities. The global minimum tax, which decreased the private tax benefit of using foreign affiliates by decreasing the effective differences in corporate tax rates across domiciles, led insurers to increase risk diversification.

Lastly, on product markets, I find that the global minimum tax led to an increase in product prices by insurers that used foreign affiliates. On product prices, I use a difference-in-differences strategy to study how insurers adjusted their product pricing in response to the tax reform, which was one of the most heavily debated potential consequences of the BEAT provision.[1] I find that insurers that used more foreign affiliated reinsurance increased the prices they charged on policies by 1.03% relative to insurers that used less foreign affiliated reinsurance. A back-of-the-envelope estimate suggests that approximately 54% of the tax was passed through to downstream product prices. Since foreign insurers used foreign affiliates more extensively than US insurers, the global minimum tax acted as a form of trade policy, by increasing the marginal cost of selling insurance for foreign insurers relative to US insurers. I also provide suggestive evidence that cross-border acquisitions of US insurers, which was a strategy commonly used by foreign insurers to enter US markets prior to the tax reform, declined significantly after the tax reform, further consistent with the tax increasing the cost of selling insurance policies for foreign-domiciled insurance companies operating in the US.

This paper contributes to several strands of literature on corporate taxation, international finance, and financial intermediation. The paper most closely relates to the literature on international capital flows, tax havens, and multinational corporations. Hines Jr and Rice (1994) study the use of offshore tax haven affiliates by US firms. Recent advances in new data on international capital flows have allowed for a more complete picture of the cross-border capital and profit flows and productivity measurements (Guvenen et al. (2017), Tørsløv et al. (2018), Coppola et al. (2020)). A growing literature also documents the impact that the use of tax havens has on employment, investment, and capital structures of multinational firms (Desai et al. (2004), Kovak et al. (2017), Suárez Serrato (2018), Garrett and Suárez Serrato (2019)). This paper studies how a global minimum tax can affect the balance sheet and product pricing decisions of multinational corporations and quantifies the effects of an important and heavily debated tax policy.

The paper also contributes to a growing literature on the financial economics of insurance. Koijen and Yogo (2016) study regulatory incentives for the use of affiliated reinsurance by life insurers and highlight the importance risks in the insurance sector have for broader financial stability. Mayers and Smith Jr (1990), Froot (2001), and Froot and O'Connell (1999) study risk-hedging incentives for use of unaffiliated reinsurance. Froot (2001) in particular proposes several expla-

[1] See e.g. "A Tax Change Threatens to Hit Insurers When Most Vulnerable": https://www.wsj.com/articles/a-tax-change-threatens-to-hit-insurers-when-most-vulnerable-1534843801; "Letter to the Senate Finance Committee": http://www.coalitionforamericaninsurance.com/wp-content/uploads/2017/09/Coalition-for-American-Insurance-Submission-to-Senate-Finance-July-2017-002.pdf; "Coalition for Competitive Insurance Rates": https://zurichadvocacy.com/CCIR-Myth-vs-Fact.pdf.

nations why risk-hedging reinsurance quantities are low. Ge (2020) and Ge and Weisbach (2019) study the effects of shocks to the financial conditions of insurance companies on product prices and investment allocations. This paper shows that tax incentives are a first-order determinant of insurers' capital flow and risk-sharing decisions, affecting affiliated reinsurance and risk-hedging reinsurance. In particular, this paper proposes that the trade-off between tax incentives and risk-sharing jointly affects both affiliated and risk-hedging reinsurance and provides a complementary explanation for why idiosyncratic shocks to liabilities matter and why these shocks in equilibrium are not hedged away. Relatively to this literature, this paper also documents novel implications of tax policies on insurance product prices.

Lastly, the paper contributes to a substantial literature on the determinants of corporate risk-hedging. A large literature explores the reasons why firms may hedge risks (e.g. Froot et al. (1993), Stulz (1984), and Smith and Stulz (1985)). Rampini and Viswanathan (2019) explore the complementary idea that many risk-hedging contracts are also intertemporal as the insured pays the insurer before the state is realized. In a world with intertemporal costs of capital, the use of risk-hedging will also depend on the cost of capital that is required to finance risk-hedging contracts. This paper provides an empirical application where financing risk-hedging contracts is costly and where changes in the opportunity costs affect demand for risk-hedging. More closely related, a recent literature explores the effect of regulatory frictions on insurers' risk management using both derivatives (Sen (2019)) and delta hedging (Ellul et al. (2018)). This paper documents an empirical setting where tax incentives, which may act in complement to regulatory frictions, affect risk management and provides a novel channel through which taxes affect risk-hedging.

The paper proceeds as follows. Section 2 describes the institutional details of the global minimum tax policy (BEAT provision), an overview of insurance companies and their operations, and the data. Section 3 models the multinational firm's profit maximization problem under a global minimum tax. Section 4 studies the effects of the global minimum tax on insurance companies' internal capital allocation decisions. Section 5 studies the tax reform's effect on insurers' external diversification of risks. Section 6 studies the tax's effect on insurers' product pricing and strategic market entry and exit decisions. Section 7 briefly discusses the interaction between tax policies and financial regulation. Section 8 concludes.

2 Institutional setting and data

2.1 Global minimum corporate tax and the BEAT provision

Multinational firms operating in the US can engage in tax planning strategies that affect their tax liabilities in the US. To address these perceived issues, both Democrats and Republicans in US Congress have introduced various base erosion and profit shifting legislations over the past decade. Most notably, the 2017 Tax Cuts and Jobs Act, in addition to the headline changes to the individual and corporate tax rates, included a Base Erosion and Anti-Abuse Tax (BEAT) provision that focused on cross-border related-parties transactions.[2] Specifically, the BEAT provision assessed a global minimum tax by recalculating a firm's tax base by adding back certain deductible payments, including affiliated reinsurance premiums paid by US insurance companies to foreign affiliates. The BEAT rate was 5% in 2018, 10% in 2019-2025, and 12.5% after 2025. Prior to the BEAT provision, insurers also paid an excise tax, of 1% or 4%, on reinsurance, both unaffiliated and affiliated, ceded to foreign reinsurers, which remained in place in addition to the new BEAT tax. In December 2017, the US Congress passed the Tax Cuts and Jobs Act (TCJA), which was then signed into law by then-President Trump.

As an illustrative calculation, consider an insurer with $100 million of gross income in the US and with $200 million of reinsurance premiums ceded to a foreign affiliate in 2021. The insurer's US federal corporate income tax liability without the global minimum tax would be $21 million. Under the BEAT provision, however, the insurer's tax liability would be $30 million, since the insurer's tax base would include the $100 million of gross income plus the $200 million of reinsurance ceded to the foreign affiliate, which is taxed at the 10% BEAT rate in 2021.

The BEAT provision was introduced to address perceived erosions of the US tax base through certain affiliated transactions such as insurance companies reinsuring policies with their foreign affiliates. By reinsuring the insurance premiums sold in the US to affiliates in other international jurisdications, proponents of the provision argued, the insurance company could be subject to more favorable regulatory and tax treatments in these foreign jurisdictions. The tax on these foreign affiliated reinsurance programs was therefore meant to discourage such transfers.

The proposed provision was the subject of intense lobbying efforts by US and foreign insurers, as well consumer and other interest groups. A coalition of US insurers, including Berkshire Hathaway, Liberty Mutual, and W.R. Berkeley, lobbied heavily in favor of the tax.[3] They argued that foreign insurers gain a competitive advantage by using foreign affiliated reinsurance programs and reinsuring policies in countries with less stringent capital and tax regimes. On the other hand, some foreign insurers lobbied against the tax, arguing that the tax increase would lead insurance companies to increase policy prices and to decrease the supply of capital to underwrite US property and casualty insurance.[4] Consequently, one of the most heavily debated aspects of the proposal was the effect on the pricing of insurance products. Foreign insurers argued that this would significantly increase the price of insurance policies they offer to consumers and businesses as the cost of using foreign affiliated reinsurance increases.[5] On the other hand, US insurers argued that any increase in price is likely to be modest in comparison to the erosion of the US tax base and the unequal

[2]The TCJA also included the Global Intangible Low-Taxed Income (GILTI) tax, which focused on intangible assets of multinational firms' foreign affiliates. The GILTI largely did not apply to insurance companies and thus its effects are not studied in this paper.

[3]See e.g. "Letter to the Senate Finance Committee": http://www.coalitionforamericaninsurance.com/wp-content/uploads/2017/09/Coalition-for-American-Insurance-Submission-to-Senate-Finance-July-2017-002.pdf; "U.S. Insurers Win 'Bermuda Loophole' Fight": https://www.wsj.com/articles/u-s-insurers-win-bermuda-loophole-fight-1513441983.

[4]See e.g. "Coalition for Competitive Insurance Rates": https://www.rstreet.org/wp-content/uploads/2018/04/CCIR-Senate-Finance-Letter-071717-1.pdf.

[5]See e.g. "Coalition for Competitive Insurance Rates": https://zurichadvocacy.com/CCIR-Myth-vs-Fact.pdf.

playing field the use of foreign affiliate reinsurance has created.

2.2 Insurance companies and reinsurance

Insurance companies sell insurance policies to households and corporations. The insurer collects premiums from their policyholders and pays out policy claims. Importantly, insurance companies can re-sell these insurance policies to reinsurers through reinsurance. Insurance companies generally use reinsurance to manage their policy liabilities to satisfy three main incentives: risk diversification, regulatory capital management, and tax management.

Figure 1 illustrates the flow of insurance premiums from consumers to the insurance group. The insurer sells policies through an operating company in the state in which it is licensed to sell insurance in to households and corporations, who pay insurance premiums to the insurer. The insurer can either retain the insurance premiums on its operating company's balance sheet, or reinsure it with a reinsurer. Reinsurance can be used between insurance companies that are either part of the same insurance group, known as affiliated reinsurance, or across different insurance groups, known as unaffiliated reinsurance. Different classes of reinsurance agreements can be used by insurance companies for different purposes. Affiliated reinsurance within the US, for example, can be used to satisfy regulatory capital requirements for the insurance company. Affiliated reinsurance with a reinsurer outside the US can change the federal and foreign taxes insurance companies pay on underwriting and investment incomes, in addition to satisfying the regulatory capital requirements. In practice, affiliated reinsurance is commonly used with reinsurers in states and foreign countries with beneficial capital regulations and tax rates, such as South Carolina, Vermont, Bermuda, Cayman Islands, and Switzerland. Both US and foreign affiliated reinsurance generally do not economically transfer risks as the policy liabilities are ultimately retained within the same insurance group (Stern et al. (2007)). Depending on the corporate tax rates in the foreign affiliate's domicile, however, the reinsured premiums could be subject to different tax rates on the profits earned from underwriting and investment activities.

Unaffiliated reinsurance agreements, on the other hand, are often between an insurance company and a third-party reinsurer. Unlike affiliated reinsurance, unaffiliated reinsurance transfers risks between insurance groups and therefore is a theoretically important tool for risk management. The main risk that insurers face is shocks to their policy liabilities. For example, insurers could face regional natural catastrophes that affect a substantial number of policies. As the insurer increases in size and sells more policies, the traditional diversification arguments for risk-hedging imply that isolated shocks that affect individual policies are diversified away. However, because insurers operate in different geographic markets and lines of businesses, larger regional natural catastrophes or man-made disasters are harder to diversify. For example, if an insurer has a large share of homeowners policies in Florida, the insurer's liability exposure to Florida hurricanes cannot be diversified away by selling more policies.

In the Modigliani and Miller (1958) framework, these policy shocks to liabilities do not affect the operations of the insurance company. However, a substantial literature on corporate risk-hedging have identified reasons why risk-hedging may be desirable for firms. Many such reasons, including costly external finance due to agency frictions or capital market imperfections, changing investment and financing opportunities, costs of financial distress, and managerial motives, also apply to insurance companies. Additionally, there are several features of property and casualty insurance that make risk-hedging particularly valuable. Property and casualty insurance companies face large idiosyncratic shocks to their liabilities arising from natural catastrophes and man-made disasters. For instance, four of the most recent major hurricanes cost in excess of $172 billion in insured losses in the US.[6] Despite recent technological advances, the exact magnitudes and locations of catastrophes such as hurricanes, earthquakes, and wildfires remain difficult to forecast.[7] These shocks can lead insurers to become financially constrained, impacting their real activities including product pricing and investment decisions, which in turn affect the consumer insurance market and broader financial conditions given the important role insurers play in many asset markets (e.g. Ge and Weisbach (2019), Ge (2020)). In more severe situations, idiosyncratic losses can deplete the loss reserves of the insurers leading to financial impairment, requiring regulators' intervention. Between 1977 and 2015, the cumulative impairment rate over a 10-year period is 8.15% across all insurance companies (A.M.Best (2015)).[8] Out of the 5183 insurance companies with at least one A.M. Best Financial Strength Ratings, 761 were financially impaired at least once during the sample period, of which at least 375 (49%) were liquidated. Furthermore, of the property and casualty insurers studied over the sub-sample between 1977 and 2006, almost half (49.3%) were impaired due to either a deficient loss reserve or catastrophe loss. The real impacts of these losses and the extensive regulatory resources dedicated to monitoring and supporting insurance companies highlight the importance of risk diversification through reinsurance, which the NAIC describes as an "essential mechanism by which insurance companies manage risks and the amount of capital they must hold to support those risks."[9]

Despite these theoretical and empirical reasons for risk-hedging, a substantial literature (e.g. Froot (2001) and Froot and O'Connell (1999)) has documented that the quantity of actual risk diversified through reinsurance is low. Several explanations have been proposed for the limited quantity of unaffiliated reinsurance: the supply of reinsurance could be constrained by capital frictions that reinsurers face or by high barriers to entry due to the specialized expertise required to underwrite catastrophe risks. On the demand side, adverse selection by insurers in which policies they choose to reinsure could also lead to low levels of reinsurance.

The increased use of affiliated reinsurance with US and foreign affiliates provides a plausibly complementary explanation for why unaffiliated reinsurance levels have remained low: insurers

[6]https://www.iii.org/fact-statistic/facts-statistics-us-catastrophes

[7]See e.g. the US Geological Survey, which states that "Neither the USGS nor any other scientists have ever predicted a major earthquake. We do not know how, and we do not expect to know how any time in the foreseeable future." https://www.usgs.gov/faqs/can-you-predict-earthquakes?qt-news_science_products=0#qt-news_science_products

[8]Impairment is defined as any regulatory action undertaken by regulators to intervene in the operation of the insurance company. One limitation to the impairment data is that it is reported for all insurance companies, including life and health insurers as well as property and casualty insurers.

[9]See e.g. https://content.naic.org/cipr_topics/topic_reinsurance.htm

can retain liabilities on balance sheet in their US and foreign affiliates to capture tax and regulatory benefits instead of hedging these liabilities. For instance, insurers can reinsure premiums with their foreign affiliates in low-tax domiciles and pay low income tax rates on their underwriting and investment profits. On the other hand, if they were to reinsure the policies with a risk-hedging reinsurer, they would be ceding a portion of the premiums to the reinsurer. As such, a global minimum tax, to the extent that it decreases the tax benefits of using foreign affiliates, as is the case for the BEAT provision, would induce insurers to increase risk-sharing.

A few additional implementation details are worth highlighting. First, to prevent insurers from engaging in complex forms of affiliated reinsurance, the BEAT provision prohibited the use of unaffiliated reinsurance through conduits or unaffiliated intermediaries that circumvent BEAT. Second, it is possible that insurers can enter into risk-hedging reinsurance agreements through their foreign and US affiliates, which are not observed on the insurers' statutory filings, as the financial filings of captives are often confidential (see e.g. the discussions in Koijen and Yogo (2016, 2017)). As such, the true amount of risk diversified could be different than the amount observed on statutory filings. There are two reasons why this may unlikely to affect the reinsurance programs of insurers. First, risk-hedging reinsurance decreases the ceding entity's statutory capital and tax liability. As discussed previously, the operating subsidiaries in the states they are licensed to sell insurance almost always have higher statutory capital requirements and tax rates than their affiliates, which is why affiliates are used in the first place, so it is advantageous for the insurer to cede reinsurance directly from the operating company, rather than indirectly through their affiliates. Second, based on available non-confidential financial filings of captives, captives do not enter into substantial risk-hedging reinsurance agreements, nor do they engage in substantial securitization activities (Stern et al. (2007)), consistent with the tax and capital management benefits of risk-hedging directly through the operating companies.[10] Nonetheless, the data limitations could mean that the true risk-hedging positions that insurers take on could potentially be different than what is observed in the data.

