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SAFETY SWITCHES:
THE MACROECONOMIC CONSEQUENCES OF TIME-VARYING ASSET SAFETY

by Andrea Foschi*

Abstract

I develop a model-based definition of time-varying sovereign bond safety and apply it empirically by constructing a news-based index, the flight-to-safety index (FLY), which measures global safe-asset demand. The FLY captures flight-to-safety episodes, the savings glut, and natural interest rate declines. Estimated FLY loadings allow the classification of bonds as safe, neutral, or risky. Post-Great-Recession, the global set of safe assets has shrunk, but the safety of US assets has increased. I detect regime switches in FLY loadings: positive switches (becoming safe) align with expansions, higher government spending, lower debt, and credit upgrades; negative switches (becoming risky) are associated with contractions, reduced spending, higher debt, and downgrades.

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I Introduction[1]

Safe assets are one of the cornerstones of the international financial system: they are the fundamental instrument through which a variety of economic agents can save, insure against adverse shocks, and store value during difficult times, while benefitting from the liquidity benefits and collateral value that holding these assets typically entails. Because of the central position safe assets have in the architecture of the world economy, the safety of an asset, be it true or perceived, is a phenomenon with far-reaching implications. At the world level, the increased hunger for safety caused by the global savings glut and the ensuing shortage of safe assets have contributed to lower interest rates and large imbalances, and remain a source of global economic fragility. At a country level, from the point of view of a government issuing sovereign debt, whether that debt is perceived as safe or risky is a crucial distinction: it can make the difference between favorable or adverse financial conditions, between having additional fiscal space for spending or being constrained in the ability to use fiscal policy, especially during crises. For all these reasons, safe assets are an important area of research that has received increasing attention over the last years. Thinking about these issues from an empirical perspective, however, requires some fundamental precondition: having a way to measure exactly when safe assets are in demand, and being able to tell what assets are safe at a given point in time. During flight-to-safety events, and if the set of safe assets changes, we should expect repercussions, both globally and at the level of the individual countries involved in the change. These are the questions that this paper is after: what is the set of global safe assets? Can we measure global demand demand for these safe assets precisely, and identify whether, at a business-cycle frequency, an asset that was considered safe can experience a "switch" and become risky, and vice versa? And do these *safety switches* have relevant macroeconomic consequences?

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The idea that the set of global safe assets can change over time is not new. At the beginning of the twentieth century, the UK was the global safe asset supplier, but it was replaced in that role by the US between the two World Wars. More recently, a number of European countries began to be treated as de facto safe after the creation of the euro, only to lose that status during the euro debt crisis. Meanwhile, in the US, the glut for safety stimulated the creation of private safe assets by financial intermediaries, ultimately generating a bubble that also burst during the crisis. Fast-forward to today, and discussions about the creation of a European safe asset have intensified, while the position of the US as the dominant global safe asset, though still undisputed, has begun to show what some might describe as cracks, such as the yield spikes that occurred during the Covid-19 dash for cash and the 2025 Trump tariff announcements. For all these reasons, an assessment of the macroeconomic implications of changes in asset safety is as relevant as ever.

Addressing these questions, I show that, over time, the perceived safety of an asset can exhibit short-to-medium-term fluctuations, and these fluctuations have significant real implications, especially for governments and their fiscal policy. To detect fluctuations in safety, I construct a text-based index from newspaper mentions, the FLY, to measure global demand for safe assets. The index picks up relevant flight-to-safety episodes and predicts declines in the natural interest rate. I then identify switches in a bond's safety, or "safety switches", through changes in the sign and significance of the correlation of its return with the FLY. I find that positive safety switches (i.e. becoming safe) are associated with expansions and increases in government spending, while negative switches (i.e. becoming risky) are associated with contractions and decreases in government spending. In addition, debt falls, its maturity shortens, and credit ratings improve after a positive switch; conversely, following a negative switch, debt grows, its maturity increases, and ratings deteriorate.

The paper begins by presenting a theoretical framework to explain the sources of an asset's safety and come up with a definition of safety that can be taken to the data. In the literature, a safe asset is generally defined as follows: it is an asset with low risk and high liquidity, used by investors to balance their portfolios and as collateral; because of these features, a safe asset will be particularly sought after during times of turmoil – namely, during flight-to-safety episodes. The model speaks to all the aspects of this definition, showing that the safety of a sovereign bond is driven by a combination of factors: country fundamentals, non-pecuniary benefits from holding the bond (which relate to the liquidity and collateral aspects of the definition), and the volatilities of idiosyncratic and country-specific risk (which relate to the low-risk and portfolio-balancing aspects of the definition). Because safety originates from this bundle of characteristics, which are potentially time-varying, safety is a time-varying phenomenon. In addition, because not all of these characteristics are perfectly observable in the data, measuring safety by relying only on some variables (such as convenience yields, which only capture the non-pecuniary benefits component of safety) can give a potentially incomplete picture. On the other hand, the model also points to a solution: the safety of an asset can be simply inferred from its correlation with global safe assets demand. This relates directly to the last aspect of the definition of safe assets mentioned above − namely, that they are sought after during flight-to-safety episodes.

Starting from this observation, the paper develops a two-step empirical procedure to identify which bonds markets consider safe at a given point in time. In the first step, I construct a novel index aimed exclusively at measuring global demand for safe assets. I call this the flight-to-safety index, or, more concisely, FLY. To construct the index, I build on the approach and methods of Baker, Bloom, and Davis (2016) and Hassan, Hollander, van Lent, and Tahoun (2019). I use academic papers related to safe assets and flights to safety to construct a library of safe-assets-related terms. I then count the articles in financial newspapers that mention these terms, weighted by their frequency in the library, to obtain the FLY. The FLY is one of the key contributions of the paper: it measures demand for safety on a continuum, and effectively captures important events that we would intuitively associate with flight-to-safety episodes, such as the Russian debt default, the subprime mortgage meltdown and financial crisis, the US debt downgrade, the European debt crisis, Brexit, and Covid, among others.

The FLY is correlated with the Chicago Board Options Exchange (CBOE) Volatility Index (VIX), but the correlation is low, and the FLY distinctly highlights dates that stand out less when looking at the VIX, such as the European debt crisis, Brexit, and the 2019 global bond rally. Moreover, the FLY exhibits a distinct positive trend starting in the 2000's, consistent with the global saving glut phenomenon: this is apparent when comparing the FLY with an estimate of R^*, and is confirmed by a VAR analysis that shows how innovations in the FLY foreshadow sizable declines in the natural interest rate.

In the second step of my empirical procedure, I estimate correlations (or, more precisely, loadings) of bond returns with the FLY index. I apply this procedure to a large dataset covering many sovereign bonds of several maturities from both advanced and emerging economies. I first estimate fixed loadings over the whole sample: this approach points to a plausible set of global safe assets. I then re-estimate the loadings by splitting the sample between before and after the global financial crisis: I show that, in the pre-crisis period, the set of global safe assets was larger, and the perceived safety of many countries was not statistically different from the one of the US; after the crisis, however, several countries lost their safe-asset status, and, even for those that retained it, their safety relative to the US eroded, so that American bonds fully emerged as the dominant global safe asset.

Extending the idea of time-varying safety, I then estimate a regime-switching model, and use it to identify switches in a bond's safety as changes in the sign and statistical significance of its loading on the FLY index. Following the reasoning outlined earlier, a bond will be safe if its returns are positively correlated with the FLY, risky if they are negatively correlated, and "neutral" if they are uncorrelated. Therefore, a positive switch happens when a bond becomes safe, i.e. its correlation with the FLY goes from negative or not significant to positive and significant. Conversely, a negative switch happens when a bond becomes risky, i.e. its correlation with the FLY goes from positive or not significant to negative and significant. I find that safety switches are frequent and fairly distributed over time and across countries.

Finally, I provide descriptive evidence on the macroeconomic dynamics associated with these switches. I find that positive switches (i.e. becoming safe) are associated with increases in government spending and economic expansions. On the other hand, negative switches (i.e. becoming risky) are associated with contractions and declines in government spending. Positive switches are also associated with a decrease in debt, and foreshadow credit rating increases, while negative switches are associated with an increase in debt and a lengthening of its maturity structure, and foreshadow credit downgrades.

The rest of the paper is structured as follows: the remainder of this section reviews the literature; section II presents a theoretical framework for thinking about safety that motivates the FLY index and the empirical methodology; section III describes the construction of the FLY index and evaluates its behavior over time and in comparison to the VIX and to natural interest rates; section IV shows the estimation of fixed factor loadings on the FLY and some facts about safe assets before and after the global financial crisis and the euro debt crisis; section V describes the identification of safety switches; section VI discusses the behavior of macroeconomic variables around switches; section VII concludes.

Related literature A rich and deep literature has analyzed many aspects of safe assets. One area of research has focused on understanding what exactly makes an asset "safe". For instance, on the theoretical side, He, Krishnamurthy, and Milbradt (2016b, 2019) show that fundamentals, investors' beliefs, and coordination play a role in determining what assets are safe. Brunnermeier, Merkel, and Sannikov (2022a) present a framework for thinking about safety as a feature of sovereign bonds emerging from the possibility of re-trading them dynamically to offset idiosyncratic shocks. On the empirical side, Habib, Stracca, and Venditti (2020) find that a limited set of fundamentals (related to inertia, institutional quality, and debt) are the key determinants of government yield movements in periods of high risk-aversion (measured by the VIX), and can therefore be thought of as safe asset fundamentals.

A number of papers have focused on exactly identifying which assets are safe, and on quantifying the convenience yields they carry. These include Gorton, Lewellen, and Metrick (2012), who analyze the behavior of the so-called safe-asset share, i.e. the share of US assets that are "safe"; Krishnamurthy and Vissing-Jørgensen (2012) and Christensen and Mirkov (2022), who quantify the convenience yield earned by US Treasuries and Swiss bonds respectively; Diamond and Van Tassel (2023), who extend the estimation of convenience yields to ten G-11 countries; and Cuevas (2023), who looks at convenience yields in emerging economies.

Another strand of the literature has studied the implications of safety for fiscal policy, debt, and macroeconomic conditions. Caballero and Farhi (2013, 2018), and Caballero, Farhi, and Gourinchas (2016a, 2017, 2021a) explore the important global macroeconomic consequences of a shortage of safe assets and present their implications for policy in a world at the zero lower bound. Gourinchas and Rey (2016) explore these issues with an eye to smaller economies and to the euro area. Zhengyang, Krishnamurthy, and Lustig (2018, 2021) explore the effects of the safety of US Treasuries on the dollar exchange rate. Van Binsbergen, Diamond, and Grotteria (2022) show that monetary policy reduces this convenience yield, especially in times of crisis. Brunnermeier et al. (2022a) explain how governments can extract seignorage revenues by taking advantage of the safe-asset status of their bonds. Aizenman, Cheung, and Qian (2019a) study how shortages of safe assets affect international reserves.

A common starting point in the literature described so far is the distinction between a set of assets that are always safe and a set of assets that are not. In such a setup, safety is therefore a largely cross-sectional phenomenon: some assets are safe, some are not, and these are essentially permanent features. Some exceptions include Christensen and Mirkov (2022), Diamond and Van Tassel (2023), and Cuevas (2023), who empirically estimate time-varying convenience yields for Switzerland and a number of other advanced and emerging economies, finding evidence of noticeable oscillations; Mota (2021), who focuses on US corporate bonds, showing that they provide a form of safety benefits and that variations in safety premia have an impact on investment decisions; Brunnermeier, Merkel, and Sannikov (2022b), who theoretically characterize the potential for gaining and losing the safe asset status as a transition between different equilibria in a framework where bond prices have a bubble term; and Pallara and Renne (2023, 2024), who estimate time-varying fiscal limits for a number of

European and OECD countries and use them to estimate sovereign credit risk premia and to price hypothetical and counterfactual Eurobonds.

My main contribution to the rich literature outlined above is a stronger focus on the time-varying dimension of safety. To do so, I use a tripartite classification, whereby each sovereign bond can be considered safe, neutral, or risky, depending on how its price correlates with the FLY. Safety switches happen when the bond moves from one category to another. To the best of my knowledge, this is the first work to present a methodology for identifying and characterizing safety switches systematically and consistently in a large panel of sovereign bonds. Similarly, to the best of my knowledge, this is also the first paper that empirically assesses the macroeconomic dynamics associated with these switches.

A separate literature has worked on measuring and identifying the global financial cycle, risk-on/risk-off events, and uncertainty shocks, as well as assessing their global implications. Some examples include the work of Akinci, Kalemli-Özcan, and Queralto (2022), Miranda-Agrippino and Rey (2021), and Kekrel and Lenel (2021). Some authors have given particular attention to the isolation and identification of flight-to-safety episodes specifically, for instance Baele, Bekaert, Inghelbrecht, and Wei (2020). My main contribution in this respect is the creation of the FLY index, which not only provides an independent indicator of flight-to-safety episodes, but also captures variations in demand for safety on a continuum, allowing the analysis to extend outside of the individual flight-to-safety events. The usefulness of the index is confirmed by the fact that it picks up relevant episodes, is consistent with the global savings glut, and it foreshadows declines in natural interest rates.

Finally, this work also relates to the many contributions in the use of text- and news-based data for measuring uncertainty, sentiment, economic activity. These include, among others, the measure of sentiment during recessions by García (2013); the Economic Policy Uncertainty (EPU) index by Baker et al. (2016); the Daily News Sentiment Index published by the Federal Reserve Bank of San Francisco, based on Shapiro, Sudhof, and Wilson (2020); and the local and global news sentiment indicators by Fraiberger, Lee, and Puy (2021). I follow a methodology similar to Hassan et al. (2019) to construct a library of terms related to safe assets that I can then search in newspapers, in order to construct an index aimed specifically at measuring demand for safe assets and flight-to-safety episodes.

II Theoretical framework

I present a theoretical framework with two main objectives in mind: explaining where the safety of an asset originates from, and come up with a definition of safety based on concepts and variables that can be measured empirically, directly or indirectly, so that it can be taken to the data. The model is a version of the one by Brunnermeier et al. (2022a), with two main extensions: I include time-varying utility benefits from holding safe bonds, and I expand the model to many countries with additional country-specific sources of risk.

The model has intentionally many ingredients, as the aim is not to fully solve it, but to derive analytical expressions that can point us to the drivers of time-varying demand for safety and how to use it to identify safe bonds. The first key ingredient is the presence of non-diversifiable idiosyncratic risk: this is one driver of the safety of bonds, because it makes them valuable as a way to insure against idiosyncratic shocks. The second key ingredient is the afore-mentioned time-varying utility of holding safe bonds: this is needed to generate convenience yields, which are another feature of safe assets that captures their attractiveness. The third key ingredient is non-diversifiable country-specific risk, which will negatively affect the safety of bonds and potentially make them behave as risky assets.

While having these many ingredients makes the model more complicated, it serves a few purposes. On the negative side, by pointing to many different potential drivers of safety, the model shows that measuring safety by individually relying on observable elements like convenience yields, the VIX, or fundamentals can give an incomplete picture: as the model will show, these variables are bundled together in determining safety, and relying on one of them without the others may not be the perfect approach. In addition, the model also suggests that measuring demand for safe assets directly in the data is quite difficult due to the many unobservable elements. On the positive side, however, the model shows that, if demand for safe assets can be measured at least indirectly, it can provide a more complete way of measuring safety in the data than relying on the individual variables mentioned above.