2.3 Data

The main data on insurance companies' regulatory filings is from S&P Market Intelligence, which compiles the information from insurance companies' statutory filings. The filings report the insurance companies' financial and operating conditions, including the amounts of insurance policy premiums sold and the payouts on those policy losses, details of the reinsurance agreements such as the counterparty, premiums ceded, and reinsurance recoverable. The filings also report the insurer's state and country of domicile, regulatory risk metrics, and taxes paid to federal and foreign (non-US) governments. The data is reported annually by all P&C insurance companies in the US and covers the sample period from 1996 to 2019, with some variables available from 2005 to 2019. All observations in the analysis are at the insurance group (i.e. insurer) by year level unless

[10] See e.g. the Iowa Insurance Division's released financial statements of captives (https://iid.iowa.gov/financial-statements?category=22).

otherwise noted.

An important feature of the data is the reinsurance agreements. I identify reinsurance programs using the S&P Market Intelligence NAIC reinsurance filing summaries. For each individual operating insurance company, I calculate the total amount of reinsurance ceded to each counterparty and sum up across all counterparties of a given affiliation status (affiliated or unaffiliated) and domicile (US or foreign) to construct a total reinsurance amount ceded by each insurance company to each type of counterparty (US affiliate, foreign affiliate, and unaffiliated) each year. I then aggregate over all insurance companies in each insurance group to calculate the total amount of reinsurance ceded to each types of reinsurers each year by each insurance group.

Table 1 reports the aggregate reinsurance summary statistics of the entire US property and casualty insurance market for 2019. There were 328 insurance groups and 2633 individual companies in the sample. The total direct insurance premiums underwritten in 2019 was $712.19 billion, of which $635.58 billion was reinsured with a reinsurer. $497.96 billion was reinsured with a US affiliated reinsurer, $28.45 billion to foreign affiliated reinsurers, and $98.8 billion to unaffiliated (risk-hedging) reinsurers. Table 2 reports the insurer-level summary statistics from 1996 to 2019. The insurer-level statistics include the amount of premiums sold and the amount of reinsurance used, both in millions USD and as a share of amount of premiums sold. The insurer-level statistics also include the domicile (foreign or US) status of the insurer, the tax rate difference each year between the insurer's domicile and the US, as well as a set of insurer characteristics that captures its financial conditions, including its total liabilities, leverage, liquidity, return on equity, and risk-based capital ratio.

For product prices, I collect product rate filings from the NAIC through S&P Market Intelligence. Insurance product prices are regulated by state regulators, so that each time an insurance company intends to change the price on one of its products sold in a given state, it is required to file a rate change request with the state regulator. For each rate filing, I observe the name of the insurance company making the request, the request date, the product line affected, and the requested and approved rate changes, and the total amount of premiums affected.[11]

I collect product rate filings from 2013 to 2019, which corresponds to the period around the BEAT implementation. In the sample, I observe rate filing requests by 2179 insurance companies in 58 lines of insurance products in all 50 states and the District of Columbia. Almost all insurance companies sell insurance policies only in a subset of states and sell a select subset of product lines. I construct a premiums-weighted price index for each line that each insurer sells each year. Since the product prices are reported in changes, I normalize all prices to be 0 in 2016, so that product prices are expressed relative to their 2016 levels. Appendix B describes the details of the construction of the index. Table 3 reports the summary statistics of product prices. Observations are at the insurer-line-year level. Notably, the average annual product price increase was 0.66% per year over the

[11]As noted in recent work in Sen and Tenekedjieva (2021), state regulators may approve an insurance rate that is different than what the insurer requested. To capture actual product prices paid by policyholders, I use the approved product prices in my main analysis. I also conduct robustness analyses using requested changes and find that the results are unchanged.

sample period, indicating that this was a period of rising insurance rates.

For supplementary data, international corporate taxation rates are from the KPMG annual corporate tax tables. Stock prices of insurance companies and stock price indices are from CRSP and Bloomberg. Mergers and acquisitions activities data is from Capital IQ. I match the insurance companies' regulatory filings to the taxation tables by their countries of domicile, to their stock prices by their stock tickers, and to mergers and acquisitions by the names of the insurers.

2.4 Descriptive evidence on insurers' use of reinsurance

This section presents descriptive evidence on the use of reinsurance by insurance companies. To measure the use of reinsurance, I tabulate the reinsurance agreements that insurance groups reported from 1996 to 2019. Importantly, the reinsurance agreements report the name of the reinsurer, whether the reinsurer is affiliated with the operating company or not, and whether the reinsurer is US or foreign-domiciled.

Figure 2 plots the allocation of insurance premiums to different types of reinsurers as a share of total direct policy premiums sold by all US property and casualty insurers from 1996 to 2019. Four facts stand out. First, there is a notable increase in the total amount of property and casualty insurance policies sold over this time. Second, the vast majority of these insurance premiums are reinsured, such that the policy premiums and liabilities are not held by the operating company that sold the policy. Third, over 80% of all reinsurance programs are with affiliated reinsurers, which are other insurance companies in the same insurance group. As discussed previously, affiliated reinsurance constitutes transfers in internal capital markets, so does not share risk between insurance groups and is often done for regulatory and tax purposes. This means that less than 20% of all reinsurance programs are risk-hedging. In 2019, 14% ($= (51.62 + 47.19)/712.19$) of insurance premiums are risk-hedged with external reinsurers. Fourth, the use of affiliated reinsurance has grown significantly over time.

Table 4 reports the total amount of premiums sold and reinsured to each type of reinsurer. The most commonly-used type of reinsurance is US affiliated reinsurance, with $498 billion in premiums in 2019. The total amount of premiums reinsured as a percentage of all insurance premiums has also increased from 67% in 1996 to 89% in 2019. This increase is notably driven by an increase in affiliated reinsurance from 52% in 1996 to 74% in 2019. This implies that the regulatory and tax incentives have increased in importance relative to risk-hedging motives over this period of time.

The descriptive evidence here contributes to the prior literature on affiliated reinsurance, including Koijen and Yogo (2016), in several ways. Much of the prior literature on affiliated reinsurance has focused on life insurers. By the nature of life insurance policy risks, life insurance policy payouts are generally less likely to have large idiosyncratic shocks. P&C insurers, however, given the unpredictability and size of natural and man-made catastrophes, are more exposed to such large-scale idiosyncratic shocks. This makes hedging of policy liability shocks plausibly more important for P&C insurers than for life insurers, yet the descriptive evidence suggests that affiliated reinsurance is much more commonly used than risk-hedging reinsurance even for P&C insurers. Additionally, P&C insurance policies are less homogeneous than most life insurance policies, which are relatively standardized as their payouts are primarily determined by actuarial mortality probabilities. Lastly, P&C policies are generally for shorter terms, of six months to a year, than life insurance policies, which can span ten or more years, thus making P&C liabilities more unpredictable and the demand for risk-hedging potentially greater than for life insurance liabilities.

3 A model of profit-maximization with a global minimum tax

In this section, I model the insurer's profit-maximization problem under a global minimum corporate tax rate. The insurer's optimization consists of two steps. In the first step, the insurer sells insurance policies in an oligopolistic market. In the second step, the insurer chooses how to manage its liabilites on and off balance sheet as an optimal allocation problem. In this second step, the insurer has three options of allocating policy liabilities: (1) retaining the liabilities in the US, (2) transfer to a foreign affiliate, or (3) externally diversify the liability with an unaffiliated reinsurer.[12] As described in Section 2, the options differ in their abilities to achieve the insurer's objectives. Only re-selling to an unaffiliated reinsurer can hedge the insurer's underlying policy risks, since transfers within the company does not change the overall risk retained. On the other hand, underwriting and investment profits earned on foreign affiliates' books may be subject to different tax rates than those earned on the US affiliates.[13]

The insurer sells Q units of identical insurance policies in an oligopolistic market, with the actuarially value of each policy V, and the price $P = (1+m)V$, where m is the difference between price and actuarial value of liabilities. The insurer then manages its liabilities by allocating across different options. Let B_H denote the share of policies retained in the US, B_F denote the share of policies transferred to the foreign affiliate, and D denote the share of policies re-sold to the unaffiliated reinsurer, so that the shares add up to 1: $B_H + B_F + D = 1$. For ease of exposition, I normalize the actuarial value of each policy to be $V = 1$ throughout and the quantity of insurance policies to be $Q = 1$ in the liability management problem.

I begin by analyzing the insurer's liability management problem. There are three ingredients: balance sheet costs, risk-hedging, and tax. First, the insurer faces a cost of holding liabilities on each of the firm's subsidiaries, $C_F(B_F)$ and $C_H(B_H)$, both with positive first and second derivatives. I parametrize the cost function as follows:

$$C_d(B_d) = \theta_d \cdot B_d^2 \tag{1}$$

For $d = F, H$ for some $\theta_d > 0$. The costs capture costly external finance or regulatory costs

[12] Given my focus on the use of foreign affiliates, I do not distinguish between the US operating company and the US affiliate, the transfers between which can be important for capital and state tax management. Extending the model to include the operating company and the US affiliate separately yields analogous results.

[13] For simplicity, I assume that unaffiliated reinsurance does not provide tax benefits as reinsurers have market power and thus capture a large portion of the tax benefits. The results would be substantively the same if unaffiliated reinsurance were affected by the tax schedules.

associated with risk-charges on insurance liabilities, which is allowed to vary between the US and foreign affiliates. Since the US liabilities are partially retained in the operating company, the cost of holding liabilities in the US is assumed to be weakly greater than holding it in the foreign affiliate, so $\theta_H \geq \theta_F$. Second, reinsurance with unaffiliated reinsurers hedges the risks of policy liabilities, as discussed in Section 2, which may be beneficial to insurers due to external financing frictions, costs of financial distress, and managerial motives. I model risk-hedging benefits as a twice-differentiable reduced-form function $H(D)$, with positive first derivatives and negative second derivatives, to capture diminishing returns associated with risk-hedging. The price of risk-hedging reinsurance is denoted P_D.

Finally, the insurers' tax liabilities consist of two parts: the US tax liability and the foreign tax liability. The BEAT provision changed the structure of insurers' US tax liabilities. Before the BEAT provision, insurers were subject to a US corporate income tax rate on the operations of the US subsidiaries, so that foreign affiliates' income was not subject to US taxation.[14] After the BEAT provision, insurers' US tax liabilities were calculated based on a global minimum corporate tax system, defined as the maximum of (1) the US corporate income tax and (2) the global minimum corporate tax, which calculates the tax base by adding back transfers to foreign affiliates. The US tax liabilities with and without a global minimum tax are therefore given as:

$$\tau = \begin{cases} \tau_H \cdot B_H \cdot m & \text{without global minimum tax} \\ \max(\tau_H \cdot B_H \cdot m, \tau_{Min} \cdot B_H \cdot m + \tau_{Min} \cdot B_F) & \text{with global minimum tax} \end{cases}$$

Where τ_H is the US corporate income tax rate and τ_{Min} is the global minimum corporate tax rate, with $\tau_{Min} \leq \tau_H$. For simplicity, I assume the foreign tax rate to be zero, so the US tax liabilities can also be interpreted as the difference between US and foreign tax rates.

The insurance company therefore solves the following optimal allocation problem to maximize profits or equivalently, minimize costs:

$$\max_{B_F, B_H, D} B = -\underbrace{(C_F(B_F) + C_H(B_H))}_{\text{balance sheet costs}} + \underbrace{H(D) - P_D D}_{\text{net hedging benefit}} - \underbrace{\tau}_{\text{tax}} \tag{2}$$

$$\text{where } B_F + B_H + D = 1$$

Let $B_{H,0}, B_{F,0}$, and D_0 denote the pre-BEAT allocations, and $B_{H,1}, B_{F,1}$, and D_1 denote the post-BEAT allocations.[15] The global minimum corporate tax therefore induces the following changes in the insurer's internal capital allocations (derivation in Appendix):

[14] There was also a separate excise tax on foreign reinsurance that was unchanged before and after the BEAT provision.

[15] Formally, risk-hedging reinsurance is modeled as a proportional or quota share arrangement, where the insurer cedes a percentage of the policies' premiums and losses with the reinsurer. Another common type of arrangement is non-proportional, in which the reinsurer pays the insurer for all losses up to a certain excedence level, excluding a deductible or limit. Studying non-proportional reinsurance requires data on the excedence and limit levels of the arrangements, as well as the probability distribution of underlying losses, which I do not observe. For a detailed examination of non-proportional reinsurance, see e.g. Froot (2001).

Proposition 1.

$$B_{F,1} \leq B_{F,0}\text{: insurers decrease allocation to foreign affiliates,}$$
$$B_{H,1} \geq B_{H,0}\text{: insurers increase allocation to US affiliates.}$$

In internal capital markets, the global minimum corporate tax increases the tax cost of using foreign affiliates, so foreign affiliated reinsurance decreases. At the same time, US and foreign affiliates are substitutes, so a greater tax cost on using foreign affiliates increases the use of US subsidiaries.

Furthermore, the following proposition applies for external diversification of risk to risk-sharing reinsurers:

Proposition 2.

$$D_1 \geq D_0\text{: insurers increase external diversification for } \tau_{Min} > \tau_H \cdot \frac{m}{1+m}.$$

The idea is that since insurers can capture tax benefits by transferring liabilities to foreign affiliates, they are incentivized to do so rather than diversifying the risk. A high global minimum corporate tax rate decreases the tax benefits of using foreign affiliates, thus leading insurers to increase their external diversification. Intuitively, if the global minimum tax rate is too low, the marginal tax cost of using US and foreign affiliates may be lower at the optimum under the global minimum tax regime than under the regime with only US corporate income tax. External risk-diversification would then depend on the trade-off between the tax cost and balance sheet costs. In practice, the condition is likely to be satisfied for most relevant ranges of the global minimum corporate tax proposals.[16]

I now analyze the insurer's product market decision in the first period. Let N denote the number of insurers in the market and i denote the insurer we analyze. In the first period, the insurer sets quantities Q_i to maximize profits, with its second-stage liability management problem known. Let $Q = \sum_{i=1,\dots,N} Q_i$ denote the total quantities sold in the market. In the product market, the insurer faces a downward-sloping demand curve, giving it a market-clearing price $P(Q)$ as a function of total quantities sold by all insurers. The insurer incurs a cost $C_i(Q_i)$ for selling insurance, which can include sales and marketing and other administrative costs. The cost function C_i has positive first and second derivatives, capturing increasing marginal costs of selling additional insurance.

The insurer solves the following profit maximization problem:

$$\max_{Q_i} P(Q) \cdot Q_i - B(\tau_H, \tau_{Min})Q_i - C_i(Q_i) \tag{3}$$

where $B(\tau_H, \tau_{Min})$ is the cost of managing liabilities in the second-step given by eq. (2). The

[16]For instance, for $m = 10\%$, US corporate income tax rate of $\tau_H = 35\%$, the condition holds for $\tau_{Min} > 3.2\%$. The BEAT provision is 5% in 2018, 10% in 2019-2025, and 12.5% from 2026 onwards.

expression for B emphasizes that it is a function of the tax rates. Let P_0 and $Q_{i,0}$ denote the market-clearing price and quantity pre-BEAT, and P_0 and $Q_{i,0}$ post-BEAT. Let $\Theta(Q) = \frac{P''(Q)Q}{P'(Q)}$ denote the slope of the inverse demand function. Assuming $\Theta(Q) \geq -2$, which guarantees the existence and uniqueness of the Cournot-Nash equilibrium, the maximization yields the following proposition (proof in the Appendix):

Proposition 3.

$$P_1 \geq P_0 \text{ if } \Theta(Q) \geq -2$$

Prop. 3 states that the global minimum corporate tax induces an increase in the price of insurance products as it weakly increases the marginal cost of selling insurance policies. The marginal cost comes from the higher effective tax rates that insurers have to pay on profits earned on insurance liabilities and the subsequent balance sheet adjustments they make.

To summarize, the model of profit-maximization with a global minimum tax generates the following four empirical predictions:

Proposition. *A global minimum corporate tax regime (BEAT) would induce firms to:*

- *Decrease internal allocations to foreign affiliates,*
- *Increase internal allocations to US affiliates,*
- *Increase external risk-diversification, and*
- *Increase product prices.*

The remainder of the paper documents these predictions using empirical evidence from the implementation of the BEAT provision in the US.