II.1 Setup

Time is continuous with an infinite horizon. There is a continuum of countries $j \in (0,1)$. In each country, there is a continuum of agents $i \in (0,1)$. To improve readability, I will always use i as a subscript and j as a superscript, so that x_{it}^{j} refers to the value of variable x for agent i in country j at time t. For bond variables, I will use two superscripts: the first identifies the country of the bond holder, and the second identified the country that issued the bond. Therefore, $b_{it}^{j,j'}$, for instance, denotes the holdings by agent i in country j of the bond issued by country j'.

II.1.1 Production

There is one consumption good, produced by each agent using a linear production technology $y_{it} = a_t k^j_{it}$. Productivity a_t is common across agents and countries, but capital is agent-specific. Each agent operates their own k^j_{it} by choosing investment ι^j_{it}. In addition, agents also face idiosyncratic capital quality shocks, $\tilde{\sigma}_t \mathrm{d}\widetilde{Z}^j_{it}$, where the tildes are used to denote the fact that the variables are idiosyncratic. Each agent's capital then evolves as

$$\frac{\mathrm{d}k^j_{it}}{k^j_{it}} = \Big(\Phi(\iota^j_{it}) - \delta\Big)\mathrm{d}t + \tilde{\sigma}_t \mathrm{d}\widetilde{Z}^j_{it} \ , \tag{1}$$

where $\Phi(\iota_{it}) = \frac{1}{\phi}\ln(1+\phi\iota_{it})$ is a function capturing capital adjustment costs and δ is the depreciation rate. The shocks follow an idiosyncratic Brownian motion $\widetilde{Z}^j_{it}$, but their volatility $\tilde{\sigma}_t$ is the same for all agents and all countries at each point in time. Note that this common global volatility is also potentially time-varying, and follows its own exogenous process.

II.1.2 Preferences

Following Krishnamurthy and Vissing-Jørgensen (2012), Di Tella (2020), and Mota (2021), among others, I assume that agents experience non-pecuniary benefits from holding safe assets.[2] More specifically, each bond j' is characterized by a certain degree of time-varying safety benefits, $v^{j'}_t$, so that holding an amount $b^{j,j'}_{it}$ provides an overall safety benefit of $v^{j'}_t \ln b^{j,j'}_{it}$. Utility is then given by

$$U^j_{i0} = \mathbb{E}\left[\int_0^\infty e^{-\rho t}\Big\{\ln c^j_{it} + \int_0^1 v^{j'}_t \ln b^{j,j'}_{it} \mathrm{d}j\Big\}\right] \ , \tag{2}$$

where ρ is the discount factor and c^j_{it} is consumption. The equilibrium will be expressed in terms of consumption as a fraction of net worth, $\hat{c}^j_{it} = \frac{c^j_{it}}{n^j_{it}}$, as this will be symmetric across

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[2] A safety premium can be generated by either having safety in the utility, as in this case, or by including a term associated with safety in the budget constraint. The former approach is the one used, for instance, by Krishnamurthy and Vissing-Jørgensen (2012), Di Tella (2020), and Mota (2021); it is similar to widely used money-in-the-utility formulations and can be interpreted as capturing non-pecuniary convenience benefits in the form of utility derived from holding safe assets. The latter approach is used, for instance, by Liu, Schmid, and Yaron (2019) and Choi, Kirpalani, and Perez (2022). If the safety term is on the left-hand side of the budget constraint, it can be interpreted as a measure of the transaction costs associated with bond trading, with safer bonds being more liquid and thus having lower transaction costs. If the term is on the right-hand side of the budget constraint, it can be seen as the pecuniary value of holding safe assets, associated, for example, to the possibility of using them as collateral to finance other investments. All these ways of introducing a safety premium vary in terms of their interpretation but generally lead to similar first-order conditions and implications.

all agents.

II.1.3 Government

A government in each country issues nominal sovereign bonds and taxes firms to fund government spending. The face value of outstanding nominal debt of country j is B^j_t, and the nominal interest paid by the bond is i^j_t. Both are exogenous. The face value in particular evolves according to an exogenous process, which is characterized by a growth rate $\mu^{B,j}_t$:

$$\frac{\mathrm{d}B^j_t}{B^j_t} = \mu^{B,j}_t \mathrm{d}t \ . \tag{3}$$

Real spending needs are also exogenous and given by $gK^j_t\mathrm{d}t$, where $K^j_t = \int k^j_{it}\mathrm{d}i$ is total capital in the country and g is a parameter relating spending to a fraction of that capital. The nominal government budget constraint is given by

$$i^j_t B^j_t + P^j_t g K^j_t = \mu^{B,j}_t B^j_t + P^j_t \tau^j_t a_t K^j_t \ , \tag{4}$$

where P^j_t is the price level. In other words, the government faces nominal liabilities in the form of nominal interest payments on existing debt and nominal government spending needs, and pays for them with new nominal debt issuance and taxes. Note that since i^j_t, g, and $\mu^{B,j}_t$ are exogenous, τ^j_t adjusts to balance the constraint.

II.1.4 Net worth

Agents can trade bonds from any country j', choosing a corresponding portfolio weight $\theta^{j,j'}_{it}$ for each. Crucially, however, there is a friction that makes risk sharing incomplete: agents face a "home-bias" constraint, so that they must hold a fraction $\hbar \in (0,1]$ of their bond investments in domestic bonds, resulting in exposure to country-specific risk that they cannot diversify. Effectively, agents are therefore going to choose how much to invest in their own domestic bonds, $\theta^{j,j}_{it}$, and how much to invest in a diversified portfolio of bonds from all countries, $\theta^{\bar{B},j}_{it}$. The home bias constraint can then be written as

$$\theta^{j,j}_{it} = \hbar(\theta^{j,j}_{it} + \theta^{\bar{B},j}_{it}) = \hbar \uptheta^j_{it} \ , \tag{5}$$

where $\uptheta^j_{it} = \theta^{j,j}_{it} + \theta^{B,j}_{it}$ is the total share of their wealth that agents invest in bonds, which equals the sum of the domestic bond investments and the diversified portfolio. As a result of the home-bias constraint, some of the country-specific risk faced by agents cannot be diversified.

Differently from bonds, agents can only trade capital within their country. More specifically, they can invest a fraction $\theta^{K,j}_{it}$ of their net worth n^j_{it} in their own capital, but they can also trade equity, by issuing claims $\theta^{E,j}_{it}$ on their capital and buying a diversified portfolio of claims on other agents' capital within the country. For capital, too, there is a fundamental friction that prevents perfect diversification: agents face a skin-in-the-game constraint, so that they have to retain ownership of a fraction $\chi \in (0,1]$ of their capital and thus they cannot issue equity claims on it. More specifically,

$$\theta^{E,j}_{it} \leq (1-\chi)\theta^{K,j}_{it} \ . \tag{6}$$

Similarly to the home-bias constraint, the skin-in-the-game constraint creates a situation where some of the idiosyncratic risk faced by agents cannot be diversified. The two non-diversifiable types of risk will create forces pushing the safety of bonds in opposite directions.

Agents earn a return from each of their investments: $\mathrm{d}r^{B,j}_t$ from their holdings of domestic bonds from their own country; $\mathrm{d}r^{\bar{B}}_t$ from their investment in the diversified bond portfolio; $\mathrm{d}r^{K,j}_{it}$ from their capital; $\mathrm{d}r^{E,j}_{it}$ from issuing equity; and $\mathrm{d}\bar{r}^{E,j}_t$ from investing in a diversified equity portfolio. Overall, each agent's net worth evolves according to their consumption and the returns that they earn on each of these investments, proportionally to the corresponding portfolio weights,[3]

$$\frac{\mathrm{d}n^j_{it}}{n^j_{it}} = -\frac{c^j_{it}}{n^j_{it}} + \theta^{j,j}_{it}\mathrm{d}r^{B,j}_t + \theta^{\bar{B},j}_{it}\mathrm{d}r^{\bar{B}}_t + \theta^{K,j}_{it}\mathrm{d}r^{K,j}_{it} - \theta^{E,j}_{it}\mathrm{d}r^{E,j}_{it} + \theta^{\bar{E},j}_{it}\mathrm{d}\bar{r}^{E,j}_t \ . \tag{7}$$

In addition, the portfolio weights must add up to 1:

$$\theta^{j,j}_{it} + \theta^{\bar{B},j}_{it} + \theta^{K,j}_{it} - \theta^{E,j}_{it} + \theta^{\bar{E},j}_{it} = 1 \ . \tag{8}$$

II.1.5 Exogenous processes

In addition to government debt, other exogenous variables include productivity, volatility of idiosyncratic risk, nominal interest rates, and convenience benefits. The processes for productivity, a_t, and for the volatility of idiosyncratic shocks, $\tilde{\sigma}_t$ (which can be related to the VIX), are assumed to take the form of generic Ito processes driven by the global Brownian

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[3] Note that $\theta^E_{it} > 0$: the negative sign in front of it makes it explicit that it represents an issuance.

motion Z_t:

$$\frac{\mathrm{d}a_t}{a_t} = \mu_t^a \mathrm{d}t + \sigma_t^a \mathrm{d}Z_t \ , \tag{9}$$

$$\frac{\mathrm{d}\tilde{\sigma}_t}{\tilde{\sigma}_t} = \mu_t^{\tilde{\sigma}} \mathrm{d}t + \sigma_t^{\tilde{\sigma}} \mathrm{d}Z_t \ . \tag{10}$$

Conversely, the nominal interest rate on each country's bonds, i_t^j, and the convenience benefits that it generates, v_t^j, are assumed to be driven by country-specific Brownian motions $\tilde{W}_t^j$:

$$\frac{\mathrm{d}i_t^j}{i_t^j} = \mu_t^{i,j} \mathrm{d}t + \tilde{\omega}_t^i \mathrm{d}\widetilde{W}_t^j \ , \tag{11}$$

$$\frac{\mathrm{d}v_t^j}{v_t^j} = \mu_t^{v,j} \mathrm{d}t + \tilde{\omega}_t^v \mathrm{d}\widetilde{W}_t^j \ . \tag{12}$$

Note the use of tildes, as in the case of the idiosyncratic Brownian motions for each agent's capital, $\widetilde{Z}_{it}^j$: like those shocks, the country-specific shocks are also idiosyncratic, but over countries instead of agents, and they will thus wash out in the diversified bond portfolio.

II.2 Prices and returns

The returns entering individuals' net worth process are driven by exogenous processes, fundamentals, and asset prices. Let $q_t^{K,j}$ denote the market price of capital in country j. For convenience, we will work with a scaled version of the real value of bond holdings, which expresses them as a fraction of capital in the issuing country:

$$q_t^{B,j'} = \frac{B_t^{j'}/P_t^{j'}}{K_t^{j'}} \ . \tag{13}$$

Before deriving processes for returns, we postulate generic Ito processes for capital and bond prices

$$\frac{\mathrm{d}q_t^{B,j'}}{q_t^{B,j'}} = \mu_t^{q^B,j'} \mathrm{d}t + \sigma_t^{q^B,j'} \mathrm{d}Z_t + \tilde{\omega}_t^{q^B} \mathrm{d}\widetilde{W}_t^{j'} \ ,$$

$$\frac{\mathrm{d}q_t^{K,j}}{q_t^{K,j}} = \mu_t^{q^K,j} \mathrm{d}t + \sigma_t^{q^K,j} \mathrm{d}Z_t \ .$$

Notice the price of capital only depends on global shocks, as idiosyncratic shocks wash out in the aggregate, but the price of bonds depends both on global and country-specific shocks.

We can now write the return on bonds issued by j' , which is going to be given by the interest it pays plus the change in the value of debt:

$$\begin{aligned} \mathrm{d}r_t^{B,j'} &= i_t^{j'}\mathrm{d}t + \frac{\mathrm{d}(1/P_t^{j'})}{1/P_t^{j'}} = i_t^{j'}\mathrm{d}t + \frac{\mathrm{d}(q_t^{B,j'}K_t^{j'}/B_t^{j'})}{q_t^{B,j'}K_t^{j'}/B_t^{j'}} \\ &= \Big[\Phi(\iota_{it}^{j'}) - \delta + \mu_t^{q^B,j'} - \check{\mu}_t^{B,j'}\Big]\mathrm{d}t + \sigma_t^{q^B,j'}\mathrm{d}Z_t + \tilde{\omega}_t^{q^B}\mathrm{d}\widetilde{W}_t^{j'} \ , \end{aligned} \tag{14}$$

where $\check{\mu}_t^{B,j'} = \mu_t^{B,j'} - i_t^{j'}$,the second equality uses (13), and the last equality uses Ito's Lemma. Investors can also invest in a diversified bond portfolio, with return

$$\mathrm{d}r_t^{\bar{B}} = \int \mathrm{d}r_t^{B,j'}\mathrm{d}j' \ . \tag{15}$$

For capital, the return is agent-specific and given by output net of taxes and investment, plus the change in the value of capital:

$$\begin{aligned} \mathrm{d}r_{it}^{K,j} &= \frac{(1-\tau_t^j)a_t - \iota_{it}^j}{q_t^{K,j}} + \frac{\mathrm{d}(q_t^{K,j}k_{it}^j)}{q_t^{K,j}k_{it}^j} \\ &= \left[\frac{(1-\tau_t^j)a_t - \iota_{it}^j}{q_t^{K,j}} + \Phi(\iota_{it}^j) - \delta + \mu_t^{q,K,j}\right]\mathrm{d}t + \sigma_t^{q^K,j}\mathrm{d}Z_t + \tilde{\sigma}_t\mathrm{d}\widetilde{Z}_{it} \ . \end{aligned} \tag{16}$$

As for equity claims, they are identical to capital in terms of risk, but potentially different in terms of expected return, which will be determined in equilibrium, due to the possibility of diversification

$$\mathrm{d}r_{it}^{E,j} = \mathbb{E}_t\big[\mathrm{d}r_{it}^{E,j}\big] + \sigma_t^{q^K,j}\mathrm{d}Z_t + \tilde{\sigma}_t\mathrm{d}\widetilde{Z}_{it} \ . \tag{17}$$

The return on the diversified equity portfolio is then given by

$$\mathrm{d}\bar{r}_t^{E,j} = \int \mathrm{d}r_{it}^{E,j}\mathrm{d}i \ . \tag{18}$$

II.3 Equilibrium

I define a symmetric competitive equilibrium. The equilibrium is symmetric across agents within each country, but not across countries, i.e. we can drop the i subscripts. Further assumptions can be made on the exogenous processes to also make it symmetric across countries, but I stick to the general case.