4 Effect of minimum tax on internal capital flow

In this section, I study the effect of the BEAT provision on insurance companies' internal capital markets. I document that the BEAT provision led to substantial changes in insurers' internal capital allocations. First, I find that insurers substituted away from the use of foreign affiliates and towards US affiliates. The quantitative shift in premiums reinsured with foreign affiliates amounts to a decrease of $30 billion dollars per year. Second, the substitution was heterogeneous amongst insurers, with insurers that used foreign affiliates the most before the BEAT implementation adjusting the most. Third, I show that foreign-domicile tax rate is a first-order determinant of the heterogeneity in the use of foreign affiliates and the response to the BEAT provision, highlighting the role that global corporate tax rate differences play in shaping internal capital markets.

4.1 Internal capital flows

I first study the effects of the tax reform on insurers' internal capital flow. I compare US P&C insurers' total flows to affiliated reinsurers before and after the global minimum tax implementation as part of the 2017 Tax Cuts and Jobs Act (TCJA).

I begin by documenting aggregate internal capital allocation changes before and after the provision was enacted. Figure 3 plots the total reinsurance premiums ceded to foreign affiliated reinsurers by all US property and casualty insurance companies from 2005 to 2019. The figure documents a dramatic decline in the share of reinsurance flows to foreign affiliates around the 2017 passage of the TCJA. The total amount of foreign affiliated reinsurance declined 59% from $51 billion in 2017 to $21 billion in 2018. As a share of all insurance premiums written, foreign affiliated reinsurance declined from 7.9% in 2017 to 3.0% in 2018. Consistent with Prop. 1 the evidence suggests that tax incentives are a first-order determinant of foreign affiliated reinsurance activities.

As discussed in Section 3, changes in tax incentives may also affect the use of US affiliated reinsurers. Figure 4 plots the total reinsurance premiums ceded to US affiliated reinsurers by all US property and casualty insurance companies from 2005 to 2019. The figure also documents an increase in the share of reinsurance flows to US affiliates around 2017. The share of all insurance premiums written that are reinsured with US affiliates increased from 66.7% in 2017 to 70.0% in 2018, or equivalently an increase from $427 billion in 2017 to $474 billion in 2018. Combined, the impact on foreign and US affiliated reinsurance programs suggest that internal capital flow of multinational insurance groups is highly responsive to international tax policies.

I next turn to formally estimating the insurer-level changes in the internal capital allocations around the BEAT provision. The empirical specification is as follows:

$$AffiliatedReinsurance_{i,t} = \alpha + \beta TCJA_t + \gamma X_{i,t} + \mu_i + \epsilon_{i,t} \tag{4}$$

Observations are at the insurer-year level from 2012 to 2019. $AffiliatedReinsurance_{i,t}$ is the share of all direct insurance premiums that are reinsured with an affiliate of a given type (foreign or US). $TCJA_t$ is an indicator variable for whether the year was after 2017, i.e. after the minimum tax implementation. $X_{i,t}$ is a vector of insurer-year characteristics including log total liabilities, leverage ratio, risk-based capital ratio, liquidity, and return on equity. μ_i are insurer fixed effects. The coefficient β measures how insurers changed their reinsurance programs in response to the BEAT provision.

Table 5 reports the results. In each of the specifications, I estimate a negative β coefficient for foreign affiliated reinsurance use and a positive β coefficient for US affiliated reinsurance use. The economic magnitudes imply that on average, insurance groups decreased their use of foreign affiliated reinsurance by 24% of the pre-BEAT average level after BEAT ($= -0.02 \div 8.2\%$). Similarly, I find that insurance groups increased their use of US affiliated reinsurance by 8.9% of the pre-BEAT average level after BEAT ($= 0.028 \div 31.5\%$).

Turning to the other variables, I find that commonly-used measures of insurer financial conditions, including total liabilities, liquidity, return on equity, and risk-based capital ratioes, are less predictive of adjustments in reinsurance programs than the effect of the tax reform. Overall, these insurer-level estimates point to insurers on average significantly adjusting their balance sheets to respond to the BEAT provision, highlighting the importance of tax incentives in driving internal capital market decisions.

I use the aggregate statistics from Figures 3 and 5 to construct a back-of-the-envelope calculation of the magnitudes of the semi-elasticity of capital flow and risk-sharing with respect to the tax rates. The average BEAT tax in 2018-2019 is 7.5% per dollar of premiums reinsured with a foreign affiliate, so the semi-elasticity of foreign affiliated capital flow with respect to the tax rate is -12.9 ($= \frac{ln(3.0\%)-ln(7.9\%)}{7.5\%}$). This means that a 1% increase in the tax rate corresponds to an approximately 8.3% decrease in the amount of capital flow to foreign affiliates.

4.2 Heterogeneity across Insurance Companies

4.2.1 Effect of tax reform

In addition to the aggregate changes in insurers' internal capital allocations, insurers may respond differently to the tax change. For example, insurers could face fixed adjustment costs with setting up or restructuring their foreign affiliates. If fixed costs to adjustments are higher than the additional costs incurred with higher tax rates, then insurers with less additional costs incurred should not adjust their reinsurance programs as much. Since the minimum tax rate on foreign affiliates is equal across insurers, any differences would come from ex-ante differences in the intensities of usage of foreign affiliated reinsurers: insurers that used more foreign affiliated reinsurers have greater incentives to make adjustments to their reinsurance programs.

I explore this heterogeneity across insurers by classifying insurers by the amount of foreign affiliated reinsurance used prior to the TCJA and estimating the following difference-in-difference regression specification:

$$AffiliatedReinsurance_{i,t} = \alpha + \beta_1 TCJA_t + \beta_2 TCJA_t \cdot 1(HighFAR2017)_i + \gamma X_{i,t} + \mu_i + \epsilon_{i,t} \quad (5)$$

Observations are at the insurer-year level from 2012 to 2019. The specification mirrors that of eq. (4), with the addition of an interaction term between the $TCJA_t$ indicator and $1(HighFAR2017)_i$, which is an insurer-level indicator for whether insurer i was above the median foreign affiliated reinsurance share in 2017 across all insurance groups. The interaction term captures the differences in changes in reinsurance shares.

Table 6 reports the results. I estimate a negative β_2 coefficient for foreign affiliated reinsurance usage and a positive β_2 coefficient for risk-sharing reinsurance usage. In particular, the adjustments are economically large: insurers with high usage of foreign affiliated reinsurance on average decreased their usage of foreign affiliates by 11% of total insurance premiums underwritten, whereas insurers with low usage of foreign affiliated reinsurance essentially had no change to their foreign affiliated reinsurance programs. On the use of US affiliated reinsurance, insurers with greater incentives to adjust their reinsurance programs increased their US affiliate usage by 3.0% more than low-usage insurers, again as a share of total insurance premiums underwritten, although the coefficient estimate is marginally statistically insignificant.

4.2.2 Determinants of heterogeneity

The discussion so far has taken heterogeneities in insurers' usage of foreign affiliates as given, but the usage of foreign affiliates itself is an endogenous choice. Insurance groups will only use foreign affiliated reinsurance if the benefits are large enough relative to the potential fixed costs. There are two ways in which the benefit can be greater. One is if the insurance group sells a large amount of insurance premiums. Another is if insurance groups already have foreign affiliates set up in a low-tax country, for example because they are domiciled in such a country. Thus, insurer size and domicile tax rate should both predict cross-sectional heterogeneity in which insurers use foreign affiliated reinsurance.

To test this hypothesis, I estimate the following regression specification:

$$1(UseFAR)_{i,t} = \alpha + \beta_1 TaxDiff_{i,t} + \beta_2 Size_{i,t} + \gamma X_{i,t} + \mu_t + \epsilon_{i,t} \tag{6}$$

Observations are at the insurer-year level from 2012 to 2019. The dependent variable $1(UseFAR)_{i,t}$ is an indicator variable for whether insurer i used foreign affiliated reinsurance in year t. The indepdent variable $TaxDiff_{i,t}$ is the difference in corporate tax rates between the insurer's home country and the US, where a more positive value corresponds to higher US taxes relative to the insurer's home country. $Size_{i,t}$ is the log total liabilities that the insurer has outstanding, which is a proxy for the size of the insurer. $X_{i,t}$ is a vector of insurer-year characteristics including leverage ratio, risk-based capital ratio, liquidity, and return on equity. μ_t are year fixed effects.

Table 7 reports the results corresponding to the linear probability model of eq. (6). Across all specifications, I estimate a positive and economically significant coefficient on $TaxDiff_{i,t}$ and on $Size_{i,t}$. In columns (1) and (2), I proxy for the tax difference by an indicator variable for whether the insurance group is domiciled in a foreign country, since almost all countries of domiciles of the foreign insurers have lower corporate tax rates than the US. In columns (3) and (4), I use the corporate tax rates from the KPMG international tax tables as a measure of the tax rates that insurance groups are expected to pay on their underwriting and investment profits. The estimates from column (2) suggest that foreign insurers are 51% more likely to use foreign affiliated reinsurance than US insurers. Likewise, the estimates from column (3) suggest that a 10% difference in the corporate tax rates between the foreign country and the US (equivalent to the difference between Australia and the US in 2017) corresponds to a 16.4% increase in the probability of using foreign affiliated reinsurance. The economic magnitudes of the coefficient estimates, in addition to the fact that the domicile status of the insurer alone explains 10-20% of the variation in foreign affiliate usage, imply that tax differences are a first-order determinant of why some insurance groups use foreign affiliated reinsurance and others do not.

Turning to the other explanatory variables, I also estimate a positive and economically significant coefficient on the size coefficient across all specifications. The estimates imply that an insurance group that has 10 times as much liabilities would be 13% ($= ln(10) \times 0.056$) more likely to use foreign affiliates. This is consistent with the idea that the costs of setting up foreign affiliates, such as registration, legal, and administrative costs, are relatively fixed, so that larger insurance groups are more likely to use foreign affiliates due to greter tax savings per dollar of premiums underwritten. I also find that insurers are more likely to use foreign affiliated reinsurance if they are more levered and if they are more liquid, which could potentially proxy for differences in capital management strategies across insurers. Overall, the analysis suggests that both tax and size differences play important roles in determining the cross-sectional heterogeneities in usage of foreign affiliated reinsurance.

5 Effect of minimum tax on external risk-sharing

In this section, I study the effect of the BEAT provision on insurance companies' risk-sharing. As discussed in Section 2, risk-sharing reinsurance is a theoretically important channel through which risk is transferred and diversified between insurance groups. I first present evidence that the BEAT provision increased global risk-sharing, and that the effect is heterogeneous across insurers, with insurers that used the most amounts of foreign affiliated reinsurance most affected. I then use a revealed preference approach to estimate the implied value of the additional risk-sharing that the BEAT provision brought about. I conclude by exploring the mechanism of how risk-sharing is valuable to insurers by documenting evidence that insurers are exposed to large idiosyncratic shocks to their liabilities.

5.1 Reduced-form evidence

I begin by documenting aggregate risk-sharing changes after the BEAT provision was implemented. I compute the total amount of risk-sharing as the total premiums reinsured with an unaffiliated reinsurer by each insurer each year. As in Section 4, I report the total amounts in both dollar amounts and as percentages of total direct premiums underwritten. Figure 5 plots the total premiums externally reinsured with risk-hedging reinsurers by all US property and casualty insurance companies from 2005 to 2019. The use of unaffiliated risk-sharing reinsurance increased around the minimum tax implementation in 2017 from 12.2% in 2017 to 13.0% in 2018 as a share of all insurance premiums, or equivalently an increase from \$78 billion to \$88 billion annually.

I formally estimate the insurer-level changes in the risk-sharing around the BEAT provision in a panel regression. The empirical specification mirrors that of eq. (5) and is as follows:

$$RiskSharing_{i,t} = \alpha + \beta_1 TCJA_t + \beta_2 TCJA_t \cdot 1(HighFAR2017)_i + \gamma X_{i,t} + \mu_i + \epsilon_{i,t} \qquad (7)$$

Observations are at the insurer-year level from 2012 to 2019. The dependent variable $RiskSharing_{i,t}$ is the share of all direct insurance premiums that are externally reinsured by an insurer each year. $TCJA_t$ is an indicator variable for whether the year was after 2017, i.e. after the global minimum tax implementation. $1(HighFAR2017)_i$ is an insurer-level indicator for whether insurer i was above the median foreign affiliated reinsurance share in 2017 across all insurance groups. $X_{i,t}$ is a vector of insurer-year characteristics including log total liabilities, leverage ratio, risk-based capital ratio, liquidity, and return on equity. μ_i are insurer fixed effects. The coefficient β_2 measures how insurers changed their reinsurance programs in response to the BEAT provision.

Table 8 reports the results. Columns (1) and (2) report the estimates without the difference-in-differences coefficient β_2 and therefore correspond to the average aggregate change. Columns (3) and (4) report the estimates with the difference-in-differences coefficient β_2 included. In columns (1) and (2), I estimate a positive β_1 coefficient, indicating that insurance groups significantly increased their external risk-sharing after the BEAT provision. Similarly, in columns (3) and (4), I estimate a positive β_2 estimate, indicating that insurance groups that were more affected by the BEAT provision, as proxied by their use of foreign affiliates prior to BEAT, increased their use of external risk-sharing by significantly more than insurance groups that were less affected by BEAT. In economic magnitudes, I find that the average insurance group increased use of risk-sharing reinsurance by 9.1% after the BEAT provision ($= 0.017 \div 18.7\%$). The difference-in-differences coefficient estimate suggests that insurance groups that were most affected by the BEAT tax increased their external risk-sharing by 21% ($= 0.056 \div 26.9\%$). Overall, the evidence is consistent with the BEAT provision decreasing the tax incentives of using foreign affiliates and making risk-sharing relatively more attractive.

Turning to the other economic variables, I find that only the insurer's leverage, which is calculated as the total liabilities divided by its total assets, is an economically and statistically significant predictor of changes in risk-sharing reinsurance usage: a one-standard-deviation (0.15) increase in the insurer's leverage corresponds to a 4.8% increase in the use of risk-sharing reinsurance. This is consistent with the marginal value of risk-hedging being higher as financial distress becomes more likely, e.g. if they are less likely to be able to sustain a large negative shock to liabilities.

I use the aggregate statistics to also construct a back-of-the-envelope calculation of the magnitudes of the semi-elasticity of risk-sharing with respect to the tax rates. The average BEAT rate in 2018-2019 is 7.5%, so the semi-elasticity of risk-sharing with respect to the BEAT rate is 0.85, implying that a 1% increase in the tax rate corresponds to an approximately 0.87% increase in the amount of risk-sharing reinsurance used. As such, the estimates imply that changes in corporate tax rates have a first-order effect on both internal capital flow and external global risk-sharing, and that the two are tightly linked.

5.2 Implied value of risk-sharing

In Section 5.1, I document evidence that insurers increased the use of external risk-sharing after the BEAT provision was implemented. In this section, I calculate the implied value of this increase in risk-sharing for insurers. Intuitively, the usage of risk-sharing reinsurance given both the high price of reinsurance (e.g. Froot and O'Connell (1999); Froot (2001)) and the tax benefits of transferring to foreign affiliates imply that risk-sharing is potentially quite valuable to insurers. I use a revealed preference approach to estimate this value based on insurers' profit-maximizing first-order conditions in their decisions to use different types of reinsurance. The main idea is that after the global minimum corporate tax is implemented, the insurer adjusts their use of external risk-sharing such that the marginal benefit of diversifying an additional dollar of liabilities equals the marginal benefit of transferring it to a foreign affiliate. The observed quantity shift and the marginal benefit of using a foreign affiliate, which is determined by the tax rates, reveals how valuable the increase in risk-sharing is for insurers.

In the insurer's profit maximization problem from Section 3, insurers adjust their foreign affiliated reinsurance if the global minimum tax binds. So under the assumption that the global minimum tax rate binds, the insurer's optimal allocation yields the following condition that equates marginal costs across foreign affiliates and risk-sharing:

$$\tau_{Min} + C'_F = P_D - H'(D) \tag{8}$$

The equation states that the insurer can either incur the minimum tax and balance sheet costs of transferring a marginal dollar of liabilities to its foreign affiliate or diversify it with a risk-hedging reinsurer and pay a price of reinsurance and receive hedging benefits. The insurer allocates liabilities across its foreign affiliate and risk-hedging reinsurer such that the two marginal costs equate.

I use eq. (8) to estimate the marginal value of risk-sharing, $H'(D)$. I take the global minimum tax rate to be $\tau_{Min} = 10\%$ and the price of reinsurance to be 0.44, which is the ratio of reinsurance premiums earned divided by the present value of accident year losses minus one reported in the literature (e.g. Weiss and Chung (2004)).[17] I also take the balance sheet cost to be 7%, equal to 10% cost of equity (e.g. Barinov et al. (2020)) times the industry-average 70% capital and surplus to total liabilities ratio in the data.

The total value of the increased risk-sharing is therefore $V = H'(D) \times \frac{\Delta D}{P_D}$, which is the product of the marginal value of risk-sharing and the total amount of additional liabilities shifted, which is proxied by the total premiums reinsured divided by the price of reinsurance.[18] Estimating eq. (8) using the post-BEAT parameters, I find that $H'(D) = 0.27$, meaning that insurers value the risk-hedging benefits of diversifying an additional dollar of liabilities at 27% of the actuarially-fair value. The total observed quantity shift in risk-sharing was \$9.97 billion per year, so the increased risk-sharing after the BEAT provision was implemented was worth $V =$\$1.9 billion per year. This is equivalent to 2.9% of insurers' total annual net income ($= 1.9 \div 63.58$). An analogous calculation

[17] Prior research (e.g. Froot (2001)) has shown that the marginal dollar of liabilities ceded to risk-hedging reinsurers is more likely to be tail risks and thus does not have the same payoff distribution as the average dollar of insurance liabilities that the insurer retains. This explains why insurers are willing to pay an average price of reinsurance per dollar of liabilities that exceeds the average price of direct insurance premiums. However, unlike prior research that focusses on risk-sharing reinsurance of catastrophe risk, this paper quantifies risk-sharing reinsurance of all risks, which is why the average price (as measured by premiums divided by actuarial losses) is lower than what is reported in Froot (2001).

[18] The total liabilities is exactly equal to total premiums divided by the price of reinsurance if losses equal liabilities.

using the pre-TCJA parameters yields a total value of $V = \$2.6$ billion per year, or 4.0% of insurers' total annual net income. The estimate implies that the increased risk-sharing is of substantial value to insurers.

The revealed preference approach to estimating the value of risk-sharing has several limitations. First, it assumes that insurers are homogeneous in their risk-hedging demand. In reality, some insurers may value risk-hedging more than others, for example if there are differences in the risk profiles of their liabilities or financing frictions. One data limitation is that I do not observe the risk profiles of the direct premiums or of the premiums reinsured of individual insurers. As a result, the loss distribution and price of reinsurance on the additional premiums ceded could be different than the average distribution and average price. Second, the estimated values could change depending on the assumed parameters, for example if the price of reinsurance or balance sheet costs are time varying. In Table A1, I report the estimated results under different parameter value assumptions. The estimated values are generally consistent with the values derived in the main specification. Lastly, in addition to the BEAT provision, the US corporate tax rate also changed at the same time, such that the observed post-BEAT quantity changes reflect both the BEAT provision changes as well as the US corporate tax rate changes. For instance, a lower US corporate tax rate could decrease the value of risk-hedging if it increases the profitability of insurers and makes bankruptcy less likely. Nonetheless, the fact that risk-sharing quantities increased, combined with the fact that risk-sharing reinsurance prices exceeds actuarially fair value, implies that the increased risk-sharing is of significant value to insurers.

5.3 Mechanisms of value of risk-sharing

Having shown that the increased risk-sharing after the BEAT provision is valuable to insurers, I now explore why risk-sharing is valuable to insurers. As discussed in Section 2, insurers, like non-financial firms, face financing frictions which make risk-hedging valuable if they experience idiosyncratic shocks to their policy liabilities, for example from regional natural catastrophes in the markets they operate in. Indeed, in this section, I show that insurers face significant variations in policy liability shocks.

I begin by measuring variation in liability shocks as the pairwise correlation coefficients in policy losses between insurance groups. If insurers did not face idiosyncratic liability shocks, they would only be subject to common shocks so policy losses should be perfectly correlated across insurers over time. Since common shocks are undiversifiable, risk-sharing across insurers would only be valuable if insurers experienced idiosyncratic shocks. How far away the pairwise correlation coefficients are from 1 indicates how important idiosyncratic shocks are to insurers' losses. If insurers' idiosyncratic shocks are large relative to their insurance policies, the correlation would be very low.

Specifically, I compute each insurer i's losses in year t as the total amount of losses normalized by the amount of premiums underwritten:

$$LossRatio_{i,t} = \frac{IncurredLosses_{i,t} + LossAdjustmentExpenses_{i,t} + DefenseExpense_{i,t}}{DirectPremiumsWritten_{i,t}} \quad (9)$$

So the loss ratio can be interpreted as the loss per dollar of insurance premiums underwritten for each insurance group i in each year t. I then compute for each pair of insurance groups the correlation coefficient of their loss ratios between 2005 and 2019. Table 10 reports the results. The median pairwise correlation in loss ratios between all US property and casualty insurance groups is 0.10. Furthermore, although diversification is increasing in the sizes of the insurance groups, risk-hedging is still limited: the median pairwise correlation in loss ratios between the largest US property and casualty insurance groups, defined as those with $10 billion or more in net premiums written annually on average, is only 0.45. Figure 6 plots the distribution of pairwise correlations in loss ratios across all US P&C insurance groups. The figure shows a similar story as Table 10, with the correlation in loss ratios low or even negative between many pairs of insurers.

One alternative explanation that the correlation is low is that insurers are hedging common shocks instead of insurer- and policy-specific shocks. To test this, I run a fixed effects regression with time and insurer fixed effects, where the time fixed effects absorbs common shocks, so that the residual variation is due to idiosyncratic shocks:

$$LossRatio_{i,t} = \mu_i + \mu_t + \epsilon_{i,t} \quad (10)$$

Where $LossRatio_{i,t}$ is insurer i's loss ratio in year t and μ_i and μ_t are insurer- and year fixed effects, respectively. Observations are at the insurer-year level.

Table 11 reports the results. Three points stand out from this analysis. First, in column (1), there are substantial idiosyncratic shocks to individual insurers, consistent with the low correlations documented in Figure 6. Second, column (2) shows that there's virtually no common shocks across all insurance groups, as the R^2 of the time fixed effects is close to zero. Third, larger insurers face more common shocks, as measured by the R^2 in column (5), but there still remains a large fraction of variance in loss ratios not explained by the time FEs. Overall, the evidence points strongly to idiosyncratic shocks being important for insurance groups.

To measure the economic magnitude of the variation in loss ratios, I next turn to the variance of losses. I measure variance as the cross-sectional standard deviation of the loss ratios across property and casualty insurance groups for each year between 2005 and 2019. Table 12 reports the statistics. Column (1) reports the estimates across all US property and casualty insurance groups. The average standard deviation is 23.2% across all insurance groups and is at least 22.2% each year during the sample period. Similarly, the annual interquartile range (column 2) is at least 26.0% each year. This suggests that there are economically substantial variations in losses between insurance groups, so the shocks that insurers experience on their liabilities must be large and idiosyncratic. Column (3) reports the estimates for the largest US property and casualty insurance groups, defined same as earlier as those with $10 billion or more in net premiums written annually on average. The average standard deviation is 7.5% across the largest insurance groups, which suggests that while diversification is increasing in size, there is still a substantial amount of idiosyncratic shocks that even the largest insurance groups experience.

Despite the large cross-sectional variations in loss ratios estimated across US property and casualty insurance groups, these estimates are likely an under-estimate of the true variance of the idiosyncratic shocks. The cross-sectional variations do not account for year-to-year variations in the natures and magnitudes of catastrophes and shocks that US insurers face. For example, a particularly bad Atlantic hurricane season or a large California earthquake would likely substantially impact the policies of all US insurers, even if they were perfectly diversified within the US. To diversify these large-scale shocks away, US insurers would need to risk-hedge with global reinsurers. So the total variation, including both cross-sectional and time-series variation, is likely greater than the cross-sectional component.

To interpret the economic magnitudes of the cross-sectional and time-series variation, I compute these idiosyncratic shocks as a share of the insurance groups' total capital and surplus. Cross-sectionally, a one-standard-deviation increase in the magnitude of the idiosyncratic shock the insurer experiences corresponds to an 18% decrease in the insurer's total capital and surplus, all else equal.[19] In the time series, the average time-series variation of loss ratios of each insurance group is 13.8%. This corresponds to a 10.6% decrease in the total capital and surplus of the insurer. Overall, the high variance, low correlation, and large economic magnitudes of idiosyncratic shocks explain why risk-hedging and transfers of risk through reinsurance are important functions for insurers, and why the increased risk-sharing induced by the BEAT provision is valuable to insurers.

6 Effect of minimum tax on product markets

In this section, I study the effect of the global minimum tax on the product market decisions of insurers, which was one of the most heavily debated aspects of the BEAT proposal. I use a difference-in-differences specification and find that insurers affected by the global minimum tax increased their product prices by 1.03% relative to insurers that were not affected. The estimates imply that approximately 54% of the tax was passed through to product prices. I also find suggestive evidence that cross-border acquisitions of US insurers by foreign insurers declined following the global minimum tax implementation. The findings overall suggest that the global minimum tax affected the downstream product market decisions of multinational insurance companies.

6.1 Product prices

As discussed in Section 3, a global minimum tax rate could increase the marginal cost of selling insurance policies for insurers that use foreign affiliates. As such, insurers that used foreign affiliates plausibly would have increased policy prices by more than insurers who were not affected by the

[19] Assuming an industry-average capital and surplus to direct premiums written ratio of 130%

minimum tax.

To test this hypothesis, I use product rate filings by P&C insurers to understand how product prices changed after the minimum tax implementation. For each line of insurance (e.g. homeowner's insurance, or auto insurance) sold by each insurance company, I calculate an annual product price index by cumulatively multiplying the reported rate changes. Since the rates are reported as rate changes, I normalize the price index of each insurer-line to be 0 at the end of the year in 2016, the year immediately preceding the BEAT provision. The price index therefore can be interpreted as the cumulative price changes relative to the price level at the end of 2016. Appendix B provides further details on the construction of the product price indices as well as sample product price data.

I begin by graphically plotting the annual average product prices around the minimum tax implementation period. Figure A1a plots the time series of average product price indices from 2013 to 2019 of all insurers, and Figure A1b plots the analogous time series averages of insurers by whether they used foreign affiliates in 2017 or not. As discussed in Section 2, I normalize the 2016 product prices for all products to be 0 to construct the price indices. Several features are worth highlighting. As Figure A1a illustrates, there is an overall trend of increasing insurance prices in this period. Figure A1b shows, however, that the product prices of insurers that used foreign affiliates differed from those that did not use foreign affiliates in two ways. First, insurers that did not use foreign affiliates increased their prices over time, both before and after the minimum tax implementation with the increase being well-described by a linear trend. However, insurers that used foreign affiliates experienced a notable change in their product prices after the minimum tax implementation: whereas these insurers kept their prices relatively constant prior to the minimum tax implementation, they increased product prices after the minimum tax was implemented. As a result, after the minimum tax implementation, insurers that used foreign affiliates increased their product prices at an economically-similar magnitude to insurers that did not use foreign affiliates.

Motivated by the graphical evidence, I formally estimate the effect of the minimum tax on product prices in the following event-study econometric specification:

$$\widetilde{P_{k,i,t}} = \alpha + \sum_{t=2013,\ldots,2019} \beta_t \cdot 1(Year = t)_t \cdot 1(FAR)_i + \mu_k + \mu_t + X_{i,t} + \epsilon_{k,i,t} \tag{11}$$

Observations are at the insurer-line-year level. Importantly, to account for the observed time trends, I follow the two-step estimation strategy proposed in Goodman-Bacon (2018) by subtracting treatment group-level linear trends estimated on the pre-period from all periods as follows:

$$P_{k,i,t} = \gamma_0 + \gamma_1 \cdot 1(FAR)_i + \gamma_2 \cdot t + \cdot \gamma_3 \cdot 1(FAR)_i \cdot t + \eta_{k,i,t} \text{ for } t < 2017 \tag{12}$$

And take $\widetilde{P_{k,i,t}}$ in eq. (11) to be the residuals in eq. (12). In both steps of the econometric specification, $1(FAR)_i$ is a binary indicator variable that is equal to 1 if insurer i used foreign affiliated reinsurance in 2017, $1(PostBEAT)_t$ is a binary indicator variable that is equal to 1 if the year t is after 2017, μ_k are line fixed effects, μ_t are year fixed effects, and $X_{i,t}$ is a set of insurer-year control variables. The coefficients of interest $\beta_{2,t}$ measure the difference in product prices between insurers that used foreign affiliates and insurers that did not use foreign affiliates in each year before and after the minimum tax was implemented after accounting for the time trends.

Figure 7 visually plots the estimated β_t coefficients. The estimates suggest that after the minimum tax implementation, insurers that used foreign affiliates prior to the tax implementation increased product prices after the tax relative to insurers that did not use foreign affiliates. Table 9 reports the full set of corresponding estimates. Columns (1) and (2) report the coefficient estimates corresponding to a pre-post difference-in-differences specification:

$$\widetilde{P_{k,i,t}} = \alpha + \beta \cdot 1(PostBEAT)_t \cdot 1(FAR)_i + \mu_k + \mu_t + X_{i,t} + \epsilon_{k,i,t} \quad (13)$$

Which mirrors eq. (11) except with an indicator for whether the year was in the pre-period or post-period instead of year-by-year coefficients. Columns (3) and (4) report the coefficient estimates corresponding to the year-by-year specification in eq. (11). In columns (1) and (2), the difference-in-differences coefficient β is positive and statistically significant, indicating that insurance companies affected by the minimum tax through the use of foreign affiliates increased product prices by 1.03% relative to insurance companis that were unaffected by the minimum tax. In columns (3) and (4), the year-by-year coefficient estimates for β_t are also positive and statistically significant for the years following the minimum tax implementation. The year-by-year coefficient estimates are increasing after the tax implementation, which could be due to the step-up in the base erosion tax, which stepped up from 5% in 2018 to 10% in 2019, or rate setting frictions that prohibit insurers from raising prices fully, as documented in Sen and Tenekedjieva (2021).

There are several potential limitations to the analysis. First, the assumption that product prices would have followed pre-period trends in the absence of a tax policy could be violated. For example, prices could have increased for the insurers that used foreign affiliates if these insurers experienced changes in their financial conditions or in the lines of insurance they sold, for instance if certain lines that insurers using foreign affiliates have greater market shares in also experienced significant losses around the minimum tax implementation. I attempt to address this in two ways. First, to account for potential changes in insurers' financial conditions, in Table 9, columns (2) and (4) include controls for a set of insurer financial variables including the insurers' leverage, liquidity, and return on equity, and the estimates on the effect of the minimum tax are comparable to the estimates without the financial variables controls. Second, to account for potential heterogeneities across lines of insurance, I estimate eq. (13) separately for each line of insurance products. Whereas it is possible that one product line could experience large changes in losses around the minimum tax implementation, it is less likely that many product lines all simultaneously experience significant increases in losses in the same year. Table A2 reports the results for the five most common lines of property and casualty insurance: personal auto, homeowners, liability, commercial auto, and property. I estimate a positive β coefficient for each line of insurance and is statistically significant for every line except property, for which the coefficient is estimated imprecisely but the point estimate is positive and similar in magnitude. As such, the price increase is unlikely to be driven by changes in different lines of insurance or in insurers' financial conditions that could result in differential trends in the post-periods. Lastly, the continuation of the pre-period rate setting trend for the control group, i.e. insurers that did not use foreign affiliates, as visualized in Figure 7, suggests that the difference-in-differences estimates are driven by changes made by insurers that used foreign affiliates rather than by changes by insurers that did not.

Another potential concern is that the product price indices, which is premiums-weighted, could be driven by products that had large market shares. To address this concern, I estimate the difference-in-differences specifications with the dependent variable as the equal-weighted product price indices, rather than weighting by premiums. Table A3 reports the results for this robustness check. I find that the coefficient estimates are comparable to the main results.