Definition 1 *A symmetric competitive equilibrium is a set of*

- *price processes* $\big\{q_t^{B,j}, q_t^{K,j}, \mathbb{E}_t\big[dr_{it}^{E,j}\big]\big\}_{t\geq 0,\ j\in(0,1)}$
- *consumption (as a share of net worth) and investment choices* $\big\{\hat{c}_t^j, \iota_t^j\big\}_{t\geq 0,\ j\in(0,1)}$

- *portfolio weights* $\left\{\theta_t^{j,j}, \theta_t^{\bar{B},j}, \theta_t^{K,j}, \theta_t^{E,j}, \theta_t^{\bar{E},j}\right\}_{t\geq 0,\ j\in(0,1)}$
- *taxes* $\left\{\tau_t^j\right\}_{t\geq 0,\ j\in(0,1)}$ *and aggregate capital* $\left\{K_t^j\right\}_{t\geq 0,\ j\in(0,1)}$

s.t., *given initial conditions and exogenous processes,*

- *aggregate capital obeys the LOM:* $dK_t^j = \left(\Phi_t^j(\iota_t^j) - \delta\right) dt \ \forall j$
- *taxes satisfy the government budget constraint:* $g_t^j K_t^j - \tau_t^j a_t K_t^j = \breve{\mu}_t^{B,j} q_t^{B,j} K_t^j \ \forall j$
- *consumption, investment, and portfolio weights max.* (2) $\forall i, j$ *with* $\mathbb{E}_t\left[dr_{it}^{E,j}\right] = \mathbb{E}_t\left[dr_t^{E,j}\right]$
- *goods markets clear:* $C_t^j + g_t^j K_t^j + \iota_t K_t^j = a_t K_t^j \ \forall j$
- *asset markets clear:* $\theta_t^{j,j} = \frac{q_t^{B,j} K_t^j}{N_t^j} \ \forall j; \ \theta_t^{K,j} = \frac{q_t^{Kj} K_t^j}{N_t^j} \ \forall j; \ \theta_t^{E,j} = \theta_t^{\bar{E},j} \ \forall j$

II.4 Bond prices and safe assets demand

First-order conditions and some algebra show that the price of a bond is given by

$$q_t^{B,j} = \theta_t^{j,j} \frac{1 + \phi(a_t - g)}{1 - \uptheta_t^j + \phi\rho} \ . \tag{19}$$

In other words, the price of the bond goes up in proportion to the demand for that bond by its domestic buyers, $\theta_t^{j,j}$. Since everyone else buys the bond as part of a perfectly diversified portfolio, the domestic buyers are the key drivers of demand due their home bias. What drives this demand in turn? Further derivations involving the first-order conditions for portfolio shares and various calculations with Ito's lemma lead to the following stochastic differential equation for the demand for a bond j:

$$\frac{\mathbb{E}_t[\mathrm{d}\theta_t^{j,j}]}{\theta_t^{j,j}} \frac{1+\hbar}{\hbar} = \frac{\rho}{1-\uptheta_t^j} + \breve{\mu}_t^{B,j}\left(1 + \frac{\hbar \uptheta_t^j}{1-\uptheta_t^j}\right) - (1-\uptheta_t^j)\chi^2\tilde{\sigma}_t^2 + (\uptheta_t^j)^2\hbar^2(\tilde{\omega}_t^{q^B})^2 - \frac{\rho v_t^j}{\hbar\uptheta_t^j} \ . \tag{20}$$

This equation cannot be solved analytically, but on its own it is informative enough for us, as it summarizes all the drivers of safe assets demand. The term on the left denotes the expected growth in the share of wealth invested in the asset, which is directly related to its demand. It can be read similarly to an expected return: in the same way a *lower* expected return implies a *higher* price today, similarly a *lower* expected growth in demand implies a *higher* demand right now.

What drives this demand? If idiosyncratic risk were absent ($\tilde{\sigma}_t = 0$) or perfectly diversifiable ($\chi = 0$), country-specific risk were absent ($\tilde{\omega}_t^{q^B} = 0$), and there were no convenience yields ($v_t^j = 0$), then demand would be driven only by debt growth net of interest payments. However, the presence of all these additional terms means that demand deviates from that baseline.[4] Two of the variables make bonds more desirable, boosting their safety: the presence of idiosyncratic capital risk makes bonds desirable because agents can buy them to insure against idiosyncratic shocks, with the possibility of liquidating them if needed; the presence of convenience yields means that agents receive non-pecuniary benefits from holding bonds, which generates an additional safety motive. The other variable makes bonds less desirable: the bonds' exposures to their own country-specific risk decreases their safety and makes them risky, which reduces their attractiveness. Whether a bond is safe or risky overall depends on the relative magnitudes of these terms. It seems natural, then, to use these quantities to define safety.

II.5 Defining safety

In light of (20) and its implications, let

$$\mathcal{S}_t^j = (1-\theta_t^j)^2\chi^2\tilde{\sigma}_t^2 - (\theta_t^j)^2\hbar^2(\tilde{\omega}_t^{q^B})^2 + \frac{\rho \upsilon_t^j}{\hbar\theta_t^j}\ . \tag{21}$$

This is the key quantity determining whether a bond is safe or risky relative to a baseline where all the causes of safety and riskiness (convenience yields and idiosyncratic, aggregate, and country-specific risk) are absent. When $\mathcal{S}_t^j$ is positive, one can think of it as the "safety boost" in demand a bond experiences; conversely, it turns into a "riskiness drag" when it is negative. I therefore adopt the following definition

Definition 2

$$\textit{A bond}\ \mathrm{j}\ \textit{is} \begin{cases} \text{safe} & \textit{if} \quad \mathcal{S}_t^j > 0\ , \\ \text{neutral} & \textit{if} \quad \mathcal{S}_t^j = 0\ , \\ \text{risky} & \textit{if} \quad \mathcal{S}_t^j < 0\ . \end{cases}$$

Note that safety is a time-varying phenomenon in this setup: a bond can switch between categories depending on how $\mathcal{S}_t^j$ moves.

A problem that immediately arises is that this definition is not easily applicable in the data. The volatility of idiosyncratic risk can be mapped into the VIX, and the convenience yields can be measured using corporate bonds, but it would be misleading to rely only on them as we do not know the portfolio weights and the aggregate and country-specific risk terms. At this point, prices can be helpful. The $\mathcal{S}_t^j$ term maps directly into a premium when

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[4] Note that, without home bias ($\hbar = 0$), everyone in every country would just hold the diversified bond portfolio, which would perfectly insure from both idiosyncratic risk and country-specific risk.

it is positive, and into a discount when it is negative. Since returns are observable, we can then use them to identify safe assets: an asset would be safe if its price goes up because $\mathcal{S}_t^j > 0$, risky if its price goes down because $\mathcal{S}_t^j < 0$, and neutral otherwise. However, this would still require observing $\mathcal{S}_t^j$ at the individual asset level. We could look at the behavior of $\breve{\mu}_t^{B,j}$, but in reality there might be other factors driving prices, especially at high frequency, so that would not be sufficient.

While relying on the value of $\mathcal{S}_t^j$ cannot help us, switching to an aggregate can: even if it cannot be measured directly, a global aggregate could be measured indirectly in the data through proxies. I therefore define global demand for safe assets as an aggregate of the global demand for all assets with a positive $\mathcal{S}_t^j$.

Definition 3 *The share of global wealth invested in safe assets, θ_t^S, is the sum of all global portfolio shares allocated to bonds with a positive $\mathcal{S}_t^j$, weighted by the wealth of the corresponding country relative to the world, i.e.*

$$\theta_t^S = \int \frac{N_t^j}{N_t} \theta_t^{j,j} \cdot \mathbb{1}_{\{\mathcal{S}_t^j \geq 0\}} \mathrm{d}j \ .$$

Here, $N_t^j = \int n_{it}^j \mathrm{d}j$ and $N_t = \int N_t^j \mathrm{d}j$. This object is directly related to demand for safe assets in equilibrium. Now, whenever a bond is safe, changes in demand for that bond will be counted as part of the change in θ_t^S. Conversely, whenever a bond is risky, it will be counted as part of $\theta_t^T - \theta_t^S$, where $\theta_t^T = \int \frac{N_t^j}{N_t} \theta_t^{j,j} \mathrm{d}j$ is the total share of global wealth invested in all bonds. We can then look at the behavior of bond prices in relation to this aggregate quantity to identify safe and risky bonds.

Definition 4 *A bond* j *is* safe *if its price (realized return) is positively correlated with global demand for safe assets, i.e.*

$$\beta_t^{r^{B,j},\theta^S} = \frac{\mathbb{C}\mathrm{ov}\left(\frac{\mathrm{d}r_t^{B,j}}{r_t^{B,j}}, \frac{\mathrm{d}\theta_t^S}{\theta_t^S}\right)}{\mathbb{V}\left[\frac{\mathrm{d}\theta_t^S}{\theta_t^S}\right]} > 0 \ .$$

Similarly, a bond j *is* risky *if its price (realized return) is negatively correlated with global demand for safe assets, i.e.*

$$\beta_t^{r^{B,j},\theta^S} = \frac{\mathbb{C}\mathrm{ov}\left(\frac{\mathrm{d}r_t^{B,j}}{r_t^{B,j}}, \frac{\mathrm{d}\theta_t^S}{\theta_t^S}\right)}{\mathbb{V}\left[\frac{\mathrm{d}\theta_t^S}{\theta_t^S}\right]} < 0 \ .$$

Lastly, a bond j *is* neutral *if its price (realized return) is uncorrelated with global demand for safe assets, i.e.*

$$\beta_t^{r^{B,j},\theta^S} = \frac{\mathbb{C}\text{ov}\left(\frac{\mathrm{d}r_t^{B,j}}{r_t^{B,j}}, \frac{\mathrm{d}\theta_t^S}{\theta_t^S}\right)}{\mathbb{V}\left[\frac{\mathrm{d}\theta_t^S}{\theta_t^S}\right]} = 0 \ .$$

This is the most intuitive definition one can think of: an asset is safe if it behaves as a safe asset, i.e. it is sought after when investors are looking for safety, and thus its price increases – or, in other words, its price goes up during flight-to-safety episodes. It is a pragmatic and operational definition that has the advantage of finally relating safety to two variables that can be observed in the data: prices (or returns) can be observed directly; global demand for safe assets is hard to measure directly as defined in the model, given the number of unobservables needed to compute it, but it can be measured indirectly in an effective way by constructing an index that tracks investor demand for safe assets through news. This will be the objective of the next section.

Note that I have used a beta notation for the definition: this is to prepare the ground for bringing the definition to the data. Of course, $\beta_t^{r^{B,j},\theta^S}$ has the same sign as $\mathbb{C}\text{ov}\left(\frac{\mathrm{d}r_t^{B,j}}{r_t^{B,j}}, \frac{\mathrm{d}\theta_t^S}{\theta_t^S}\right)$, but it has a more immediate interpretation as a factor loading of the kind that are usually estimated by time-series regressions of returns on factors in empirical asset pricing. Indeed, $\beta_t^{r^{B,j},\theta^S}$ will be interpretable as a "beta" in those terms, and will be estimated from a similar setup.

This definition of safety does not exactly coincide with the one given by Brunnermeier et al. (2022a): in their paper, an asset is defined as safe if it is a "good friend", i.e. it serves as a safe haven after adverse aggregate shocks. In practice, this means that the relevant covariance is the one between the bond's return and an individual's (or an aggregate) stochastic discount factor. Such a definition is also very intuitive, and points directly at the key feature that we typically associate with safe assets. However, it comes with some caveats. First, it relies on the assumption that the volatility of idiosyncratic risk is countercyclical, i.e. it goes up in recessions and falls in expansions. While this is a reasonable and realistic assumption, it also abstracts away from the possibility that idiosyncratic risk can rise "in the background" in normal times as well. An example of this might be the 2019 bond rally: this was a period were investors started hoarding safe bonds while the stock market was doing well and general economic conditions were stable. I will touch upon this event again later in the paper. For the moment, the bond rally is an example of a kind of flight-to-safety episode that occurred outside of a recessionary period. If investors seek safe assets outside of recessions, we want to use that information to identify which assets are safe, but a definition based on the assumption of countercyclical idiosyncratic risk is not able to pick that up. In any case, assuming countercyclical idiosyncratic risk in the model, global demand for safe assets always rises in recessions, so that definition 4 and the good-friend definition lead to the same conclusion.

A second, related caveat is that the good friend definition relies on the volatility of idiosyncratic risk as a driver of safety. As all bonds are characterized by their capability of protecting agents against idiosyncratic capital risk, this definition would have a harder time capturing differences in safety between different bonds in a model with many countries as in this case. The introduction of heterogeneous convenience benefits from holding different bonds would help in that respect, but would likely still require an assumption about their countercyclicality to fit the good-friend definition. Given these consideration, I choose to define safety based on the covariance of bond prices with global demand for safe assets, instead of the covariance with the stochastic discount factor, because it is, arguably, equally intuitive, but more flexible in terms of accommodating heterogeneity and information about safety coming from non-recessionary periods; moreover, global demand for safe assets can be measured indirectly in the data independently from prices, while this is harder to do for the stochastic discount factor.

II.6 Takeaways from the model

We can summarize the takeaway from the model in three points

1. the safety of an asset depends on its fundamentals, the volatility of idiosyncratic risk, exposure to aggregate and country-specific risk, convenience benefits, and exogenous shocks, inasmuch as these enter the processes driving all the previous factors;
2. the safety of an asset can vary over time;
3. the safety of an asset can be identified from its correlation with global safe assets demand.

The first and second takeaway will help us in setting up and putting structure on the empirical framework that will be used to identify safety switches in the data. Before we can do that, however, we have to deal with the third takeaway: we need a way to measure global safe assets demand. The model suggests that this is hard, if not impossible, to do directly, due to all the unobservable variables involved. However, it is possible to measure it indirectly, through news. This will be the focus of the next section.

III The FLY index

I use newspaper articles to construct a FLight-to-safetY index, or, more concisely, FLY, aimed at measuring changes in demand for safe assets. News are a natural way of measuring demand for safe assets since, generally, whenever there is a flight-to-safety episode or an increased desire for safe assets, financial media will pick it up and mention it in the news, with little to no delay. The construction of the index requires two steps. First, one needs to come up with a library of terms related to safe assets: these must be terms that are specific enough to discussions about safe assets that they are likely to appear distinctively in financial media when demand for safety rises. Then, the actual search happens: the terms are searched one by one, the number of articles that mention them are counted, and the results are aggregated into the index. Finally, we can assess how the index performs relative to other existing measures.

III.1 Libraries

I consider two safe-assets libraries, and therefore come up with two versions of the index. The first library, which I call the benchmark or simple library $\mathscr{L}^0$, is simply a set of bigrams that I hand-pick because they are intuitively related to safe assets and flight to safety:

$$\mathscr{L}^0 = \{\text{“safe asset”},\ \text{“flight safety”},\ \text{“flight quality”}\}\ .$$

The second library, which I call the full library $\mathscr{L}$, is constructed as follows. To create a list of relevant terms related to safe assets, I first download all working papers from the National Bureau of Economic Research (NBER) that contain terms from the simple library $\mathscr{L}^0$ in their abstract.[5] I did not look for mentions of those terms in the title only, since I consider that too restrictive (a paper might well be related to safe assets without mentioning them in the title); similarly, I did not look for mentions in the full body of the paper, since that would have been too loose (a paper might well be about an entirely different topic but might briefly mention an application to safe assets). I chose to look at NBER working papers because they have a consistent format, they are freely accessible, they reflect a large variety of fields, and they include unpublished work that nonetheless can contain relevant vocabulary related to safe assets.

I end up with a total of 56 papers, which are listed in Table A1 in the appendix. I take the main body of each paper and merge them all together into a single document; I remove

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[5] I did this in November 2021, so I do not account for new papers that were added since then.

headers, footers, and numbers; and I tokenize the text, lemmatize and stem the words, and erase punctuation and stop words. I then create a list of all the bigrams that are present in the document. I manually remove from the list all those bigrams that are evidently very common in economic research but are not useful for newspaper searches (for instance, "euler equation" or "statistically significant").

I thus end up with a temporary safe-assets library $\widetilde{\mathscr{L}} = \{b_k\}$, consisting of a list of all the bigrams from the selected 56 NBER papers. Each bigram b_k is characterized by its count, $n_k(\widetilde{\mathscr{L}})$, defined as the number of times the bigram b_k appears in the NBER papers. Denoting by $N(\widetilde{\mathscr{L}})$ the total number of bigrams contained in the NBER papers, one can also define the relative frequency of each bigram $f_k(\widetilde{\mathscr{L}}) = n_k(\widetilde{\mathscr{L}})/N(\widetilde{\mathscr{L}})$.