I use the estimated coefficients to construct a back-of-the-envelope calculation of the pass-through of the tax. Taking the product price increase estimate of 1.03% in column (1) in Table 9, the average share of premiums reinsured with foreign affiliates by insurers who use foreign affiliates was 19% in 2017, and 0% by definition for insurers who did not use foreign affiliates in 2017. As such, the minimum tax was equal to 1.9% ($= 10\% \times (19\% - 0\%)$) of premiums, so the pass-through was 54% ($= 1.03\% \div 1.9\%$). This pass-through is likely a lower bound of the true pass-through, since the insurers' endogenous usage of foreign affiliate also declined post-2017, which means the effective minimum tax on the product price was lower than 1.9%, so if the insurers' foreign affiliate use were held constant then the price increase would have likely been greater than 1.03%.

6.2 Strategic market entry and acquisition

In addition to changes in product pricing, insurers can also engage in mergers and acquisitions to strategically enter or exit the US insurance market. One common way for foreign insurers to expand their market share in the US was through acquisitions of existing US insurers. Prior to the minimum tax, foreign insurers acquiring US insurers could reinsure premiums with their foreign affiliates to capture the previously-discussed tax benefits. The global minimum tax significantly reduced this incentive to acquire US insurers for foreign insurers. As such, it is plausible that foreign insurance companies would decrease their acquisitions of US insurers as US insurers become less attractive acquisition targets. To test this hypothesis, I use announced mergers and acquisitions transactions by insurance companies from the S&P Capital IQ dataset to identify all acquisitions of US insurers from 2005 to 2019. I then compute for each year the average annual deal volume of such acquisitions by US acquirers and by foreign acquirers. I compare the annual deal volumes before and after the minimum tax.

Figure 8 reports the results. Prior to the minimum tax, foreign acquirers accounted for 47% of all acquisitions of US insurers by deal volume ($7.3 billion per year out of $15.5 billion total per year). After the minimum tax, foreign acquirers' share of acquisitions decreased to 7% ($2.2 billion per year out of $30.8 billion total per year). By number of deals, the share of acquisitions of US insurers that are made by foreign acquirers declined from 16% of deals (5.3 deals per year out of

34.0 total deals per year) to 10% of deals (2.3 deals per year out of 22.3 total deals per year). Overall, the evidence suggests that US insurance companies became less attractive acquisition targets for foreign acquirers after the minimum tax. These changes in acquisitions and strategic market entry and expansion decisions by foreign insurers highlight the important role tax incentives play in driving cross-border corporate activities.

7 Interaction of global minimum tax and financial regulation

In this section, I briefly discuss the interaction between the tax incentives insurers face and financial regulation. As prior literature (e.g. Koijen and Yogo (2016, 2017)) has shown, the internal capital allocation and balance sheet activities of insurance companies are of central importance in understanding insurers' financial conditions. Reinsurance in particular constitutes a major channel through which changes are made to insurers' balance sheets and their capital and tax positions. As such, the adjustments to the reinsurance programs as a result of the global minimum tax likely impacted the regulatory profiles of insurers as well. If this is the case, it would suggest that tax policies are an important factor to consider in designing financial regulations.

As discussed in Sections 4 and 5, there are two main changes that insurers made to their reinsurance programs: affected insurers used less foreign affiliated reinsurance, which increased the reported net premiums underwritten by the US insurer. On the other hand, insurers used more risk-sharing reinsurance, which would decrease the reported net premiums underwritten. To identify the net effect, I compute two commonly-used regulatory risk metrics for foreign and US insurers before and after the tax provision change. The first metric is the consolidated NAIC Overall Ratio 2, which is the ratio of net policy premiums underwritten to the policyholder surplus and measures the adequacy of the insurer's surpluses. A higher ratio indicates that the insurer is underwriting more policies relative to their capital.

Figure 10 reports the aggregate ratio for all foreign insurers and all US insurers based on the total net premiums underwritten and total policy surpluses of all insurers of a given type (US or foreign). The figure documents a sharp increase in the aggregate ratio of foreign insurers after the enactment of the BEAT provision as they adjusted their reinsurance programs. Whereas before the minimum tax, foreign insurers had a lower aggregate ratio than US insurers, the pattern reverses after the minimum tax. Foreign insurers' reported aggregate risk ratio increases from 55% to 82% after the changes to reinsurance programs as a result of the minimum tax, whereas the US insurers' aggregate ratio remained largely unchanged from 59% to 63%. The reporting difference comes primarily from foreign insurers winding down their foreign affiliated reinsurance programs, which do not hedge risk with other reinsurers. These changes therefore do not represent any actual changes in the insurers' riskiness but merely reflect internal capital allocations that were previously reinsured with foreign affiliates.

The second metric is the aggregate retention ratio, which is the ratio of net policy premiums underwritten to the gross policy premiums underwritten and measures the proportion of liabilities that are kept on the insurer's reported balance sheets. A higher retention ratio means that more of the policy liabilities are retained on reported balance sheets. Figure 11 reports the aggregate retention ratio for foreign and US insurers before and after the minimum tax. Two findings stand out. First, US insurers retain more of their policy liabilities on balance sheets than foreign insurers. This is consistent with foreign insurers both using more risk-sharing reinsurance as well as using more affiliated reinsurance. Second, the global minimum tax significantly increased the aggregate reported retention ratio of foreign insurers. This occurred despite an increase in the use of risk-sharing reinsurance, implying that a substantial portion of the difference between foreign and US insurers in their retention ratios were due to the use of foreign affiliated reinsurance. Overall, the evidence affirms the findings of prior work (e.g. Koijen and Yogo (2016)) and documents a new channel through which tax policies affect the regulatory profiles of insurers.

8 Conclusion

This paper studies the effect of a global minimum tax on corporate balance sheets and real activities using the insurance industry as a laboratory. I begin by providing a model of insurers' profit maximization problem under a global minimum tax, where the insurer's product market and balance sheet management decisions are responsive to the minimum tax policy. I derive a set of empirical predictions on the effects of a global minimum tax. I then take these empirical predictions to the data by studying the US implementation of the BEAT provision, which assessed a minimum tax on insurance premiums transferred to foreign affiliates. Consistent with the empirical predictions, I document that the tax significantly affected insurers' internal capital flows, increased external risk-sharing, and increased product prices.

As more policy and academic interest is paid to international tax regimes, understanding the effects of different tax policies is becoming increasing important. For example, how do global minimum tax rates affect other industries, such as technology or manufacturing firms? Furthermore, while the results in this paper may shed light on the positive effects, the normative consequences are also worth exploring. Overall, studying the effects of new international tax policies and instruments on corporate activities is a promising and important area of future work.

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9 Figures and Tables

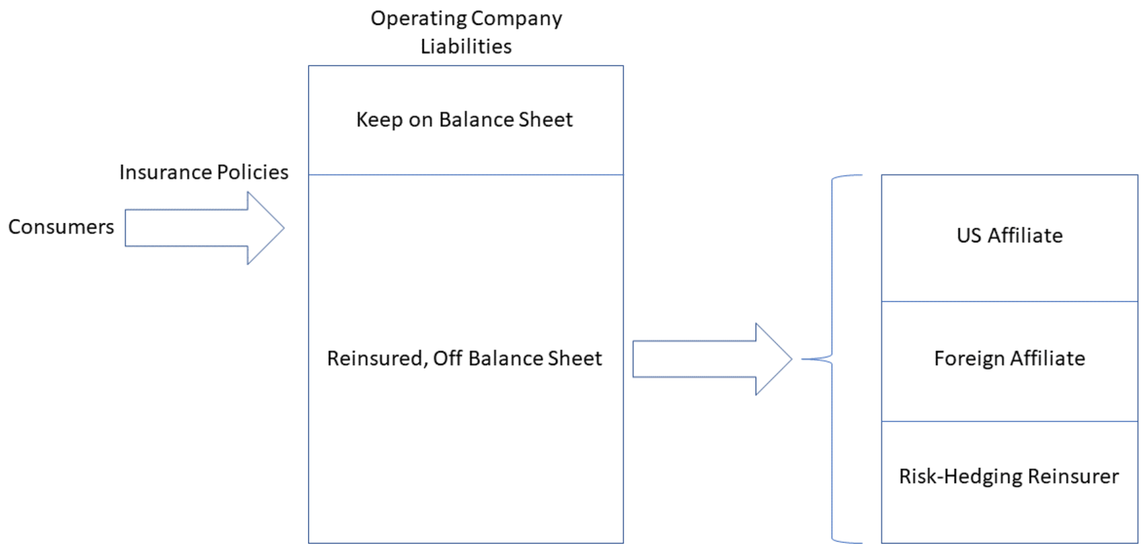


Figure 1: Insurance and Reinsurance Flows

Note: Figure 1 presents the flow of insurance premiums from the policyholder (consumer or firm) to the operating company of the insurance group and to the affiliated and unaffiliated reinsurers.

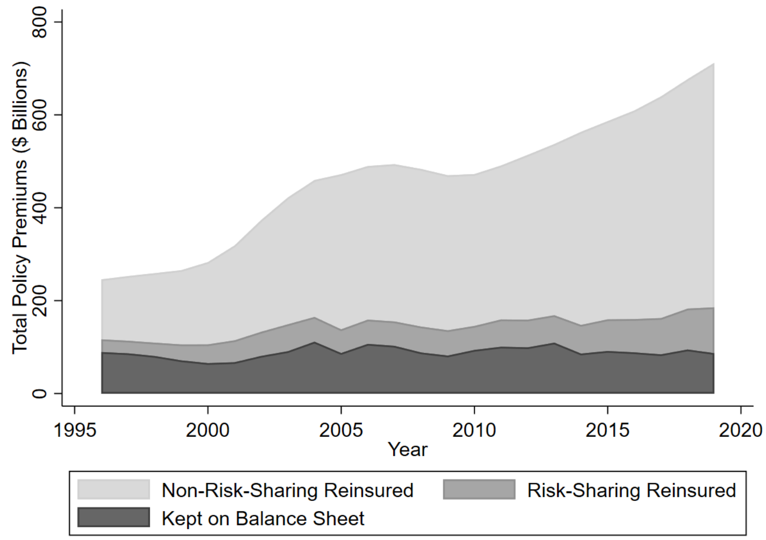
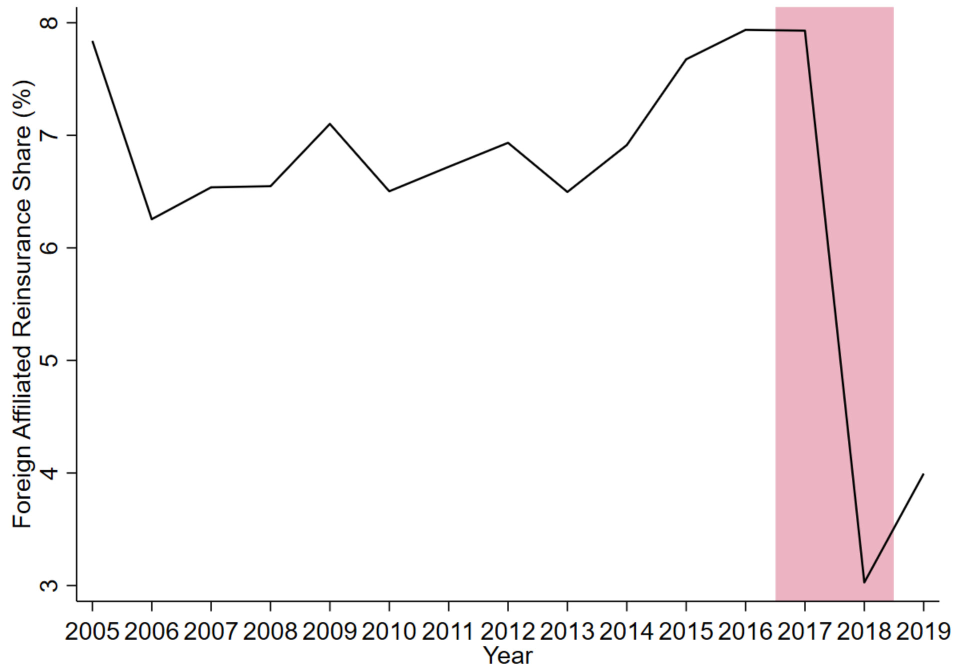


Figure 2: Insurance Policy Liabilities of US P&C Insurance Groups

Note: Figure 2 presents the time series of insurance premiums by the proportions reinsured with a risk-sharing (unaffiliated) counterparty, a non-risk-sharing (affiliated) counterparty, or kept on the originating insurer's balance sheet.

Figure 3: Effect of Global Minimum Tax on Foreign Affiliated Reinsurance



Note: Figure 3 reports the fraction of insurance premiums reinsured with foreign affiliated reinsurers by US property and casualty insurers from 2005 to 2019. The numerator is the sum of all insurance premiums reinsured with a foreign affiliated reinsurer by all US property and casualty insurers each year. The denominator is the sum of all insurance premiums underwritten by all US property and casualty insurers each year.

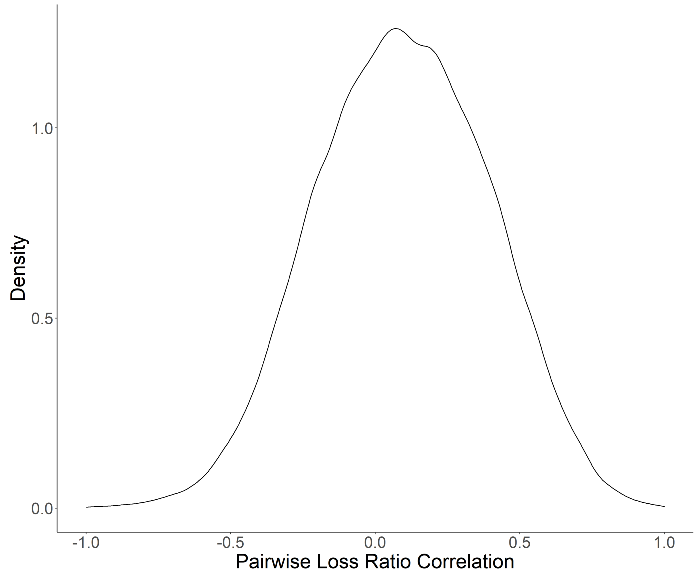
Figure 4: Effect of Global Minimum Tax on US Affiliated Reinsurance

Note: Figure 4 reports the fraction of insurance premiums reinsured with US affiliated reinsurers by US property and casualty insurers from 2005 to 2019. The numerator is the sum of all insurance premiums reinsured with a US affiliated reinsurer by all US property and casualty insurers each year. The denominator is the sum of all insurance premiums underwritten by all US property and casualty insurers each year.

Figure 5: Effect of Global Minimum Tax on Risk-Sharing Reinsurance

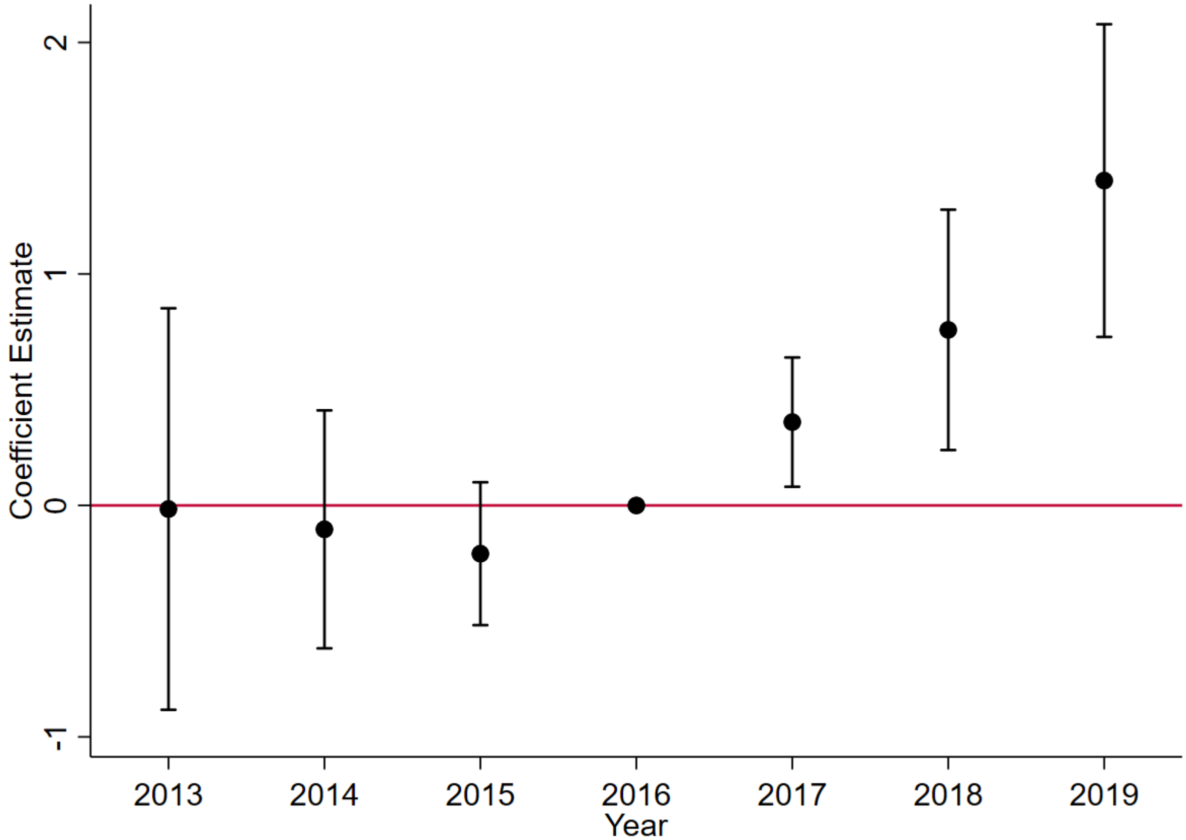
Note: Figure 5 reports the fraction of insurance premiums reinsured with unaffiliated reinsurers by US property and casualty insurers from 2005 to 2019. The numerator is the sum of all insurance premiums reinsured with an unaffiliated reinsurer by all US property and casualty insurers each year. The denominator is the sum of all insurance premiums underwritten by all US property and casualty insurers each year.