To construct the final library $\mathscr{L}$, an extra step is required. I carry out the exact same textual analysis on the eighth edition of Greg Mankiw's *Principles of Economics* (Mankiw, 2017),[6] thus creating another library of bigrams, $\mathscr{L}^{econ} = \{b_k\}$, each characterized by its count in the book $n_k(\mathscr{L}^{econ})$. The total number of bigrams in Mankiw's book is given by $N(\mathscr{L}^{econ})$. I call this the economic library, and, due to the introductory but detailed nature of the book and its coverage of many topics, I take it as a benchmark of the vocabulary used in economics and of the prevalence of different terms in economic discourse. The top 100 bigrams in the economics library are summarized in the wordcloud in Fig. B1 in the appendix.

The purpose of the economic library is to help identify which bigrams in the 56 NBER papers appear often because they are really strongly related to safe assets, as opposed to those that appear often because they are simply very common in the economic vocabulary. For instance, a top bigram in the NBER papers would be "interest rate"; however, the appearance of such a bigram in a newspaper article would hardly be informative about a flight-to-safety episode, given how generally ubiquitous the bigram is in economics.

To construct my final full safe-assets library, I therefore weigh the frequency of bigrams from the NBER papers based on their prevalence in Mankiw's book as follows:

$$f_k^{weight} = f_k(\widetilde{\mathscr{L}})\ \frac{N(\mathscr{L}^{econ})}{1 + n_k(\mathscr{L}^{econ})}\ .$$

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[6] I choose the eighth edition of Mankiw's textbook because it is a more recent version of a textbook that has been around since 1997 and has been widely used to teach introductory economics since then. As such, the book hopefully contains a widely representative synthesis of the general vocabulary, lexicon, and jargon used in economics in the last 25 years – the same years that constitute a majority of my sample. As a university textbook, its language should be specialized enough that it is entirely specific to economics, but given its introductory nature, it should also be representative of economic terminology used by the general population and more specifically by financial newspapers.

This works as a kind of signal-to-noise ratio: bigrams that are rare in Mankiw's book but prevalent in the NBER papers receive a higher weight, as they are likely the most informative about flight-to-safety. Lastly, I keep the bigrams with the 100 largest frequencies:[7]

$$\mathscr{L} = \left\{ b_k \;\middle|\; rank(f_k^{weight}) \leq 100 \right\} \; ,$$

and I renormalize the frequencies accordingly

$$f_k(\mathscr{L}) = \frac{f_k^{weight}}{\sum_{k=1}^{100} f_k^{weight}} \; .$$

The resulting bigrams are listed in Table A2 and summarized by the word cloud in Fig. 1.

Figure 1: Wordcloud summarizing the relative importance of the bigrams in the full safe-assets library

Note: The figure shows the list of 100 bigrams that form the full safe-assets library, $\mathscr{L}$; the size of each bigram k is proportional to its frequency $f_k(\mathscr{L})$; the construction of the library and frequencies is described in section III.1; the list of bigrams can also be found in Table A2.

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[7] The decision to focus on the first 100 bigrams is due to constraints in actually searching for mentions on Factiva, which is very time consuming. Arguably, however, focusing on the top 100 bigrams is not a problem, since the remaining terms have relative frequencies of less than 0.025% and their contribution to the index would be negligible.

III.2 Search

I search for mentions of the bigrams in the Financial Times and The Wall Street Journal. Due to their coverage and circulation, these two newspapers should arguably capture all global flight-to-safety episodes. Since I search for mentions through Factiva and I do not have direct access to the full underlying text of all the articles, I manually carry out a reverse-stemming and reverse-lemmatizing procedure to account for relevant variations of each bigram. For instance, in the case of the bigram "safe asset", I adjust the search to account for variations such as "safe assets", "safer asset", "safer assets", "safest asset", "safest assets". In the case of a bigram like "flight safety", instead, I account for all conjugations of the verb "fly".[8] Finally, I ensure the search accounts for occurrences of the two elements of each bigram appearing within three words from each other. Therefore, when searching for the bigram "flight safety" I also find all articles containing "flight to safety" (or any other word other than "to" in between); the same is true for all the variations of the bigram (e.g. "fly safety", "flying safety", etc.).

For each bigram b_k from either the simple or the full library, the result of the search is the daily count of articles that contain the terms of the bigram or their variations within three words of each other. Let A_{kt} be the set of all articles a_t published in day t that mention bigram k, i.e.

$$A_{kt} = \left\{ a_t \mid b_k \in a_t \right\} .$$

In the case of the simple library, all bigrams are equally weighted, so the total number of relevant mentions in a day is simply the total number of articles that mention any of the bigrams, avoiding repetitions:

$$M_t^0 = \left| \bigcup_{k | b_k \in \mathscr{L}^0} A_{kt} \right| ,$$

where the notations $\bigcup$ and $\left| \cdot \right|$ refer to union and cardinality, respectively. In the case of the full library, instead, articles that mention more frequent terms should receive a higher

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[8] I decide not to use the wildcard search function available in Factiva to avoid including unrelated terms in the mentions count. For instance, in the above example, searching for both "flight" and "flying" would require using the notation "fl?*" in Factiva: these would allow for the the presence of both "i" and "y" in the third character and would account for different word endings. However, this would obviously also capture a myriad other unrelated words, such as "flow", "flag", "floor", or "Florida". Similarly, using "saf*" to search for "safe", "safer", and "safest" would also capture words like "safari". This could dramatically contaminate the results. For consistency, I then stick to manually accounting for word variants also with bigrams for which the wildcard search would plausibly work without such risks.

weight, so the total number of mentions is a frequency-weighted sum:

$$M_t = \sum_{k|b_k \in \mathscr{L}} f_k(\mathscr{L}) \big| A_{kt} \big| ,$$

where $\big| \cdot \big|$ again denotes cardinality. Note repeated articles are included in this case because they receive different weights each time they are counted.

I finally normalize the number of mentions by the total number of articles published in the corresponding period

$$m_t^0 = \frac{M_t^0}{\text{total \# of articles}_t} ,$$

$$m_t = \frac{M_t}{\text{total \# of articles}_t} ,$$

and lastly standardize these measures to obtain the simple and the full FLY indices

$$FLY_t^0 = 100 \cdot \frac{m_t^0 - \overline{m}^0}{\sigma(m_t^0)} ,$$

$$FLY_t = 100 \cdot \frac{m_t - \overline{m}}{\sigma(m_t)} .$$

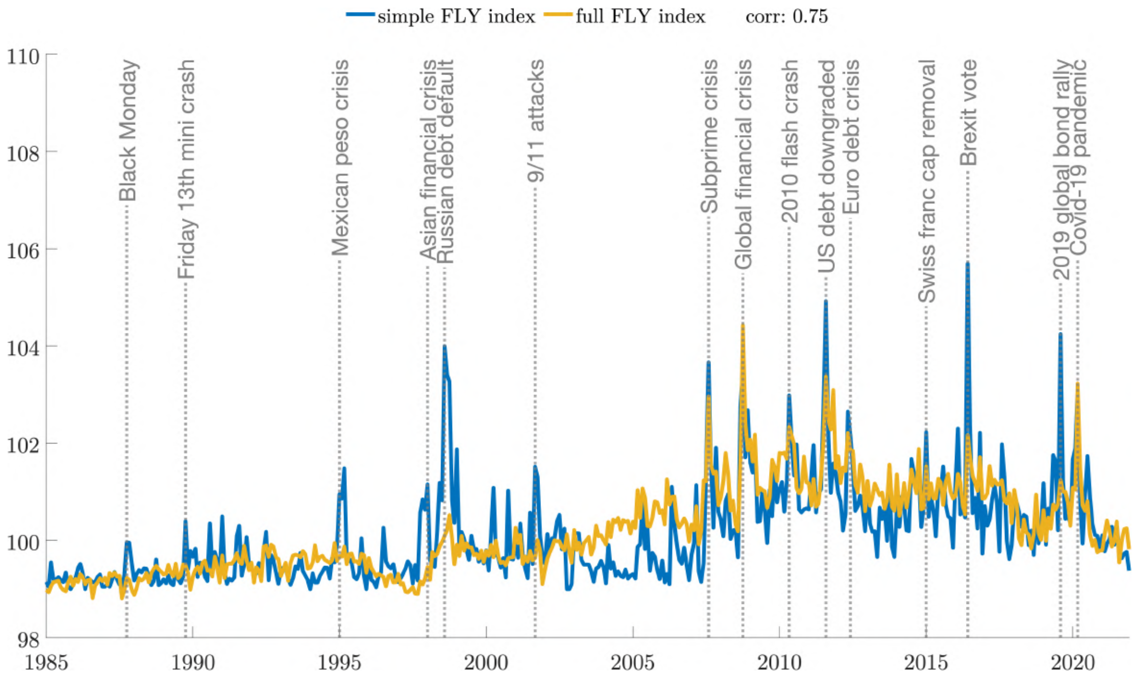
Monthly and quarterly versions of the indices are constructed in the exact same way, simply letting t denote a month or quarter instead of a day.

III.3 Evaluating the index

The resulting monthly versions of the indices constructed according to the above procedure are shown in Fig. 2. As the figure shows, the indices exhibit a considerable degree of variation and do a good job at capturing important events that we would intuitively associate with flight-to-safety episodes. The indices are correlated, as expected, though the simple version of the index exhibits somewhat more pronounced spikes, due to its sensitivity to fewer key terms compared to the full index. Both indices spike at the Russian debt default, the subprime mortgage meltdown and financial crisis, the US debt downgrade, the European debt crisis, Brexit, and Covid, among other events.

Importantly, not all these events, which we can associate with flight-to-safety episodes, were accompanied by market downturns. Cases in points include the Swiss central bank's removal of its cap on the franc and the global bond rally that occurred in 2019. This confirms the importance of measuring demand for safety separately from market returns. Moreover, the indices distinctly capture or give different emphasis to dates that stand out less when looking at the Chicago Board Options Exchange (CBOE) Volatility Index (VIX), which is traditionally the variable of choice when looking at uncertainty and demand for safe assets. Indeed, while both FLY indices are correlated with the VIX, that correlation is relatively low. Understandably, being a measure of expected volatility in the US stock market, the VIX largely misses or gives little importance to events like the the European debt crisis, Brexit, and the 2019 global bond rally, but also the initial subprime meltdown that preceded the financial crisis. Furthermore, through the lens of the model, we can think back to the volatility of idiosyncratic risk, $\tilde{\sigma}_t$, and to the global demand for safe assets, θ_t^S: the VIX maps into the former, while the FLY maps into the latter. The model suggests that $\tilde{\sigma}_t$ is a key driver of θ_t^S, but not the only one: this is consistent with what the plots show for the VIX and the FLY.[9]

Figure 2: Simple FLY index and Full FLY index comparison, with highlighted relevant events



Note: the figure plots the simple version of the FLY index, based on the simple safe assets library $\mathscr{L}^0$, and the full version of the FLY index, based on the full safe assets library $\mathscr{L}$; vertical lines highlight major global events that coincide with spikes in the indices; details on the construction of the FLY are described in section III.1; the correlation between the two versions of the index is shown at the top of the graph; the frequency is monthly.

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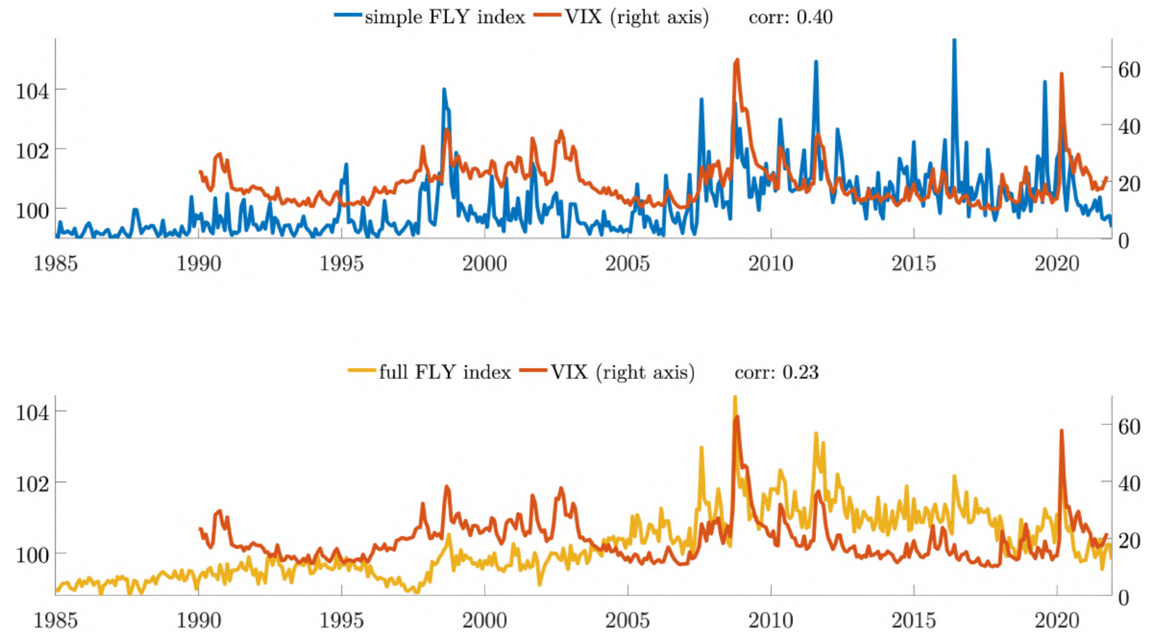
[9] Additional figures in the appendix (Figg. B2-B6) provide further comparisons of the two FLY indices with the Economic Policy Uncertainty (EPU) index by Baker et al. (2016), the Global Financial Factor (GFF) computed by Miranda-Agrippino and Rey (2021), and the price of gold.

Another feature that the FLY indices exhibit and that the VIX does not capture is a distinct positive trend starting in the 2000's. This is consistent with the global saving glut phenomenon, whereby the global supply of savings increased considerably starting around 2003, and correspondingly the demand for safe assets also got permanently higher. The ability of the FLY index to capture this trend makes it potentially useful to also think about other phenomena related to the global savings glut, such as the decline in global interest rates. This is apparent, for instance, when comparing the indices against an estimate of R^* for the United States, as shown in Fig. 4. For these reasons, I will focus my main analysis on the post-2003 period, where safe-assets dynamics are expected to be particularly relevant due to the global savings glut, and I will then compare this with the pre-2003 period.

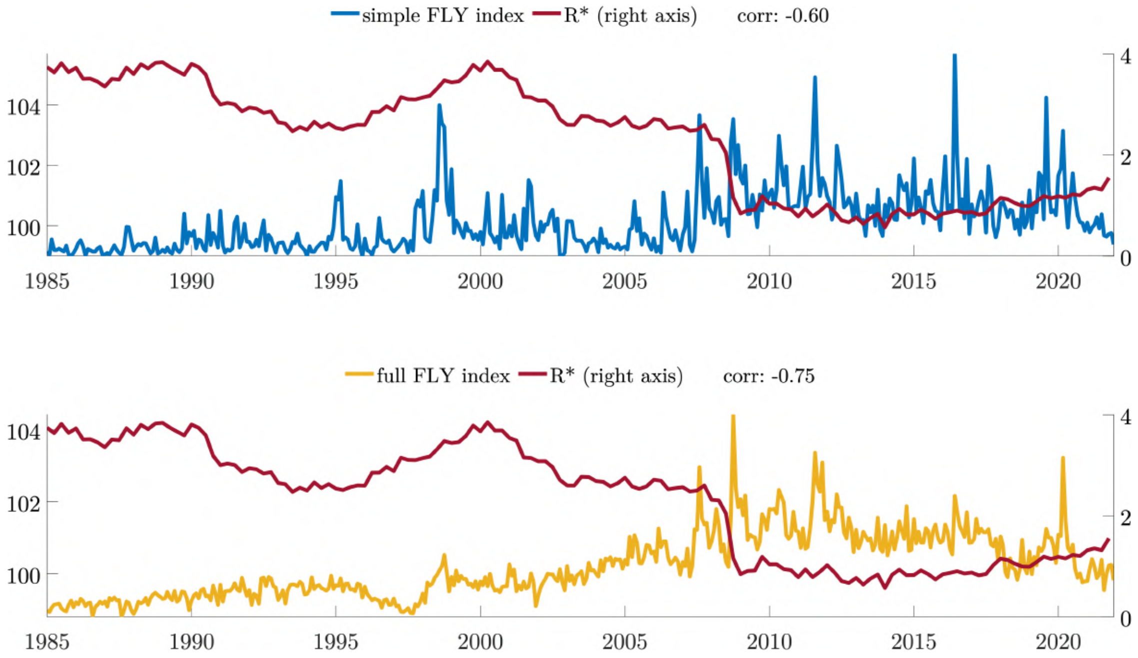
Figure 3: Simple FLY index and Full FLY index compared with the VIX



Note: the figure plots the simple version of the FLY index, based on the simple safe assets library $\mathscr{L}^0$, and the full version of the FLY index, based on the full safe assets library $\mathscr{L}$, and compares each of them to the VIX (with units on the right axis); details on the construction of the FLY are described in section III.1; the VIX is from the CBOE; the correlation between each version of the index and the VIX is shown at the top of each graph; the frequency is monthly.

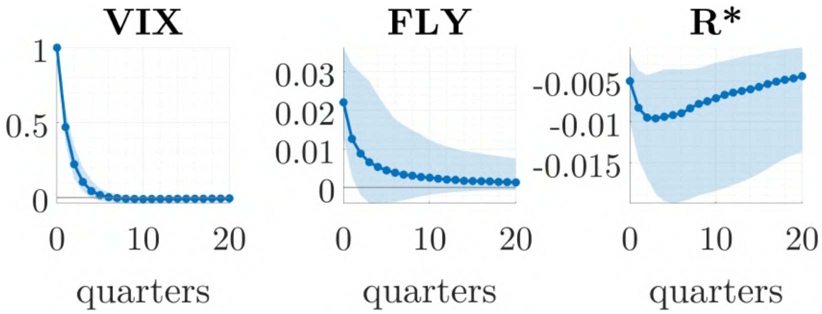
To further investigate the relationship of the FLY to the VIX and to natural interest rates, I use a VAR with the full FLY index, the VIX, and the estimate of R^* for the US plotted above. Specifically, we want to better assess two ideas: first, that the VIX is one of the components driving the FLY, but does not fully explain its fluctuations; and second, that the FLY can capture phenomena like the global savings glut, and generally that the hunger for safe assets that it measures can be associated with declines in natural interest rates. For this reason, I use the following ordering for the VAR: VIX first, FLY second, and R^* last. I then plot impulse responses to innovations in the VIX and the FLY, identified via Cholesky decomposition. The results are plotted in Figg. 5-6.

Figure 4: Simple FLY index and Full FLY index compared with R^*



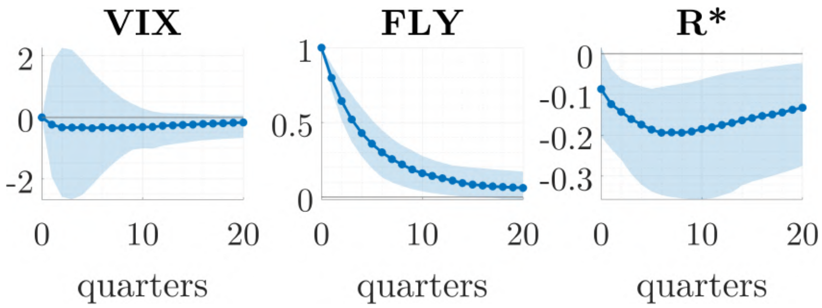
Note: the figure plots the simple version of the FLY index, based on the simple safe assets library $\mathscr{L}^0$, and the full version of the FLY index, based on the full safe assets library $\mathscr{L}$, and compares each of them to an estimate of R^* (in %, with units on the right axis); details on the construction of the FLY are described in section III.1; the estimate of R^* is from Holston, Laubach, and Williams (2023); the correlation between each version of the index and R^* is shown at the top of each graph; the frequency is monthly.

Figure 5: Impulse responses to a VIX innovation



Note: the figure plots the impulse response functions in response to an orthogonalized VIX shock, obtained via Cholesky decomposition in a VAR with VIX, FLY, and R^*, in that ordering; the lag is 1 and was selected according to the Akaike information criterion; shaded areas denote 90% confidence intervals; the VIX is from the CBOE; the estimate of R^* is from Holston et al. (2023).

Figure 6: Impulse responses to a FLY innovation



Note: the figure plots the impulse response functions in response to an orthogonalized FLY shock, obtained via Cholesky decomposition in a VAR with VIX, FLY, and R^*, in that ordering; the lag is 1 and was selected according to the Akaike information criterion; shaded areas denote 90% confidence intervals; the VIX is from the CBOE; the estimate of R^* is from Holston et al. (2023).

The results corroborate both stories. As Fig. 5 shows, an innovation in the VIX foreshadows both an increase in the FLY and a decline in R^*: this makes sense, as it suggests an increase in volatility generates a precautionary motive for demanding more safe assets and saving more, thus lowering the natural interest rate. However, as Fig. 6 shows, there are also innovations in the FLY that are not driven by volatility and are thus unrelated to the VIX, which in fact does not respond to them. These innovations still matter greatly for the natural interest rate, which indeed declines considerably. For reference, since the FLY is standardized, a unitary shock corresponds to a one standard deviation shock; this corresponds, for instance, to about a quarter of the increase that can be observed in the FLY at the height of the financial crisis, and, as the figure shows, it foreshadows an up to

20 basis points decline in the natural interest rate.

IV Safety with fixed factor loadings

Before allowing for safety to change over time, as a first assessment of its importance across countries, I start by assuming that it is constant over the full sample, and then over two subsamples obtained by splitting the series around a key event: the global financial crisis. I describe here the data that I will use for both this section and the next one, where safety is allowed to be time-varying. After describing the data, I briefly show some takeaways of constant safety and some comparisons between the pre- and post-crisis periods.

IV.1 Data

I download data on local-currency-denominated sovereign bond yields from Bloomberg for a total of 40 countries, covering maturities between 3 months and 10 years. The countries include 24 advanced economies and 16 emerging economies, according to country groupings from the International Monetary Fund. For 8 countries, foreign-currency-denominated bond yields are also available, but are not used in the analysis. The panel is unbalanced, but the oldest data dates to 1991. A summary of the available data is provided in Table A3.

I approximate returns on the sovereign bond of country j with maturity m by using the first-difference of yields, $\Delta y_t^{j,m} = y_t^{j,m} - y_{t-1}^{j,m}$. Given the presence of a heterogeneous group of countries, some of which have structurally more volatile yields, I standardize the change in yields in each country by its standard deviation:

$$\Delta \tilde{y}_t^{j,m} = \frac{\Delta y_t^{j,m}}{\mathbb{V}[\Delta y_t^{j,m}]^{\frac{1}{2}}} \ .$$

To further reduce the effect of outliers, I finally winsorize this object at the 1st and 99th percentiles.

IV.2 The safe asset set and global safety rankings

Following the intuition that the safety of a bond can be assessed by looking at its comovement with global demand for safe assets, I run the following set of regressions: using monthly data, separately for each country j, I run

$$\Delta \tilde{y}_t^{j,m} = \gamma^{j,m} + \beta^{FLY,j} FLY_t^{\Delta} + \eta_t^j \ . \tag{22}$$

Note that the regression uses information on yields of different maturities, but includes a maturity fixed effect to control for heterogeneity across maturities. This is equivalent to demeaning the left-hand side variable by each country-maturity mean. Here FLY_t^{Δ} is the percentage change in the full FLY index (for the rest of the paper, when I mention the FLY I will always be referring to its full version unless otherwise stated).

If we think back to definition 4, $\beta^{FLY,j}$ maps into the (negative of) $\beta^{r^{B,j},\theta^S}$ we had defined there:[10] the FLY, as an indicator of global flight to safety, provides a measure of θ^S, and thus the sign of the country loading on the FLY is informative about whether its debt is safe, neutral, or risky. By assuming $\beta^{FLY,j}$ to be fixed, the resulting estimates should give us an idea of which bonds, on average over the whole sample, behave as safe assets, which ones behave as risky assets, and which ones are neutral. Fig. 7 shows a bar graph of the factor loadings on the FLY index ($\beta^{FLY,j}$), using data from 1991 to 2021. A few things stand out. The US and Switzerland sit at the top with the largest loading on safety. A number of other countries rank just after the US and display significant safety betas. In fact, this method indicates a whole set of safe assets; the members of this group are relatively usual suspects, comprising countries traditionally considered to be safe havens. Some other countries appear to be neutral, and the remaining ones seem to be risky.

Fig. 8 presents a comparison of the $\hat{\beta}^{FLY,j}$'s obtained by re-estimating (22) in a pre-crisis (1991-2008) and a post-crisis (2009-2021) subsample, for a selection of countries. A few things stand out by comparing it to Fig. 7. First, one can immediately notice that the composition of the safe asset basket changed after the crisis. Some countries that were perceived as safe before the crisis retained that status, but several other lost it, including two (Austria and France) who transitioned to neutral and, not surprisingly, Ireland, Italy, and Portugal, which transitioned to risky (plus Spain, which switched from neutral to risky). A few countries that were neutral before the crisis gained a safe asset status afterwards (Canada, Denmark, Japan, and the United Kingdom).[11]

Another interesting finding that emerges from the plot is that, even within the set of safe assets, there was a considerable resorting after the crisis: the US emerged as the safest of the group; some countries, like Australia, Canada, Germany, and Norway, also saw their relative safety increase; others, like Switzerland and South Korea, instead experienced a decline in their relative safety. A natural question is then what exactly these safety rankings looked like before and after the crisis, and whether we can say something about their significance

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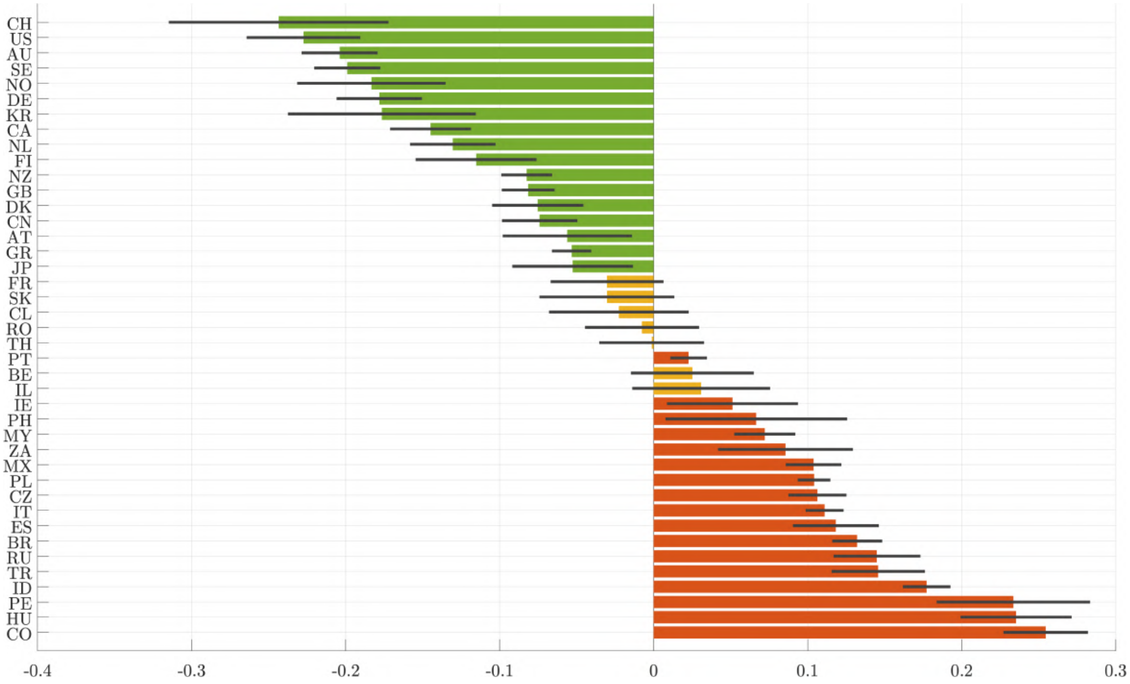
[10] The change in yields approximates the negative of the return, so $\beta^{FLY,j}$ and $\beta^{r^{B,j},\theta^S}$ have opposite signs.

[11] I also assessed the safety of gold before and after the financial crisis: its role as a systematic safe haven seems to emerge largely after the crisis, while before the crisis the coefficient is not statistically significant.

– i.e., if the US is at the top, does it mean it is really safer than the others, or can we not reject that they are all equally safe?

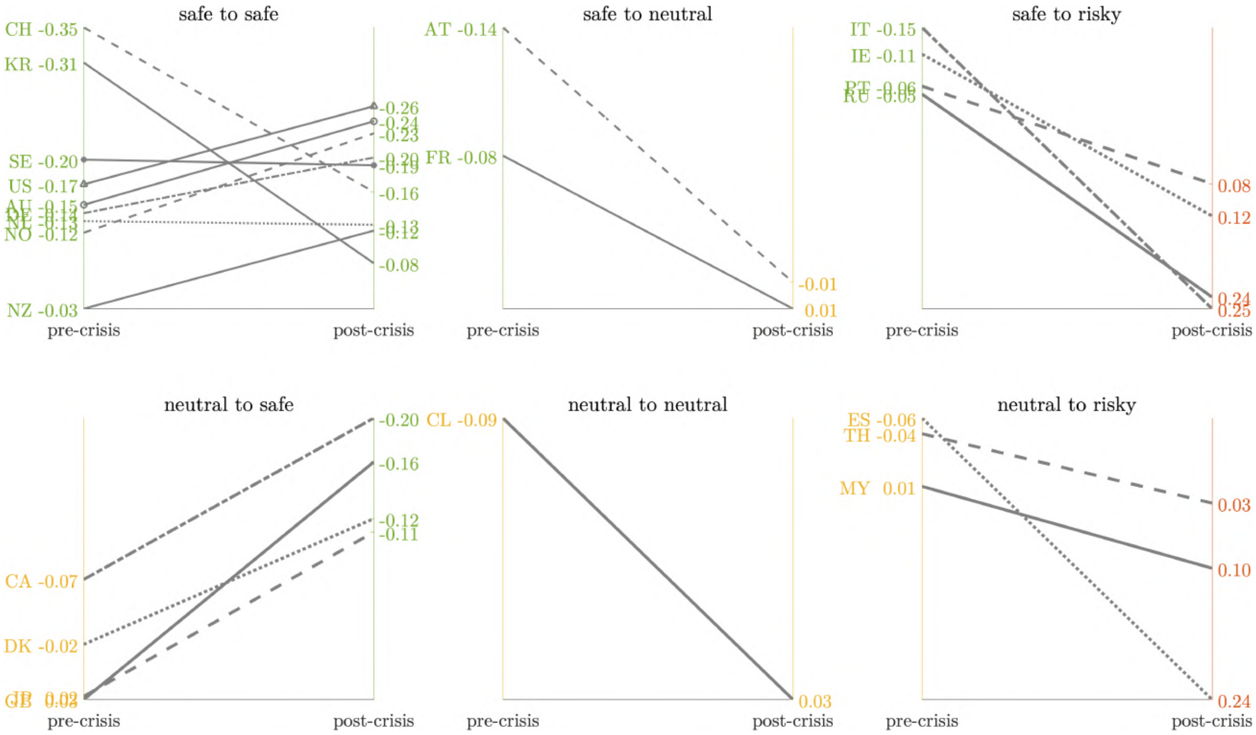
Figure 7: Loadings on the FLY index by country, 1991-2021



Note: each bar corresponds to a country j; the ISO-2 code of the corresponding country is reported on the y-axis; the associated x-axis value is the estimated $\hat{\beta}^{FLY,j}$ from running regression (22) for country j in the period from 1991 to 2021, using monthly data; grey bars denote 90% confidence intervals; countries highlighted in green have a negative and statistically significant $\hat{\beta}^{FLY,j}$ (the safe group); countries highlighted in yellow have a non-statistically-significant $\hat{\beta}^{FLY,j}$ (the neutral group); countries highlighted in red have a positive and statistically significant $\hat{\beta}^{FLY,j}$ (the risky group) .