Figure 6: Pairwise Correlation of Loss Ratios Between US P&C Insurance Groups



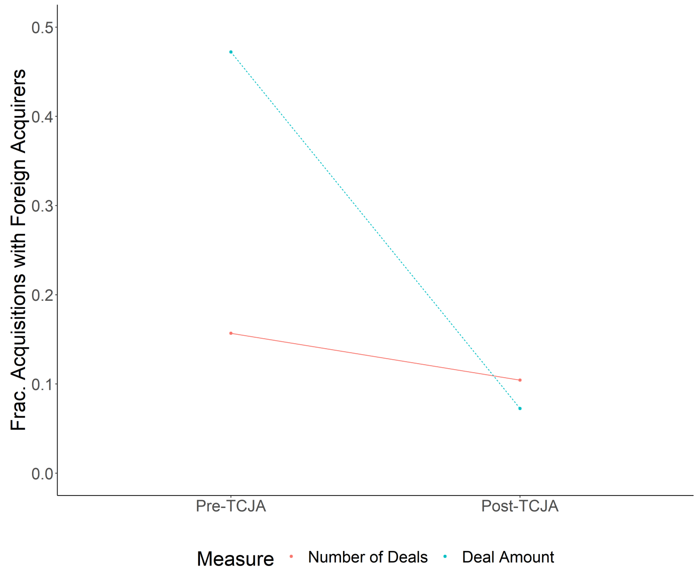
Note: Figure 6 presents the distribution of pairwise correlation of loss ratios between US property and casualty insurance groups from 2005 to 2019. The loss ratios are computed for each insurance group following eq. (9).

Figure 7: Product Prices around Minimum Tax Implementation



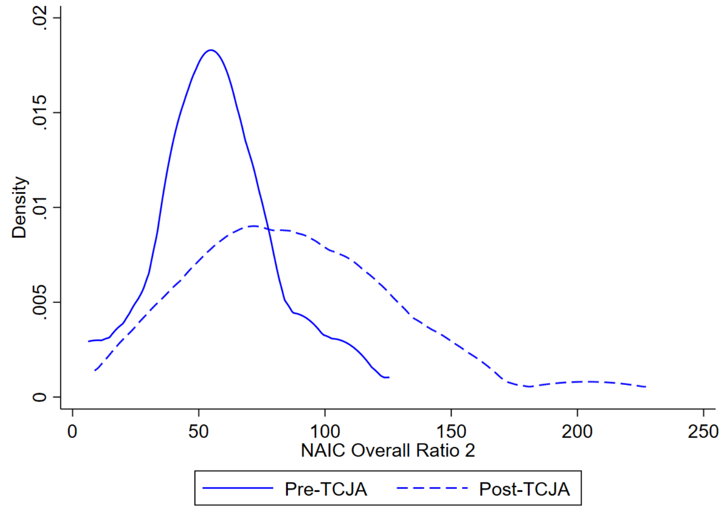
Note: Figure 7 plots the estimates of the difference-in-differences coefficient corresponding to eq. (11). Observations are at the insurer-line-year level. The dependent variable, the product price index, is measured in percentage points.

Figure 8: Acquisitions of US Insurers by Acquirer Domicile

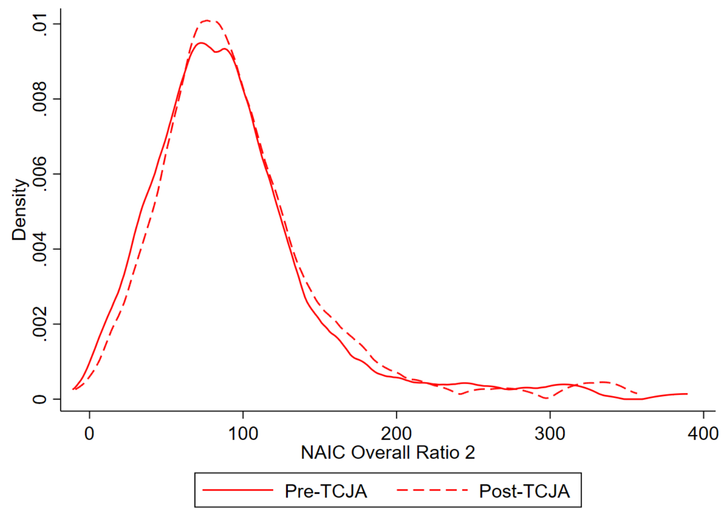


Note: Figure 8 plots the average annual volume of corporate acquisitions of US insurers by US acquirers and foreign acquirers before and after the BEAT global minimum tax implementation as part of the 2017 Tax Cuts and Jobs Act. Deal Volume is in millions USD per year. Pre-TCJA is from January 1, 2005 to December 22, 2017. Post-TCJA is from December 23, 2017 to July 1, 2020.

Figure 9: Regulatory Ratios



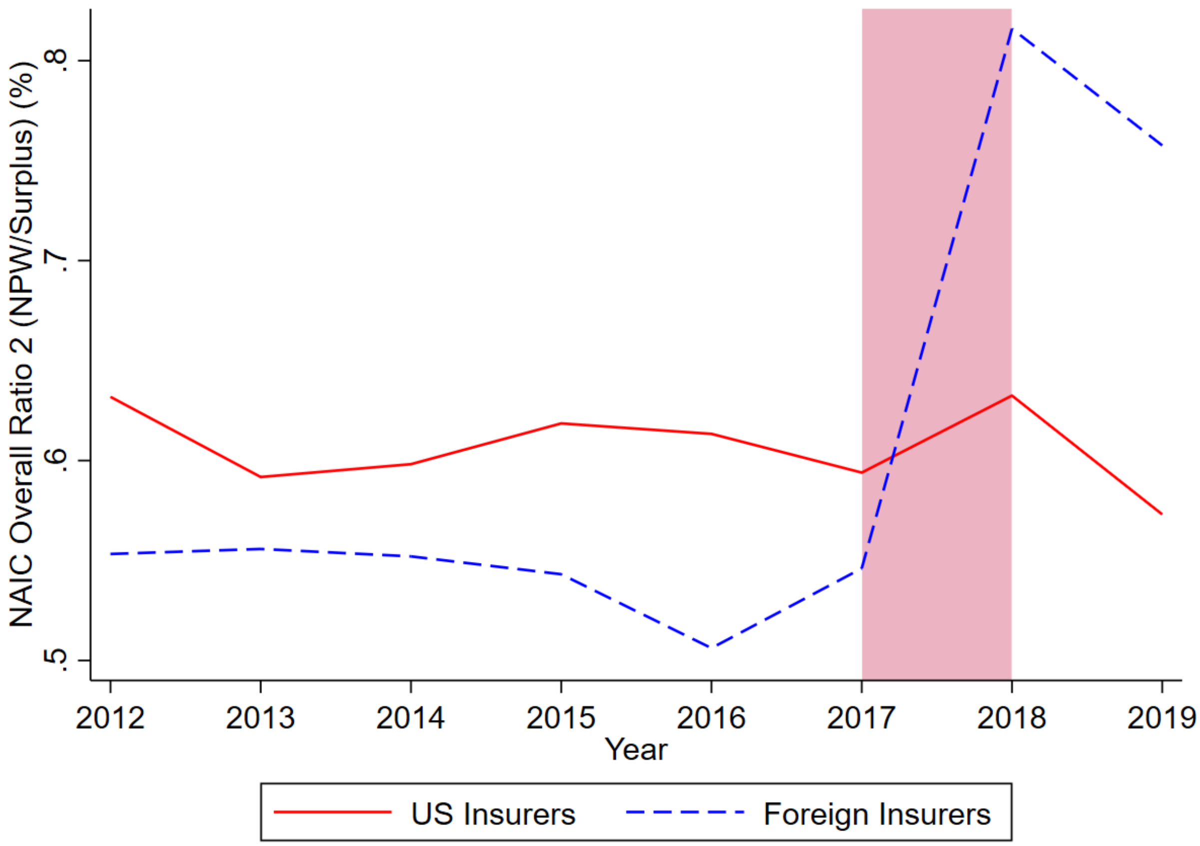
(a) Foreign Insurers NAIC Overall Ratio 2 Pre/Post-TCJA



(b) US Insurers NAIC Overall Ratio 2 Pre/Post-TCJA

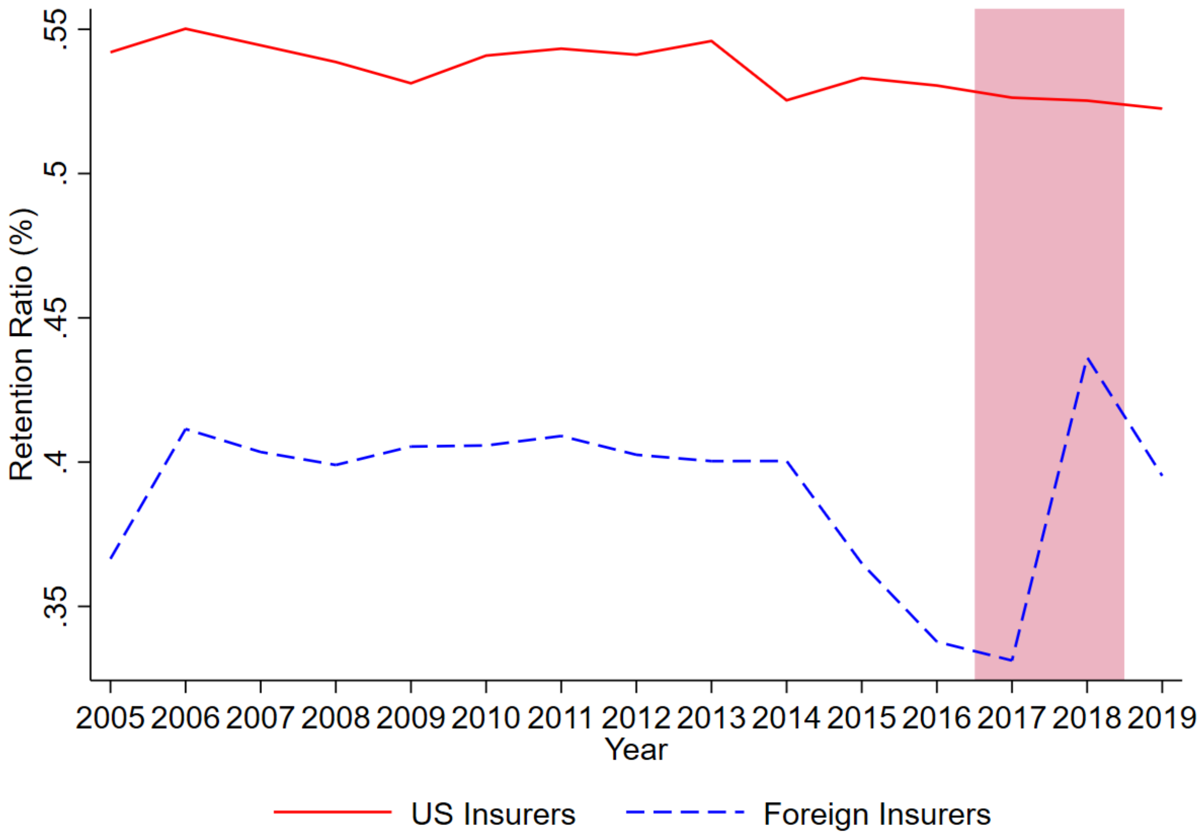
Note: Figures 9a and 9b report insurers' NAIC Overall Risk Ratio 2 before and after the BEAT global minimum tax implementation as part of the 2017 Tax Cuts and Jobs Act. The NAIC Overall Risk Ratio 2 is computed as the total net premiums underwritten divided by the total policyholder surplus each year. Figure 9a reports the distribution of the ratio for foreign insurers with at least $100 million net premiums written pre-TCJA (2017) and post-TCJA (2018). Figure 9b reports the distribution of the same ratio for US insurers with at least $100 million net premiums written pre-TCJA (2017) and post-TCJA (2018).

Figure 10: Aggregate NAIC Overall Ratio 2 for US and Foreign Insurers



Note: Figure 10 reports insurers' NAIC Overall Risk Ratio 2 before and after the BEAT global minimum tax implementation as part of the 2017 Tax Cuts and Jobs Act. The NAIC Overall Risk Ratio 2 is computed as the total net premiums underwritten divided by the total policyholder surplus each year. The variable of interest is the total ratio for all foreign insurers and for all US insurers based on the total net premiums underwritten and total policy surpluses of all insurers of a given domicile type (US or foreign).

Figure 11: Aggregate Retention Ratios for US and Foreign Insurers



Note: Figure 11 reports insurers' aggregate retention ratios before and after the BEAT global minimum tax implementation as part of the 2017 Tax Cuts and Jobs Act. The retention ratio is computed as the total net premiums underwritten divided by the total gross premiums written each year. The variable of interest is the total ratio for all foreign insurers and for all US insurers based on the total net premiums underwritten and total gross premiums written of all insurers of a given domicile type (US or foreign).

Table 1: Summary Statistics: Market-Level

Variable	Amount
No. Groups	328
No. Companies	2633
Total Direct Premiums	712.19
Reinsurance Total	635.58
US Affiliated	497.96
Foreign Affiliated	28.45
Unaffiliated	98.8

Note: Table 1 reports the summary statistics of reinsurance activities at the market-level for the entire US property and casualty insurance market in 2019. No. Groups and No. Companies refer to the numbers of total P&C insurance groups and individual insurance companies, respectively. All variables, excluding No. Groups and No. Companies, are in billions USD.