Answering this question requires testing whether the differences between the US safety beta and the betas of other countries are statistically significant. To do so, I re-estimate (22), but this time I stack the dataset, and run all the regressions together. This allows me to compute standard errors for the difference $\beta^{FLY,j \neq US} - \beta^{FLY,US}$ and test it. The results are presented in Table 1. Perhaps surprisingly, before the financial crisis, there was one country, Switzerland, that appeared to be seen as even safer than the US, and, for most of the other countries in the safe group, we cannot reject that they were just as safe as the US. The situation changed drastically after the crisis: now only for two countries, Australia and Norway, we cannot reject that they are as safe as the US; with all the others, even those that remained safe, the US dominates. An interesting conclusion from this analysis would be that, even though the US has been the key global safe asset supplier since World War II, its safety, at least if one starts looking from the 1990s, was still comparable to that of a few other countries. The emergence of the US as the safest asset seems to be a more recent phenomenon, probably driven by the combination of the global savings glut, the financial crisis, and the euro debt crisis, which taken together led to an increase in safe assets demand and a decrease in its supply, so that the shortage made investors converge on American bonds. All in all, one thing the results in this section highlight is that safety can oscillate and switch over time. The next question, then, is how to capture these safety switches.

Figure 8: Safety transitions before and after the global financial crisis



Note: each line corresponds to a country j; the ISO-2 code of the corresponding country is reported on the y-axis; the associated value is the estimated $\hat{\beta}^{FLY,j}$ from running regression (22) in the period from 1991 to 2008 (for pre-crisis) and from 2009 to 2021 (for the post-crisis), using monthly data; the top row of plots focuses on a selection of countries that were safe in the pre-crisis period, and maps their pre-crisis loadings into their post-crisis loadings; the bottom row of plots focuses on a selection of countries that were neutral in the pre-crisis period, and maps their pre-crisis loadings into their post-crisis loadings; see the note in Fig. 7 for more info on the color coding.

Table 1: Safety betas relative to the US

	Pre-crisis		Post-crisis		Full sample	
	$\hat{\beta}^{FLY,j}$	$\hat{\beta}^{FLY,j}-\hat{\beta}^{FLY,US}$	$\hat{\beta}^{FLY,j}$	$\hat{\beta}^{FLY,j}-\hat{\beta}^{FLY,US}$	$\hat{\beta}^{FLY,j}$	$\hat{\beta}^{FLY,j}-\hat{\beta}^{FLY,US}$
US	-0.17^{**}	–	-0.26^{***}	–	-0.23^{***}	–
	(0.07)		(0.04)		(0.02)	
CH	-0.35^{***}	-0.18^{**}	-0.16^{***}	0.10^{***}	-0.24^{***}	-0.02
	(0.10)	(0.07)	(0.01)	(0.03)	(0.04)	(0.04)
KR	-0.31^{***}	-0.14	-0.08^{***}	0.18^{***}	-0.18^{***}	0.05
	(0.08)	(0.12)	(0.01)	(0.03)	(0.04)	(0.03)
SE	-0.20^{***}	-0.03	-0.19^{***}	0.07^{**}	-0.20^{***}	0.03
	(0.01)	(0.07)	(0.02)	(0.03)	(0.01)	(0.02)
AU	-0.15^{***}	0.02	-0.24^{***}	0.02	-0.20^{***}	0.02
	(0.02)	(0.07)	(0.01)	(0.03)	(0.01)	(0.02)
CN	-0.15^{***}	0.03	-0.03	0.23^{***}	-0.07^{***}	0.15^{***}
	(0.04)	(0.10)	(0.02)	(0.05)	(0.01)	(0.03)
IT	-0.15^{***}	0.03	0.29^{***}	0.55^{***}	0.11^{***}	0.34^{***}
	(0.04)	(0.05)	(0.01)	(0.04)	(0.01)	(0.02)
AT	-0.14^{***}	0.03	0.01	0.27^{***}	-0.06^{**}	0.17^{***}
	(0.06)	(0.08)	(0.01)	(0.04)	(0.03)	(0.02)
DE	-0.14^{***}	0.03	-0.20^{***}	0.06^{**}	-0.18^{***}	0.05^{***}
	(0.03)	(0.05)	(0.01)	(0.03)	(0.02)	(0.01)
NL	-0.13^{***}	0.04	-0.13^{***}	0.13^{***}	-0.13^{***}	0.10^{***}
	(0.04)	(0.06)	(0.01)	(0.03)	(0.02)	(0.01)
FI	-0.13^{***}	0.04	-0.11^{***}	0.15^{***}	-0.12^{***}	0.11^{***}
	(0.05)	(0.05)	(0.01)	(0.03)	(0.02)	(0.01)
NO	-0.12^{***}	0.05	-0.23^{***}	0.03	-0.18^{***}	0.04
	(0.04)	(0.10)	(0.04)	(0.03)	(0.03)	(0.04)
BE	-0.11^{**}	0.06	0.12^{***}	0.38^{***}	0.03	0.25^{***}
	(0.05)	(0.06)	(0.02)	(0.05)	(0.02)	(0.01)
IE	-0.11^{***}	0.07	0.17^{***}	0.43^{***}	0.05^{**}	0.28^{***}
	(0.02)	(0.05)	(0.03)	(0.07)	(0.03)	(0.04)
CL	-0.09	0.08	0.03^{**}	0.29^{***}	-0.02	0.20^{***}
	(0.06)	(0.11)	(0.01)	(0.04)	(0.03)	(0.04)
FR	-0.08^{**}	0.10^{**}	0.01	0.27^{***}	-0.03	0.20^{***}
	(0.04)	(0.04)	(0.01)	(0.04)	(0.02)	(0.01)

Note: the table reports the estimated differences between each country's safety beta and the US safety beta, i.e. $\beta^{FLY,j\neq US}-\beta^{FLY,US}$, obtained by running a stacked version of (22) for 1991-2021 (full sample), 1991-2008 (pre-crisis), and 2009-2021 (post-crisis); *,** ,*** denote significance at the 1%, 5%, and 10% level, respectively.

V Finding safety switches

The previous section highlighted an example of safety switches that can be identified by splitting the sample and looking at how the safety beta changes between the two subsamples. However, to really identify safety switches, we want to take this reasoning to an extreme. Thinking back about the model and definition 4 again, safety was defined by the sign of $\beta_t^{r^{B,j},\theta^S}$, and it changed over time as $\beta_t^{r^{B,j},\theta^S}$ fluctuated, driven by all the variables driving demand for safe assets: fundamentals, idiosyncratic risk, and the non-fundamental drivers of convenience yields and bond exposures to aggregate and country-specific risk. Connecting back to that reasoning, I allow for $\beta_t^{FLY,j}$ to change period-to-period.

More specifically, I estimate an autoregressive Markov-switching version of (22), for each country-maturity bond, allowing for intercepts, variances, and the safety beta to switch between two regimes. The model can be written as

$$\Delta\tilde{y}_t^{j,m} = \gamma_{s_t}^{j,m} + \beta_{s_t}^{FLY,j,m} FLY_t^{\Delta} + \phi^{j,m}\left(\Delta\tilde{y}_{t-1}^{j,m} - \gamma_{s_{t-1}}^{j,m} + \beta_{s_{t-1}}^{FLY,j,m} FLY_{t-1}^{\Delta}\right) + \eta_t^{j,m} \ , \qquad (23)$$

where $s_t = 1, 2$ denotes the regime at time t and $\sigma_{s_t}^{\eta^{j,m}}$ is also allowed to switch. Since the model has to be estimated for each country-maturity pair individually, to account for heterogeneity across maturities, I demean each $\tilde{y}_t^{j,m}$ by its overall mean − akin to the fixed effects in specification (22). The presence of an AR(1) component makes the process more gradual and less abrupt, which seems reasonable when considering the safe-asset status of a bond, and is also appropriate given that this estimation now relies on quarterly instead of monthly data − this is to avoid the issue of temporal aggregation when mapping into the frequency of macroeconomic variables that will be used in the following section.

The model is going to return estimates of $\beta_{s_t}^{FLY,j,m}$ for each country and maturity. In line with the previous section, I call regime s_t "safe" if $\beta_{s_t}^{FLY,j,m}$ is negative and statistically significant (at the 90% level); I call regime s_t "neutral" if $\beta_{s_t}^{FLY,j,m}$ is not statistically significant; and I call regime s_t "risky" if $\beta_{s_t}^{FLY,j,m}$ is positive and statistically significant. A positive safety switch then occurs whenever a bond enters a safe regime; conversely, a negative safety switch occurs when a bond enters a risky regime. To define switches at the country level, I assume that a country experiences a switch if any of its short-term bonds (3-month, 6-month, and 1-year maturities) experiences a switch.[12]

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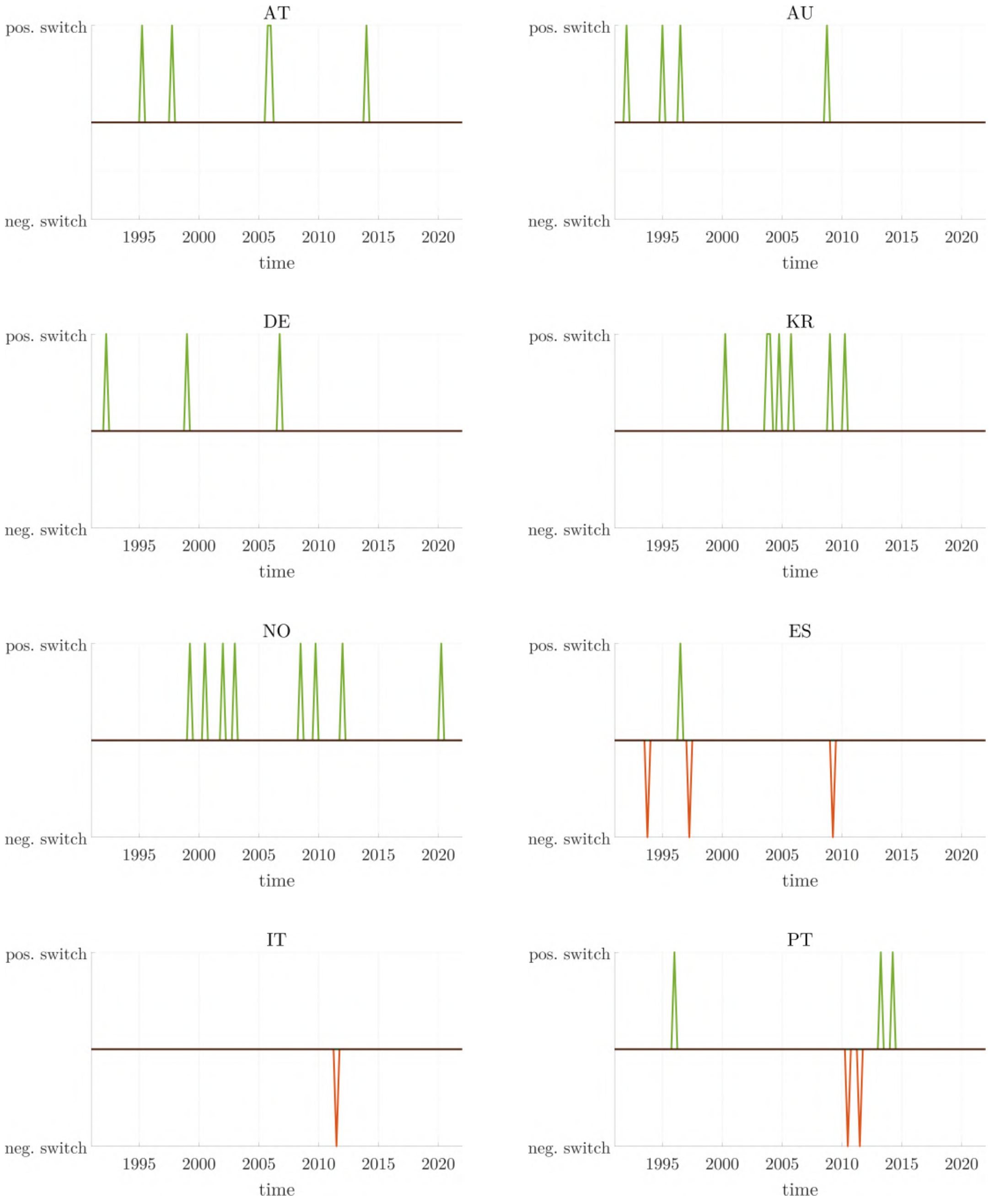
[12] I focus on short-term bonds because they are generally the most traded for safety and liquidity purposes.

Figure 9: Estimated safety switches, selected countries



Note: green and red lines indicate positive and negative safety switches, respectively, obtained by estimating the Markov switching model in (23) and then following the procedure described in the text.

Fig. 9 shows the resulting safety switches for a selection of countries.[13] There are some

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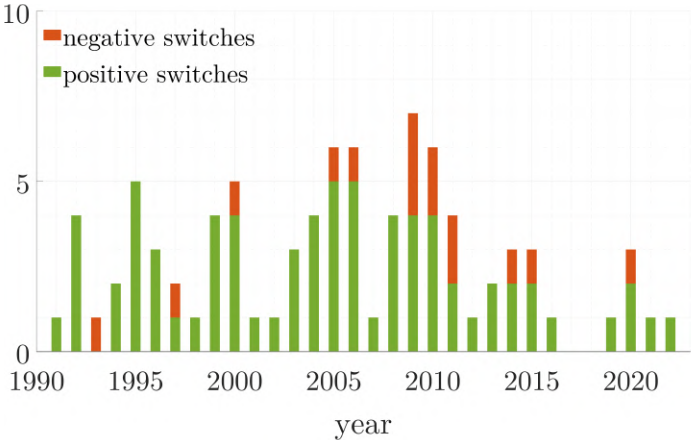
[13] The spikes in the plot correspond to periods in which one of the country's short-term bonds experiences

countries, like Switzerland, that are always safe, and therefore never experience any switch (hence why Switzerland is not plotted). There are others, like Germany and Norway, that are never risky, but switch in and out of enjoying a safety status. Spain and Portugal, on the other hand, are examples of countries whose bonds behaved as both safe and risky assets in different periods.

Fig. 10 shows the resulting total number of switches by year. Switches appear to be fairly distributed over time, especially positive ones. The biggest concentration of positive switches happens during the early 2000s, probably following the emergence of the global savings glut and the creation of the euro area. Many positive switches then occur again during the financial crisis, the euro debt crisis, and Covid, although many switches also occur outside of these crisis periods. Negative switches also occur outside of crisis periods, although larger occurrences are concentrated around the Great Recession, the euro debt crisis, and Covid.