Table 2: Summary Statistics: Insurer-Level

VARIABLES	(1) N	(2) mean	(3) sd	(4) min	(5) max
Total Direct Premiums	2,616	1,731	5,541	-4.24	65,862
Total Net Premiums	2,616	1,565	5,387	-183	65,463
Reinsurance Total	2,616	1,536	5,652	-109	55,426
US Affiliated	2,616	1,225	5,058	-123	50,100
Foreign Affiliated	2,616	113	551	-1,760	7,676
Unaffiliated	2,616	198	631	-94.2	6,450
Reinsurance Share Total	2,616	0.51	0.34	0	1
US Affiliated	2,616	0.31	0.35	0	1
Foreign Affiliated	2,616	0.071	0.21	0	1
Unaffiliated	2,616	0.19	0.22	0	1
Foreign	2,616	0.12	0.33	0	1
Tax Rate Difference	2,616	-0.34	0.10	-0.40	0
Liabilities	2,562	12.9	2.13	6.97	17.9
Leverage	2,564	0.57	0.15	0.033	0.88
Liquidity	2,527	150	68.1	36.8	461
Return on Equity	2,553	5.48	9.79	-33.2	34.8
Risk-Based Capital Ratio	2,493	1,070	1,317	173	10,576

Note: Table 2 reports summary statistics of the insurers' financial statements dataset. Observations are at the insurer-year level from 1996 to 2019. Total Direct Premiums, Total Net Premiums, and Reinsurance Total, including US Affiliated, Foreign Affiliated, and Unaffiliated, are in millions USD. Reinsurance Share Total, including US Affiliated, Foreign Affiliated, and Unaffiliated, are in decimal points and are winsorized at the 1% level. Foreign is an indicator variable that is 1 if the insurer's parent company is domiciled outside of the US and 0 if it is domiciled in the US. Tax Rate Difference is the difference in corporate tax rates between the insurer's home country and the US and is measured in decimal points. A more positive Tax Rate Differential corresponds to higher US taxes relative to the insurer's home country. Liabilities is the log total liabilities of the insurer. Leverage is the insurer's total liabilities divided by its net total assets. Liquidity is the insurer's cash plus short-term investments divided by its total liabilities. Return on Equity is the insurer's annualized income after taxes as a percent of average capital and surplus. Risk-Based Capital Ratio is the insurer's ACL risk-based capital ratio.

Table 3: Summary Statistics: Product Prices

VARIABLES	(1) N	(2) mean	(3) sd	(4) min	(5) max
Product Price (Premiums-Weighted)	69,846	0.30	10.5	-100	769
Product Price (Equal-Weighted)	69,846	0.23	9.07	-85.5	614
Price Change (Premiums-Weighted)	69,819	0.66	5.85	-100	203
Price Change (Equal-Weighted)	69,829	0.63	5.20	-100	203
Foreign Affiliates Use	57,764	0.48	0.50	0	1
Foreign Affiliated Reinsurance Share	57,764	0.073	0.17	0	1

Note: Table 3 reports summary statistics of the product prices. Observations are at the insurer-line-year level from 2013 to 2019. Product Prices are the premiums-weighted or equal-weighted price index constructed from the rate changes reported on insurers' statutory product rate filings and are reported in percentage points. Product Prices are normalized to 0 for each insurer-line at the end of 2016. Price Changes are the premiums-weighted or equal-weighted annual changes in the product price indices and are reported in percentage points. Foreign Affiliates Use is an indicator variable that is 1 if the insurance group reinsured any premiums with a foreign affiliate in 2017. Foreign Affiliated Reinsurance Share is the share of direct premiums underwritten by the insurance group that was reinsured with a foreign affiliate in 2017.

Table 4: Reinsurance Volumes By Year

Year	Total Premiums	Reinsured US Aff.	Reinsured Foreign Aff.	Reinsured Unaff.	Total Reinsured (%)	Total Reinsured Aff. (%)	Total Reinsured Unaff. (%)
1996	246	126	3	27	67	52	11
1997	253	136	3	27	69	55	11
1998	259	145	4	29	71	58	11
1999	266	153	7	34	75	60	13
2000	283	170	8	40	79	63	14
2001	319	191	14	47	81	64	15
2002	374	217	24	52	81	64	14
2003	422	244	29	58	80	65	14
2004	460	265	29	53	77	64	12
2005	472	297	37	51	83	71	11
2006	490	300	31	52	80	68	11
2007	494	306	32	53	81	69	11
2008	484	308	32	56	83	70	12
2009	470	300	33	54	84	71	12
2010	473	296	31	52	82	69	11
2011	491	299	33	59	81	68	12
2012	514	319	36	60	82	69	12
2013	537	334	35	59	81	69	11
2014	564	377	39	62	86	74	11
2015	587	382	45	68	86	73	12
2016	610	401	48	72	87	74	12
2017	640	427	51	78	88	75	12
2018	677	474	21	88	87	73	13
2019	712	498	28	99	89	74	14

Note: Table 4 reports total insurance and reinsurance volumes each year by the type of reinsurance by all US property and casualty insurance companies. Total Premiums is the total amount of insurance premiums sold in billions USD. Reinsured US Aff., Reinsured Foreign Aff., and Reinsured Unaff. are the total amount of premiums reinsured with US affiliated reinsurers, foreign affiliated reinsurers, and unaffiliated reinsurers, respectively, and are measured in billions USD. Total Reinsured (%), Total Reinsured Aff. (%), and Total Reinsured Unaff. (%) are the share of all premiums reinsured with affiliated reinsurers and with unaffiliated reinsurers, respectively, and are measured in percentage points.

Table 5: Insurer-Level Internal Capital Allocation Response to Global Minimum Tax

VARIABLES	(1) Foreign Aff.	(2) Foreign Aff.	(3) US Aff.	(4) US Aff.
1(TCJA)	-0.026***	-0.020**	0.014*	0.028***
	(0.0084)	(0.0084)	(0.0082)	(0.0085)
ln(Liabilities)		-0.030		-0.0036
		(0.022)		(0.032)
Leverage		-0.065		0.13
		(0.12)		(0.12)
Liquidity		-0.00016		0.000058
		(0.00018)		(0.00026)
Return on Equity		0.00087**		3.5e-06
		(0.00035)		(0.00028)
Risk-Based Capital Ratio		-2.3e-06		0.000025
		(0.000014)		(0.000015)
Observations	2,616	2,456	2,616	2,456
R-squared	0.742	0.798	0.896	0.931
Group FEs	X	X	X	X

Note: Table 5 reports the results corresponding to the linear regression in eq. (4). Observations are at the insurer-year level from 2012 to 2019. The dependent variable is the share of insurance premiums underwritten that is reinsured with a foreign affiliate in columns (1) and (2) and with a US affiliate in columns (3) and (4). The dependent variable is measured in percentage points. The independent variable $1(TCJA)$ is an indicator variable for whether the year is after 2017. ln(Liabilities) is the log total liabilities of the insurer. Leverage is the insurer's total liabilities divided by its net total assets. Liquidity is the insurer's cash plus short-term investments divided by its total liabilities. Return on Equity is the insurer's annualized income after taxes as a percent of average capital and surplus. Risk-Based Capital Ratio is the insurer's ACL risk-based capital ratio. Standard errors are clustered at the insurer level.

Table 6: Insurer-Level Internal Capital Allocation Response to Global Minimum Tax: Heterogeneity

VARIABLES	(1) Foreign Aff.	(2) Foreign Aff.	(3) US Aff.	(4) US Aff.
1(TCJA)	0.0032	0.0076*	0.011	0.020**
	(0.0046)	(0.0044)	(0.0086)	(0.0086)
1(TCJA) × $1(HighFAR2017)$	-0.12***	-0.11***	0.014	0.030*
	(0.029)	(0.029)	(0.022)	(0.017)
ln(Liabilities)		-0.025		-0.0047
		(0.021)		(0.031)
Leverage		-0.014		0.12
		(0.11)		(0.12)
Liquidity		-0.00016		0.000058
		(0.00019)		(0.00026)
Return on Equity		0.00077**		0.000028
		(0.00036)		(0.00028)
Risk-Based Capital Ratio		9.1e-07		0.000024
		(0.000014)		(0.000015)
Observations	2,616	2,456	2,616	2,456
R-squared	0.754	0.810	0.896	0.931
Group FEs	X	X	X	X

Note: Table 6 reports the results corresponding to the linear regression in eq. (5). Observations are at the insurer-year level from 2012 to 2019. The dependent variable is the share of insurance premiums underwritten that is reinsured with a foreign affiliate in columns (1) and (2) and with a US affiliate in columns (3) and (4). The dependent variable is measured in percentage points. The independent variable $1(TCJA)$ is an indicator variable for whether the year is after 2017. The independent variable $1(TCJA) \times 1(HighFAR2017)$ is an interaction indicator variable for whether the year is after 2017 and the insurer used above the median share of foreign affiliated reinsurance across all insurance groups in 2017. ln(Liabilities) is the log total liabilities of the insurer. Leverage is the insurer's total liabilities divided by its net total assets. Liquidity is the insurer's cash plus short-term investments divided by its total liabilities. Return on Equity is the insurer's annualized income after taxes as a percent of average capital and surplus. Risk-Based Capital Ratio is the insurer's ACL risk-based capital ratio. Standard errors are clustered at the insurer level.

Table 7: Determinants of Foreign Affiliate Usage

VARIABLES	(1)	(2)	(3)	(4)
1(Foreign)	0.63***	0.51***		
	(0.058)	(0.063)		
Tax Rate Difference			1.54***	1.64***
			(0.14)	(0.20)
ln(Liabilities)		0.047***		0.056***
		(0.013)		(0.013)
Leverage		1.16***		1.24***
		(0.30)		(0.30)
Liquidity		0.0019***		0.0020***
		(0.00066)		(0.00067)
Return on Equity		0.0018		0.00092
		(0.0016)		(0.0016)
Risk-Based Capital Ratio		-0.000017		-0.000018
		(0.000016)		(0.000017)
Observations	2,616	2,458	2,616	2,458
R-squared	0.199	0.268	0.110	0.237
Year FEs		X		X

Note: Table 7 reports the results corresponding to the linear regression in eq. (6). Observations are at the insurer-year level from 2012 to 2019. The dependent variable is an indicator variable for whether the insurer used any foreign affiliated reinsurance in each year. The independent variable $1(TCJA)$ is an indicator variable for whether the year is after 2017. The independent variable Tax Rate Difference is the difference in corporate tax rates between the insurer's home country and the US and is measured in decimal points. A more positive Tax Rate Differential corresponds to higher US taxes relative to the insurer's home country. The independent variable ln(Liabilities) is the log total liabilities of the insurer. Leverage is the insurer's total liabilities divided by its net total assets. Liquidity is the insurer's cash plus short-term investments divided by its total liabilities. Return on Equity is the insurer's annualized income after taxes as a percent of average capital and surplus. Risk-Based Capital Ratio is the insurer's ACL risk-based capital ratio. Standard errors are clustered at the insurer level.

Table 8: Insurer-Level External Risk-Sharing Response to Global Minimum Tax

VARIABLES	(1) Unaff.	(2) Unaff.	(3) Unaff.	(4) Unaff.
1(TCJA)	0.017**	0.017**	0.0071	0.0041
	(0.0075)	(0.0067)	(0.0078)	(0.0065)
1(TCJA) $\times$ $1(HighFAR2017)$			0.040**	0.056***
			(0.020)	(0.018)
ln(Liabilities)		-0.0047		-0.0069
		(0.021)		(0.021)
Leverage		0.32**		0.30**
		(0.14)		(0.13)
Liquidity		0.00034		0.00034
		(0.00025)		(0.00025)
Return on Equity		0.000046		0.000093
		(0.00044)		(0.00043)
Risk-Based Capital Ratio		0.000018		0.000016
		(0.000014)		(0.000013)
Observations	2,616	2,456	2,616	2,456
R-squared	0.775	0.835	0.776	0.837
Group FEs	X	X	X	X

Note: Table 8 reports the results corresponding to the linear regression in eq. (7). Observations are at the insurer-year level from 2012 to 2019. The dependent variable is the share of insurance premiums underwritten that is reinsured with a risk-hedging unaffiliated reinsurer. The dependent variable is measured in percentage points. The independent variable $1(TCJA)$ is an indicator variable for whether the year is after 2017. The independent variable $1(TCJA) \times 1(HighFAR2017)$ is an interaction indicator variable for whether the year is after 2017 and the insurer used above the median share of foreign affiliated reinsurance across all insurance groups in 2017. ln(Liabilities) is the log total liabilities of the insurer. Leverage is the insurer's total liabilities divided by its net total assets. Liquidity is the insurer's cash plus short-term investments divided by its total liabilities. Return on Equity is the insurer's annualized income after taxes as a percent of average capital and surplus. Risk-Based Capital Ratio is the insurer's ACL risk-based capital ratio. Standard errors are clustered at the insurer level.

Table 9: Product Price Response to Global Minimum Tax

VARIABLES	(1) Price	(2) Price	(3) Price	(4) Price
1(TCJA)	0.41*	0.42*		
	(0.22)	(0.22)		
1(FAR)	0.11	0.28	0.12***	0.28***
	(0.16)	(0.18)	(0.028)	(0.100)
1(TCJA) × 1(FAR)	1.03***	1.07***		
	(0.34)	(0.34)		
1(FAR) × 2013			-0.044	-0.016
			(0.44)	(0.44)
1(FAR) × 2014			-0.095	-0.10
			(0.26)	(0.26)
1(FAR) × 2015			-0.23	-0.21
			(0.16)	(0.16)
1(FAR) × 2017			0.31**	0.36**
			(0.14)	(0.14)
1(FAR) × 2018			0.71***	0.76***
			(0.26)	(0.26)
1(FAR) × 2019			1.33***	1.40***
			(0.34)	(0.34)
ln(Liabilities)		-0.012		-0.016
		(0.039)		(0.039)
Leverage		-3.87***		-3.97***
		(1.06)		(1.06)
Liquidity		-0.0047**		-0.0050**
		(0.0019)		(0.0020)
ROE		0.012		0.014*
		(0.0077)		(0.0079)
Capital Ratio		-0.000082**		-0.000081**
		(0.000033)		(0.000033)
Observations	57,764	57,346	57,764	57,346
R-squared	0.011	0.012	0.012	0.012
Year FEs			X	X
Line FEs	X	X	X	X

Note: Table 9 reports the results corresponding to the linear regression in eq. (11). Observations are at the insurer-line-year level from 2013 to 2019. The dependent variable is the premiums-weighted product price index and is measured in percentage points. $1(TCJA)$ is an indicator variable for whether the year is after 2017. $1(FAR)$ is an indicator variable for whether the insurer used foreign affiliates in 2017. ln(Liabilities) is the log total liabilities. Leverage is the total liabilities divided by total assets. Liquidity is cash plus short-term investments divided by total liabilities. Return on Equity is annualized post-tax income as a percent of average capital and surplus. Capital Ratio is the ACL risk-based capital ratio. Standard errors are clustered at the insurer level.

Table 10: Pairwise Correlation of Underwriting Losses

Insurers	N	Mean	Median	Min	Max	P25	P75
All	328	0.10	0.10	-1	1	-0.11	0.31
Largest	13	0.41	0.45	-0.49	0.85	0.24	0.66

Note: Table 10 reports summary statistics of the distribution of pairwise correlations in underwriting losses of insurers between all pairs of insurers as estimated in eq. (9) from 1996 to 2019. Underwriting losses are measured as the amount of losses per dollar of premiums underwritten by the insurance group each year. All denotes the sample of all US property and casualty insurers and Largest denotes the sample of US property and casualty insurers with at least $10 billion in premiums written annually.

Table 11: Loss Ratios Fixed Effects Regression

	(1)	(2)	(3)	(4)	(5)	(6)
Insurer FEs	X		X	X		X
Year FEs		X	X	X		X
Sample	All	All	All	Largest	Largest	Largest
Observations	25,181	25,181	25,181	195	195	195
R^2	0.25	0.002	0.25	0.40	0.23	0.62

Note: Table 11 reports the fixed effects regressions corresponding to eq. (10). Observations are at the insurer-year level from 1996 to 2019. The dependent variable is the loss ratio of insurer i in year t. μ_i and μ_t are insurer and year fixed effects, respectively. The sample of insurers is all US property and casualty insurance groups (328 total) in columns (1)-(3) and only the largest insurance groups ($10 billion or more in premiums each year, 13 total) in columns (4)-(6).

Table 12: Variation in Loss Ratios

Year	SD (All)	IQR (All)	SD (Largest)	IQR (Largest)
2005	22.5	26	8.3	8
2006	22.2	26	5	8
2007	22.3	29	6.6	12
2008	24.1	32	7.9	5
2009	23.3	29	7.9	3
2010	23.6	32	9.8	6
2011	25.5	37	5.8	7
2012	24	33	3.4	3
2013	23.2	31	6.8	9
2014	23.3	30	6.2	5
2015	22.3	30	11.4	11
2016	22.7	29	9.8	10
2017	23.1	29	8.2	11
2018	23.7	29	10	9
2019	22.8	27	5.5	8

Note: Table 12 reports the standard deviation and interquartile ranges of underwriting losses. Underwriting losses are measured as the amount of losses per dollar of premiums underwritten by the insurance group each year. All denotes the sample of all US property and casualty insurers and Largest denotes the sample of US property and casualty insurers with at least $10 billion in premiums written annually.