Figure 10: Total number of positive and negative safety switches each year



Note: the figure plots the total number of positive and negative switches occurring each year across all countries.

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a safety switch. However, the figure does not indicate how long the bond remains in the "safe" state after a positive switch or in the "risky" state after a negative one. The lines should therefore not be interpreted as representing the duration of these states. For example, Italy shows only a single spike in 2011, corresponding to a negative switch. This does not imply that the subsequent period of riskiness ended immediately; in fact, the model estimates indicate that Italy remained risky until 2013.

VI Macroeconomic dynamics around safety switches

At this point, we have a panel of positive and negative safety switches. I collect additional data on GDP, consumption, investment, and government spending from the International Monetary Fund; on debt as a share of GDP from the IMF-World Bank Public Sector Debt database; and on average credit ratings from the World Bank Fiscal Space Database.[14] I then run the following local projections for y equal to GDP, consumption, investment, and government spending

$$100\cdot\frac{y_{j,t+h}-y_{j,t-1}}{y_{j,t-1}}=\delta_i+\delta_t+\lambda_h^+\cdot\text{switch}_{j,t}^+ +\lambda_h^-\cdot\text{switch}_{j,t}^- +\mu_h\cdot 100\cdot\frac{y_{j,t-1}-y_{j,t-2}}{y_{j,t-2}}+u_{j,t+h}\ , \quad (24)$$

and the following local projections for y equal to debt-to-GDP ratios (in %) and credit ratings (translated into a numerical equivalent)

$$y_{j,t+h}-y_{j,t-1}=\delta_i+\delta_t+\lambda_h^+\cdot\text{switch}_{j,t}^+ +\lambda_h^-\cdot\text{switch}_{j,t}^- +\mu_h\cdot(y_{j,t-1}-y_{j,t-2})+u_{j,t+h}\ . \quad (25)$$

The horizons are $h = 0, 1, \ldots 20$. Here, switch^+ and switch^- denote positive and negative safety switches, respectively. Notice the presence of country and time fixed effects and a control for the lagged value of the dependent variable. Following the discussion in Section III.3, I focus my baseline analysis on the post-2002 period when the global savings glut made safe-assets dynamics particularly relevant, and in advanced economies, which were the ones most directly impacted by the phenomenon.

Fig. 11 shows the resulting local projections for GDP and its components. Safety switches are associated with sizable movements in macroeconomic variables. Positive switches (in green) are associated with expansions in consumption and GDP and increases in government spending. The story is different for negative switches (in red). Consumption, investment, and GDP all contract considerably, and government spending falls.

Fig. 12 shows the local projections for debt-to-GDP ratios and credit ratings. Positive and negative safety switches respectively foreshadow upgrades and downgrades in ratings. The behavior of debt-to-GDP is opposite: positive safety switches are associated with a persistent decrease in debt; conversely, negative switches are associated with an equally persistent, but twice as large, increase in debt. In both cases, the adjustment comes from long-term debt, while short-term debt does not move much. As a result, the maturity structure seems to get shorter after positive switches, and longer after negative switches. The

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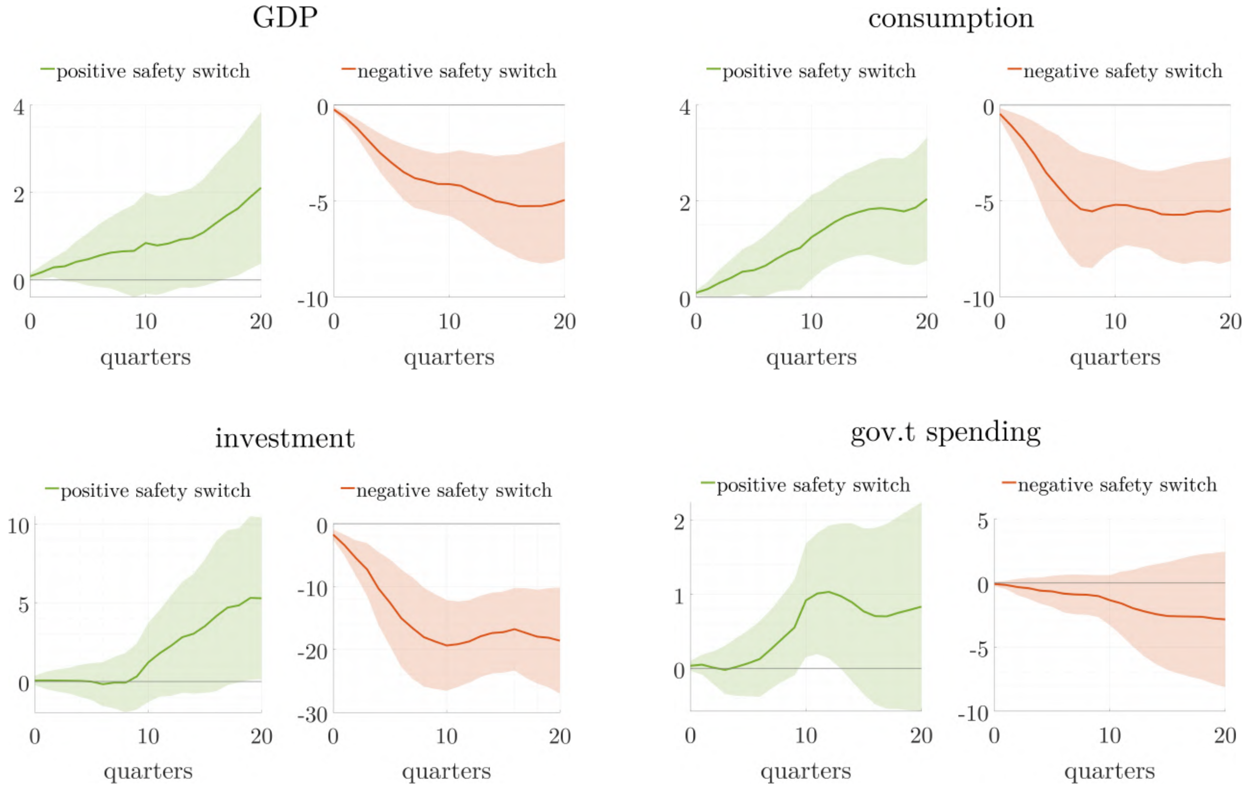
[14] Further details can be found in Kose, Kurlat, Ohnsorge, and Sugawara (2022); I use the 2021 version of the data.

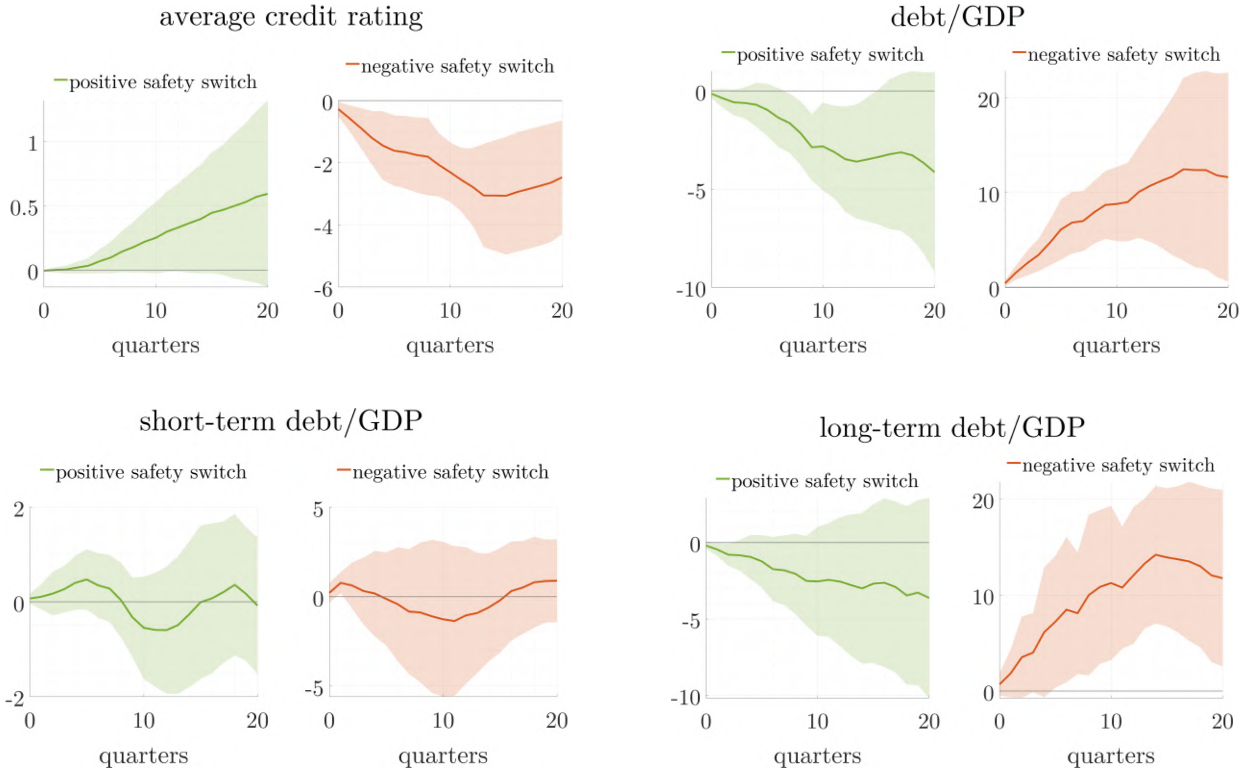
rationale is probably opposite: while for negative switches it is likely a rollover risk story, for positive switches the cheapness of short-term debt outweighs the insurance benefits of long-term debt in the trade-off the government faces when adjusting the maturity structure of its debt in response to a switch. As a result, newly-safe governments that want to reduce their debt but still need to borrow will do the borrowing via short-term debt and will do the debt reduction through the long-term margin. The result is a tilting of the maturity structure towards shorter maturities.

Figure 11: Macroeconomic dynamics after safety switches: positive switch to safe (green) and negative switch to risky (red)



Note: dark green lines plot the estimated $\hat{\lambda}_h^+$ obtained by running regression (24); dark red lines plot the estimated $\hat{\lambda}_h^-$ obtained by running the same regressions; shaded areas denote 90% confidence intervals; standard errors for the confidence intervals are block-bootstrapped to cluster by country.

Figure 12: Debt dynamics after safety switches: positive switch to safe (green) and negative switch to risky (red)



Note: dark green lines plot the estimated $\hat{\lambda}_h^+$ obtained by running regression (25); dark red lines plot the estimated $\hat{\lambda}_h^-$ obtained by running the same regressions; shaded areas denote 90% confidence intervals; standard errors for the confidence intervals are block-bootstrapped to cluster by country.

VII Conclusion

This paper presents a model for thinking about sovereign safety and for defining it in a way that can be taken to the data. It introduces a novel, news-based index of global demand for safe assets, the FLY, which picks up relevant flight-to-safety episodes and the global savings glut, and predicts movements in the natural interest rate. It then proposes a methodology that exploits the FLY to identify switches in a bond's safety through changes in the sign and significance of its loading on the index. Safety switches are common and are associated with sizable movements in macroeconomic variables among advanced economies in the post-global-savings-glut period: positive switches (i.e. becoming safe) are associated with expansions, increases in government spending, and lower debt with a shorter maturity structure; conversely, negative switches (i.e. becoming risky) are associated with contractions, decreases in government spending, and higher debt with a longer maturity structure.

The findings have potentially relevant policy implications. The relationship between the FLY and the natural interest rate highlights the impact that worldwide savings patterns and hunger for safe assets can have for international interest rates, bond markets, and the financial system as a whole. At the country level, results for negative switches suggest dire consequences for countries' fragility, and emphasize the importance of retaining fiscal space. Symmetrically, positive switches do seem to provide additional fiscal space that the government uses to finance more spending. Exploiting the benefits of positive switches productively seems desirable, but should not come at the cost of eroding the fiscal situation of the country, as that could ultimately prove detrimental if the safe-asset status is lost again – something poorer fiscal fundamentals might also directly contribute to.

References

Aizenman, J., Y.-W. Cheung, and X. Qian (2019a): "The Currency Composition of International Reserves, Demand for International Reserves, and Global Safe Assets," *Journal of International Money and Finance*, 102.

——— (2019b): "The Currency Composition of International Reserves, Demand for International Reserves, and Global Safe Assets," Working Paper 25934, National Bureau of Economic Research.

Akcigit, U. and Q. Liu (2011): "The Role of Information in Competitive Experimentation," Working Paper 17602, National Bureau of Economic Research.

Akinci, O., Ş. Kalemli-Özcan, and A. Queralto (2022): "Uncertainty Shocks, Capital Flows, and International Risk Spillovers," Working Paper 30026, National Bureau of Economic Research.

Azzimonti, M. and P. Yared (2018): "The Optimal Public and Private Provision of Safe Assets," Working Paper 24534, National Bureau of Economic Research.

Baele, L., G. Bekaert, K. Inghelbrecht, and M. Wei (2020): "Flights to Safety," *Review of Financial Studies*, 33, 689–746.

Baker, S. R., N. Bloom, and S. J. Davis (2016): "Measuring Economic Policy Uncertainty," *Quarterly Journal of Economics*, 131, 1593–1636.

Barro, R. J. (2021): "r Minus g," Working Paper 28002, National Bureau of Economic Research.

Barro, R. J., J. Fernández-Villaverde, O. Levintal, and A. Mollerus (2017): "Safe Assets," Working Paper 20652, National Bureau of Economic Research.

Basu, S., G. Candian, R. Chahrour, and R. Valchev (2021): "Risky Business Cycles," Working Paper 28693, National Bureau of Economic Research.

Bernanke, B., M. Gertler, and S. Gilchrist (1994): "The Financial Accelerator and the Flight to Quality," Working Paper 4789, National Bureau of Economic Research.

Bernstein, S., R. R. Townsend, and T. Xu (2021): "Flight to Safety: How Economic Downturns Affect Talent Flows to Startups," Working Paper 27907, National Bureau of Economic Research.

Bertaut, C., L. P. DeMarco, S. B. Kamin, and R. W. Tryon (2011): "ABS Inflows to the United States and the Global Financial Crisis," Working Paper 17350, National Bureau of Economic Research.

Boissay, F. and R. Cooper (2016): "The Collateral Trap," Working Paper 20703, National Bureau of Economic Research.

Bordo, M. D. and R. N. McCauley (2018): "Triffin: Dilemma or Myth?" Working Paper 24195, National Bureau of Economic Research.

Boudoukh, J., J. Brooks, M. Richardson, and Z. Xu (2016): "The Complexity of Liquidity: The Extraordinary Case of Sovereign Bonds," Working Paper 22576, National Bureau of Economic Research.

Brock, W. A. and C. F. Manski (2009): "Competitive Lending with Partial Knowledge of Loan Repayment," Working Paper 14378, National Bureau of Economic Research.

Brunnermeier, M. K., L. Garicano, P. Lane, M. Pagano, R. Reis, T. Santos, D. Thesmar, S. Van Nieuwerburgh, and D. Vayanos (2016): "The Sovereign-Bank Diabolic Loop and ESBIES," Working Paper 21993, National Bureau of Economic Research.

Brunnermeier, M. K. and L. Huang (2018): "A Global Safe Asset for and from Emerging Market Economies," Working Paper 25373, National Bureau of Economic Research.

Brunnermeier, M. K., S. Merkel, and Y. Sannikov (2022a): "Debt as Safe Asset," Working Paper 29626, National Bureau of Economic Research.