A Model Proof

Following the setup in Section 3, the insurance company therefore solves the following optimal allocation problem to maximize profits or equivalently, minimize costs:

$$\max_{B_F,B_H,D} B = -\underbrace{(C_F(B_F) + C_H(B_H))}_{\text{balance sheet costs}} + \underbrace{H(D) - P_D D}_{\text{net hedging benefit}} - \underbrace{\tau}_{\text{tax}} \tag{14}$$

$$\text{where } B_F + B_H + D = 1$$

and

$$\tau = \begin{cases} \tau_H \cdot B_H \cdot m & \text{without global minimum tax} \\ \max(\tau_H \cdot B_H \cdot m, \tau_{Min} \cdot B_H \cdot m + \tau_{Min} \cdot B_F) & \text{with global minimum tax} \end{cases}.$$

Where τ_H is the US corporate income tax rate and τ_{Min} is the global minimum corporate tax rate, with $\tau_{Min} \leq \tau_H$. For simplicity, I assume the foreign tax rate to be zero, so the US tax liabilities can also be interpreted as the difference between US and foreign tax rates.

The Lagrangian for the problem is thus given as:

$$\mathcal{L} = -(C_F(B_F) + C_H(B_H)) + H(D) - P_D D - \tau - \lambda[1 - B_F - B_H - D] \tag{15}$$

Let $B_{H,0}, B_{F,0}$, and D_0 denote the pre-BEAT allocations, and $B_{H,1}, B_{F,1}$, and D_1 denote the post-BEAT allocations. Let λ_0 denote the Lagrange multiplier in the pre-BEAT problem and λ_1 denote the post-BEAT Lagrange multiplier.

Let Case 1 denote the case without the global minimum tax and Case 2 denote the case with the global minimum tax. First, note that if at the optimal post-BEAT allocation, the global minimum tax does not bind, then the solution is equivalent to the pre-BEAT allocation without the global minimum tax. I thus derive the two sets of first order conditions to the constrained optimization problem as follows:

Case 1:

$$\begin{aligned} \tau_H m + C'_H &= \lambda_0 \\ C'_F &= \lambda_0 \\ -H'(D) + P_D &= \lambda_0 \\ B_F + B_H + D &= 1 \end{aligned}$$

Case 2:

$$\begin{aligned} \tau_{Min} m + C'_H &= \lambda_1 \\ \tau_{Min} + C'_F &= \lambda_1 \\ -H'(D) + P_D &= \lambda_1 \\ B_F + B_H + D &= 1 \end{aligned}$$

Claim: $B_{F,1} \leq B_{F,0}$.
Proof: Suppose $B_{F,1} > B_{F,0}$. Then

$$\begin{aligned} B_{F,1} > B_{F,0} &\implies C'_F(B_{F,1}) > C'_F(B_{F,0}) \\ &\implies \lambda_1 > \lambda_0 \text{ since } \tau_{Min} > 0 \\ &\implies -H'(D_1) > -H'(D_0) \\ &\implies D_1 > D_0 \\ \text{and } \lambda_1 > \lambda_0 \text{ and } \tau_{Min} < \tau_H &\implies C'_H(B_{H,1}) > C'_H(B_{H,0}) \\ &\implies B_{H,1} > B_{H,0} \\ &\implies 1 = B_{F,1} + B_{H,1} + D_1 > B_{F,0} + B_{H,0} + D_0 = 1 \end{aligned}$$

which is a contradiction, so $B_{F,1} \leq B_{F,0}$.
Claim: $B_{H,1} \geq B_{H,0}$.
Proof: Suppose $B_{H,1} < B_{H,0}$. Then,

$$\begin{aligned} B_{H,1} < B_{H,0} &\implies C'_{H,1} < C'_{H,0} \\ &\implies \lambda_1 < \lambda_0 \\ &\implies -H'(D_1) < -H'(D_0) \\ &\implies D_1 < D_0 \\ &\implies 1 = B_{F,1} + B_{H,1} + D_1 < B_{F,0} + B_{H,0} + D_0 = 1 \end{aligned}$$

which is a contradiction, so $B_{H,1} \geq B_{H,0}$.
Claim: $D_1 > D_0$.
Proof: The first order conditions can be written as follows:

$$\begin{aligned} \tau_H m + C'_F + C'_H &= 2(P_D - H'(D)) \text{ for Case 1} \\ \tau_{Min} m + \tau_{Min} + C'_F + C'_H &= 2(P_D - H'(D)) \text{ for Case 2} \end{aligned}$$

Plugging in the parametrization for C_F and C_H, the expressions can be rewritten as:

$$\tau_H m + 2\theta_F(B_{H,0} + B_{F,0}) + 2(\theta_H - \theta_F)B_{H,0} = 2(P_D - H'(D)) \text{ for Case 1}$$
$$\tau_{Min} m + \tau_{Min} + 2\theta_F(B_{H,1} + B_{F,1}) + 2(\theta_H - \theta_F)B_{H,1} = 2(P_D - H'(D)) \text{ for Case 2}$$

Now, by assumption, $\tau_{Min} > \tau_H \cdot \frac{m}{1+m}$, and $\theta_H > \theta_F$. Suppose $B_{F,1} + B_{H,1} > B_{F,0} + B_{H,0}$. Then,

$$\begin{aligned} B_{F,1} + B_{H,1} > B_{F,0} + B_{H,0} &\implies -H'(D_1) > -'(D_0) \\ &\implies D_1 > D_0 \\ &\implies 1 = B_{F,1} + B_{H,1} + D_1 > B_{F,0} + B_{H,0} + D_0 = 1 \end{aligned}$$

which is a contradiction, so $D_1 > D_0$.

Let B_0 denote the value of the objective function, B without a global minimum tax, and B_1 denote the value with a global minimum tax. Note that $B_1 \geq B_0$, since any feasible allocation of liabilities with a global minimum tax is also attainable without a global minimum tax, and the total tax liability without a global minimum tax is weakly lower than the total tax liability with a global minimum tax.

Lastly, on product pricing, the insurer solves the following profit-maximization problem:

$$\max_{Q_i} P(Q) \cdot Q_i - B(\tau_H, \tau_{Min})Q_i - C_i(Q_i) \tag{16}$$

The problem has the following first order condition:

$$\begin{aligned} P'(Q) + P - B - C_i'(Q_i) = 0, &\text{ and summing over all insurers } i \\ P'(Q)Q + NP - NB - N \cdot C_i'(Q_i) = 0& \end{aligned}$$

Totally differentiating with respect to B,

$$\begin{aligned} \frac{1}{N} \cdot P'' \cdot \frac{\partial Q_i}{\partial B} + \frac{1}{N} \cdot P' \cdot \frac{\partial Q_i}{\partial B} + P' \cdot \frac{\partial Q_i}{\partial B} - 1 - C_i'' \cdot \frac{\partial Q_i}{\partial B} &= 0 \\ \frac{\partial Q_i}{\partial B} &= \frac{N}{P' \cdot (\Theta + N + 1) - C_i'' \cdot N} \end{aligned}$$

where $\Theta(Q) = \frac{P''(Q)Q}{P'(Q)}$ denote the slope of the inverse demand function. Assuming $\Theta(Q) \geq -2$,

$$\frac{\partial P}{\partial B} = P' \cdot \frac{\partial Q_i}{\partial B} > 0$$

So $P_1 > P_0$.

B Product Price Indices Construction

In this section of the Online Appendix, I describe the methodology of how I construct the product price data.

The product price data comes from insurers' rate filing forms submitted to state regulators. Each rate filing contains the name of the insurer, the filing date, line of insurance, the state in which the rate change is requested, the amount of premiums affected, and the rate change as a percentage of the previous price.

Construct index

I construct the product price indices by computing a premiums-weighted average rate change for each insurance company in each line of insurance each year and then cumulatively multiplying the rate changes. Specifically, for insurer i, in line of insurance k, the premiums-weighted average rate change in year t is defined as the following:

$$RateChange_{i,k,t} = \frac{\sum_{j \in J} RateChangeFiling_{j,i,k,t} \cdot Premiums_{i,k,t}}{\sum_{j} Premiums_{i,k,t}} \tag{17}$$

Where the set J has $|J|$ number of elements and denotes the set of all rate filings made by insurer i in line of insurance k in year t. I also define an equal-weighted average rate change for each insurer-line-year as:

$$RateChange_{i,k,t} = \frac{1}{|J|} \sum_{j \in J} RateChangeFiling_{j,i,k,t} \tag{18}$$

I thus compute an annual price index for each insurer-line by cumulatively multiplying the rate changes as follows:

$$PriceIndex_{i,k,t} = \Pi_{y=2013,\ldots,2019}(1 + RateChange_{i,k,y}) \tag{19}$$

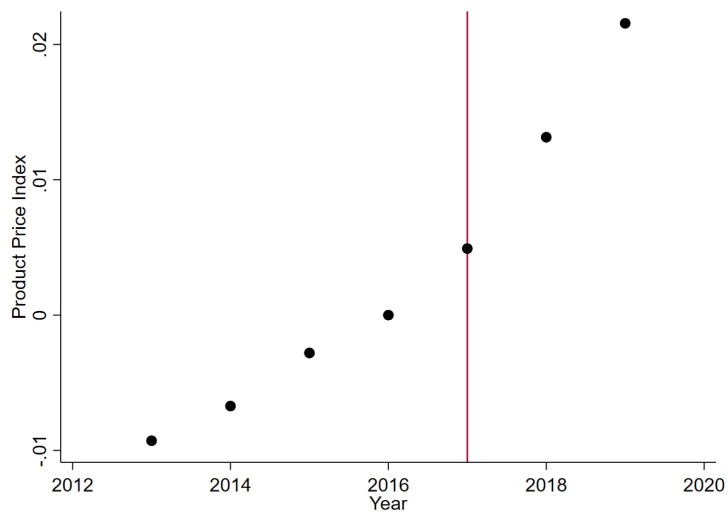
I then normalize 2016 prices for all insurer-lines to be 0 by dividing the price for each insurer-line in each year by its end-of-year 2016 price:

$$Price_{i,k,t} = \frac{PriceIndex_{i,k,t}}{PriceIndex_{i,k,2016}} - 1 \tag{20}$$

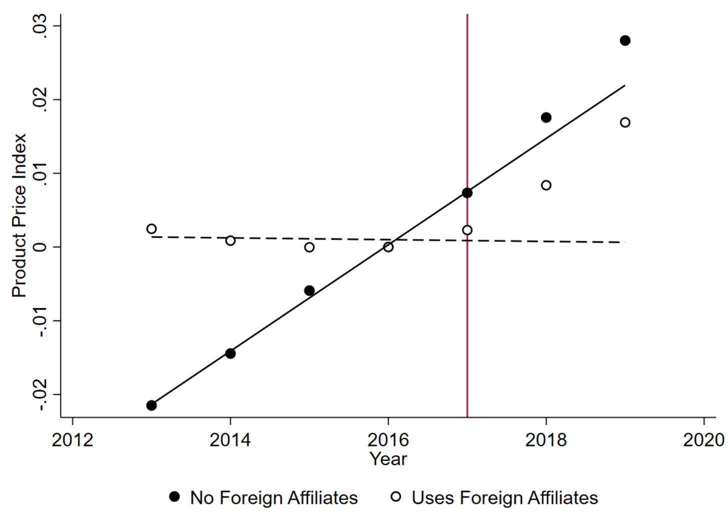
The prices can therefore be interpreted as the cumulative percent change relative to end-of-year 2016 prices.

C Additional Figures and Tables

Figure A1: Product Prices



(a) Aggregate P&C Product Price Index



(b) P&C Product Price Index, by Insurer Foreign Affiliate Use

Note: Figures A1a and A1b plot the time series of average product prices for all insurer-lines and by whether the insurer uses foreign affiliates or not, separately. Product Price Index is the premiums-weighted product price index constructed from the rate changes reported on insurers' statutory product rate filings, as described in Section 2, and are normalized to 0 in 2016 for all insurer-lines.

Table A1: Value of Risk-Sharing: Different Parameter Values

τ_{Min}	C'_F	P_D	V_1	V_0	V_1/NI_0	V_0/NI_0
0.05	0	0.44	2.70	3.05	4.25%	4.79%
0.05	0	0.72	3.88	4.17	6.11%	6.56%
0.05	0.07	0.44	2.22	2.56	3.48%	4.03%
0.05	0.07	0.72	3.48	3.77	5.47%	5.93%
0.10	0	0.44	2.35	3.05	3.70%	4.79%
0.10	0	0.72	3.59	4.17	5.65%	6.56%
0.10	0.07	0.44	1.87	2.56	2.94%	4.03%
0.10	0.07	0.72	3.19	3.77	5.01%	5.93%

Note: Table A1 reports the estimated value of increased risk sharing corresponding to eq. (8). τ_{Min} is the global minimum tax rate, where 0.05 corresponds to the 2018 BEAT rate and 0.10 corresponds to the 2019 BEAT rate. C'_F is the balance sheet cost. P_D is the price of reinsurance, where the values reported are the lowest and highest estimates reported in Weiss and Chung (2004). V denotes the total value of increased risk sharing estimates using the pre-BEAT parameter values (0) and the post-BEAT parameter values (1), respectively. NI denotes the total net income of the firms in the sample.

Table A2: Product Price Response to Global Minimum Tax: Heterogeneity by Line

VARIABLES	(1) Price	(2) Price	(3) Price	(4) Price	(5) Price
1(TCJA)	7.82***	5.86***	-1.50***	9.12***	1.24***
	(0.41)	(0.42)	(0.54)	(0.60)	(0.43)
1(FAR)	-0.99***	-0.75**	-0.88**	-2.08***	-0.80**
	(0.33)	(0.33)	(0.38)	(0.51)	(0.39)
1(TCJA) × 1(FAR)	1.54**	2.11***	2.72***	5.34***	1.06
	(0.70)	(0.71)	(0.85)	(1.01)	(0.70)
Observations	5,509	4,823	4,459	4,606	4,403
R-squared	0.272	0.196	0.006	0.262	0.017
Line	Personal Auto	Home	Liability	Commercial Auto	Property

Note: Table A2 reports the results corresponding to the linear regression in eq. (13) by product line. Observations are at the insurer-line-year level from 2013 to 2019. The dependent variable is the premiums-weighted product price index and is measured in percentage points. The independent variable $1(TCJA)$ is an indicator variable for whether the year is after 2017. $1(FAR)$ is an indicator variable for whether the insurer used foreign affiliates in 2017. Standard errors are clustered at the insurer level.

Table A3: Product Price Response to Global Minimum Tax: Equal-Weighted Premiums

VARIABLES	(1) Price	(2) Price	(3) Price	(4) Price
1(TCJA)	0.28	0.31		
	(0.21)	(0.21)		
1(FAR)	0.038	0.15	0.13***	0.24***
	(0.16)	(0.18)	(0.025)	(0.080)
1(TCJA) × 1(FAR)	0.60*	0.64**		
	(0.31)	(0.31)		
1(FAR) × 2013			-0.038	-0.013
			(0.38)	(0.38)
1(FAR) × 2014			-0.11	-0.11
			(0.21)	(0.21)
1(FAR) × 2015			-0.22*	-0.21*
			(0.11)	(0.12)
1(FAR) × 2017			0.27**	0.32**
			(0.12)	(0.13)
1(FAR) × 2018			0.44*	0.48*
			(0.24)	(0.24)
1(FAR) × 2019			0.81***	0.88***
			(0.31)	(0.32)
ln(Liabilities)		-0.010		-0.011
		(0.033)		(0.033)
Leverage		-3.29***		-3.36***
		(0.92)		(0.92)
Liquidity		-0.0039**		-0.0040**
		(0.0016)		(0.0016)
ROE		0.019***		0.017***
		(0.0055)		(0.0056)
Capital Ratio		-0.000068**		-0.000071***
		(0.000027)		(0.000027)
Observations	57,764	57,346	57,764	57,346
R-squared	0.012	0.013	0.013	0.014
Year FEs			X	X
Line FEs	X	X	X	X

Note: Table A3 reports the results corresponding to the linear regression in eq. (13) with equal-weighted product price indices. Observations are at the insurer-line-year level from 2013 to 2019. The dependent variable is the equal-weighted product price index and is measured in percentage points. The independent variable $1(TCJA)$ is an indicator variable for whether the year is after 2017. $1(FAR)$ is an indicator variable for whether the insurer used foreign affiliates in 2017. Standard errors are clustered at the insurer level.