——— (2022b): "The Fiscal Theory of Price Level with a Bubble," Working Paper 27116, National Bureau of Economic Research.

Brunnermeier, M. K. and L. H. Pedersen (2007): "Market Liquidity and Funding Liquidity," Working Paper 12939, National Bureau of Economic Research.

Caballero, R. J. and E. Farhi (2013): "A Model of the Safe Asset Mechanism (SAM): Safety Traps and Economic Policy," Working Paper 18737, National Bureau of Economic Research.

——— (2017): "The Safety Trap," Working Paper 19927, National Bureau of Economic Research.

——— (2018): "The Safety Trap," *Review of Economic Studies*, 85, 223–274.

Caballero, R. J., E. Farhi, and P.-O. Gourinchas (2016a): "Safe Asset Scarcity and Aggregate Demand," *American Economic Review*, 106, 513–518.

——— (2016b): "Safe Asset Scarcity and Aggregate Demand," Working Paper 22044, National Bureau of Economic Research.

——— (2017): "The Safe Assets Shortage Conundrum," *Journal of Economic Perspectives*, 31, 29.46.

——— (2021a): "Global Imbalances and Policy Wars at the Zero Lower Bound," *Review of Economic Studies*, 88, 2570–2621.

——— (2021b): "Global Imbalances and Policy Wars at the Zero Lower Bound," Working Paper 21670, National Bureau of Economic Research.

Caballero, R. J. and A. Krishnamurthy (2005): "Financial System Risk and Flight to Quality," Working Paper 11834, National Bureau of Economic Research.

——— (2006): "Flight to Quality and Collective Risk Management," Working Paper 12136, National Bureau of Economic Research.

——— (2007): "Collective Risk Management in a Flight to Quality Episode," Working Paper 12896, National Bureau of Economic Research.

Cai, Y., K. L. Judd, and R. Xu (2013): "Numerical Solution of Dynamic Portfolio Optimization with Transaction Costs," Working Paper 18709, National Bureau of Economic Research.

Campbell, J. Y., R. J. Shiller, and L. M. Viceira (2009): "Understanding Inflation-Indexed Bond Markets," Working Paper 15014, National Bureau of Economic Research.

Chinn, M. D. and H. Ito (2019): "A Requiem for "Blame It on Beijing": Interpreting Rotating Global Current Account Surpluses," Working Paper 26226, National Bureau of Economic Research.

Choi, J., R. Kirpalani, and D. J. Perez (2022): "The Macroeconomic Implications of US Market Power in Safe Assets," Working Paper 30720, National Bureau of Economic Research.

Christensen, J. H. E. and N. Mirkov (2022): "The Safety Premium of Safe Assets," Working Paper 2019-28, Federal Reserve Bank of San Francisco.

Cuevas, C. C. (2023): "Safe Assets in Emerging Market Economies," Working paper.

Davis, J. S. and E. van Wincoop (2021): "A Theory of the Global Financial Cycle," Working Paper 29217, National Bureau of Economic Research.

Di Tella, S. (2020): "Risk Premia and the Real Effects of Money," *American Economic Review*, 110, 1995–2040.

Diamond, W. and P. Van Tassel (2023): "Risk-Free Rates and Convenience Yields around the World," Staff Reports 1032, Federal Reserve Bank of New York.

Edwards, S., F. A. Longstaff, and A. Garcia Marin (2015): "The US Debt Restructuring of 1933: Consequences and Lessons," Working Paper 21694, National Bureau of Economic Research.

Egan, M., S. Lewellen, and A. Sunderam (2021): "The Cross Section of Bank Value," Working Paper 23291, National Bureau of Economic Research.

Erel, I., B. Julio, W. Kim, and M. Weisbach (2009): "Market Conditions and the Structure of Securities," Working Paper 14952, National Bureau of Economic Research.

Fleckenstein, M. and F. A. Longstaff (2018): "Floating Rate Money? The Stability of Premium in Treasury Floating Rate Notes," Working Paper 25216, National Bureau of Economic Research.

Fraiberger, S. P., D. Lee, and a. R. R. Puy, Damien (2021): "Media Sentiment and International Asset Prices," *Journal of International Economics*, 133.

Fukuda, S.-i. (2016): "Strong Sterling Pound and Weak European Currencies in the Crises: Evidence from Covered Interest Parity of Secured Rates," Working Paper 21938, National Bureau of Economic Research.

García, D. (2013): "Sentiment during Recessions," *Journal of Finance*, 68, 1267–1300.

Gopinath, G. and J. C. Stein (2018): "Banking, Trade, and the Making of a Dominant Currency," Working Paper 24485, National Bureau of Economic Research.

Gorton, B. B. (2016): "The History and Economics of Safe Assets," Working Paper 22210, National Bureau of Economic Research.

Gorton, G., T. Laarits, and T. Muir (2019): "1930: First Modern Crisis," Working Paper 25452, National Bureau of Economic Research.

Gorton, G., S. Lewellen, and A. Metrick (2012): "The Safe-Asset Share," *American Economic Review*, 102, 101–106.

GORTON, G. B. AND G. ORDOÑEZ (2020): "The Supply and Demand for Safe Assets," Working Paper 18732, National Bureau of Economic Research.

GOURINCHAS, P.-O. AND H. REY (2016): "Real Interest Rates, Imbalances and the Curse of Regional Safe Asset Providers at the Zero Lower Bound," Working Paper 22618, National Bureau of Economic Research.

GOURIO, F. (2009): "Disasters Risk and Business Cycles," Working Paper 15399, National Bureau of Economic Research.

GUERRIERI, V. AND R. SHIMER (2012): "Dynamic Adverse Selection: A Theory of Illiquidity, Fire Sales, and Flight to Quality," Working Paper 17876, National Bureau of Economic Research.

GUTIÉRREZ, G. AND T. PHILIPPON (2016): "Investment-Less Growth: An Empirical Investigation," Working Paper 22897, National Bureau of Economic Research.

HABIB, M. M., L. STRACCA, AND F. VENDITTI (2020): "The Fundamentals of Safe Assets," *Journal of International Money and Finance*, 102.

HALE, G. AND L. JUVENAL (2021): "External Balance Sheets and the Covid-19 Crisis," Working Paper 29277, National Bureau of Economic Research.

HART, O. D. AND L. ZINGALES (2011): "Inefficient Provision of Liquidity," Working Paper 17299, National Bureau of Economic Research.

HASSAN, T., S. HOLLANDER, L. VAN LENT, AND A. TAHOUN (2019): "Firm-Level Political Risk: Measurement and Effects," *Quarterly Journal of Economics*, 134, 2135–2202.

HE, Z., A. KRISHNAMURTHY, AND K. MILBRADT (2016a): "A Model of Safe Asset Determination," Working Paper 22271, National Bureau of Economic Research.

——— (2016b): "What Makes US Government Bonds Safe Assets?" *American Economic Review*, 106, 519–523.

——— (2016c): "What Makes US Government Bonds Safe Assets?" Working Paper 22017, National Bureau of Economic Research.

——— (2019): "A Model of Safe Asset Determination," *American Economic Review*, 109, 1230–62.

HOLSTON, K., T. LAUBACH, AND J. C. WILLIAMS (2023): "Measuring the Natural Rate of Interest after COVID-19," Staff Report 1063, Federal Reserve Bank of New York.

Kashyap, A. K., D. P. Tsomocos, and A. P. Vardoulakis (2014): "How Does Macroprudential Regulation Change Bank Credit Supply?" Working Paper 20165, National Bureau of Economic Research.

Kekre, R. and M. Lenel (2021): "The Flight to Safety and International Risk Sharing," Working Paper 29238, National Bureau of Economic Research.

Kekrel, R. and M. Lenel (2021): "The Flight to Safety and International Risk Sharing," Working Paper 29238, National Bureau of Economic Research.

Kose, M. A., S. Kurlat, F. Ohnsorge, and N. Sugawara (2022): "A Cross-Country Database of Fiscal Space," *Journal of International Money and Finance*, 128.

Krishnamurthy, A. and A. Vissing-Jørgensen (2011): "The Effects of Quantitative Easing on Interest Rates: Channels and Implications for Policy," Working Paper 17555, National Bureau of Economic Research.

——— (2012): "The Aggregate Demand for Treasury Debt," *Journal of Political Economy*, 120, 233–267.

Liu, Y., L. Schmid, and A. Yaron (2019): "The Risks of Safe Assets," 2019 Meeting Paper 1418, Society for Economic Dynamics.

Mankiw, N. G. (2017): *Principles of Economics*, Cencage Learning, 8th ed.

Meeuwis, M., J. A. Parker, A. Schoar, and D. I. Simester (2021): "Belief Disagreement and Portfolio Choice," Working Paper 25108, National Bureau of Economic Research.

Miranda-Agrippino, S. and H. Rey (2021): "The Global Financial Cycle," *Handbook of International Economics*, 6, 1–43.

Moreira, A. and A. Savov (2014): "The Macroeconomics of Shadow Banking," Working Paper 20335, National Bureau of Economic Research.

Mota, L. (2021): "The Corporate Supply of (Quasi) Safe Assets," Available at https://ssrn.com/abstract=3732444, Social Science Research Network.

Pallara, K. and J.-P. Renne (2023): "Fiscal Limits and the Pricing of Eurobonds," *Management Science*, 70, 1216–1237.

——— (2024): "Fiscal Fatigue and Sovereign Credit Spreads," Available at https://ssrn.com/abstract=3475425, Social Science Research Network.

Panageas, S. (2009): "Bailouts, the Incentive to Manage Risk, and Financial Crises," Working Paper 15058, National Bureau of Economic Research.

Pavlova, A. and R. Rigobon (2005): "Wealth Transfers, Contagion, and Portfolio Constraints," Working Paper 11440, National Bureau of Economic Research.

Pflueger, C., E. Siriwardane, and A. Sunderam (2019): "Financial Market Risk Perceptions and the Macroeconomy," Working Paper 26290, National Bureau of Economic Research.

Rosen, H. S. and S. Wu (2003): "Portfolio Choice and Health Status," Working Paper 9453, National Bureau of Economic Research.

Shapiro, A. H., M. Sudhof, and D. J. Wilson (2020): "Measuring News Sentiment," Working Paper 2017-01, FRB San Francisco.

Sialm, C. (2002): "Stochastic Taxation and Asset Pricing in Dynamic General Equilibrium," Working Paper 9301, National Bureau of Economic Research.

Van Binsbergen, J. H., W. F. Diamond, and M. Grotteria (2019): "Risk-Free Interest Rates," Working Paper 26138, National Bureau of Economic Research.

——— (2022): "Risk-Free Interest Rates," *Journal of Financial Economics*, 143, 1–29.

Zhengyang, J., A. Krishnamurthy, and H. Lustig (2018): "Foreign Safe Asset Demand for US Treasurys and the Dollar," *AEA Papers and Proceedings*, 108, 537–541.

——— (2020): "Foreign Safe Asset Demand and the Dollar Exchange Rate," Working Paper 24439, National Bureau of Economic Research.

——— (2021): "Foreign Safe Asset Demand and the Dollar Exchange Rate," *Journal of Finance*, 76, 1049–1089.

A Additional tables

Table A1: NBER papers used to construct the safe assets library

Authors	**Title**	**Date**	**JEL**	**Number**
Ben Bernanke, Mark Gertler, Simon Gilchrist	THE FINANCIAL ACCELERATOR AND THE FLIGHT TO QUALITY	July 1994	N/A	4789
Clemens Sialm	STOCHASTIC TAXATION AND ASSET PRICING IN DYNAMIC GENERAL EQUILIBRIUM	October 2002	G1, H2, E4	9301
Harvey S. Rosen, Stephen Wu	PORTFOLIO CHOICE AND HEALTH STATUS	January 2003	G11, I19	9453
Anna Pavlova, Roberto Rigobon	WEALTH TRANSFERS, CONTAGION, AND PORTFOLIO CONSTRAINTS	June 2005	G12, G15, F31, F36	11440
Ricardo J. Caballero, Arvind Krishnamurthy	FINANCIAL SYSTEM RISK AND FLIGHT TO QUALITY	December 2005	E30, E44, E5, F34, G1, G22, G28	11834
Ricardo J. Caballero, Arvind Krishnamurthy	FLIGHT TO QUALITY AND COLLECTIVE RISK MANAGEMENT	March 2006	E30, E44, E5, F34, G1, G22, G28	12136
Ricardo J. Caballero, Arvind Krishnamurthy	COLLECTIVE RISK MANAGEMENT IN A FLIGHT TO QUALITY EPISODE	February 2007	E30, E44, E5, F34, G1, G21, G22, G28	12896
Markus K. Brunnermeier, Lasse Heje Pedersen	MARKET LIQUIDITY AND FUNDING LIQUIDITY	February 2007	G12, G21, G24	12939
William A. Brock, Charles F. Manski	COMPETITIVE LENDING WITH PARTIAL KNOWLEDGE OF LOAN REPAYMENT	October 2008, Revised July 2009	E43, G11, G18, H81	14378
Isil Erel, Brandon Julio, Woojin Kim, Michael Weisbach	MARKET CONDITIONS AND THE STRUCTURE OF SECURITIES	May 2009	E00, G01, G32	14952
John Y. Campbell, Robert J. Shiller, Luis M. Viceira	UNDERSTANDING INFLATION-INDEXED BOND MARKETS	May 2009	E43, E44, G12	15014
Stavros Panageas	BAILOUTS, THE INCENTIVE TO MANAGE RISK, AND FINANCIAL CRISES	June 2009	G01, G32, G33	15058
François Gourio	DISASTERS RISK AND BUSINESS CYCLES	October 2009	E32, E44, G12	15399
Oliver D. Hart, Luigi Zingales	INEFFICIENT PROVISION OF LIQUIDITY	August 2011	E41, E51, G21	17299
Carol Bertaut, Laurie Pounder DeMarco, Steven B. Kamin, Ralph W. Tryon	ABS INFLOWS TO THE UNITED STATES AND THE GLOBAL FINANCIAL CRISIS	August 2011	F3, G1	17350
Arvind Krishnamurthy, Annette Vissing-Jorgensen	THE EFFECTS OF QUANTITATIVE EASING ON INTEREST RATES: CHANNELS AND IMPLICATIONS FOR POLICY	October 2011	E4, E5, G01, G14, G18	17555
Ufuk Akcigit, Qingmin Liu	THE ROLE OF INFORMATION IN COMPETITIVE EXPERIMENTATION	November 2011, Revised November 2011	D83, D92, O31	17602
Veronica Guerrieri, Robert Shimer	DYNAMIC ADVERSE SELECTION: A THEORY OF ILLIQUIDITY, FIRE SALES, AND FLIGHT TO QUALITY	March 2012	D82, E44, G14	17876

Yongyang Cai, Kenneth L. Judd, Rong Xu	NUMERICAL SOLUTION OF DYNAMIC PORTFOLIO OPTIMIZATION WITH TRANSACTION COSTS	January 2013	C61, C63, G11	18709
Gary B. Gorton, Guillermo Ordoñez	THE SUPPLY AND DEMAND FOR SAFE ASSETS	January 2013, Revised April 2020	E0, E02, E2, E3, E32, E4, E41, G01, G12, G2	18732
Ricardo J. Caballero, Emmanuel Farhi	A MODEL OF THE SAFE ASSET MECHANISM (SAM): SAFETY TRAPS AND ECONOMIC POLICY	January 2013, Revised August 2013	E32, E4, E5, E52, E62, E63, F3, F33, F41, G01, G1, G28	18737
Ricardo J. Caballero, Emmanuel Farhi	THE SAFETY TRAP	February 2014, Revised January 2017	E0, E1, E5, E52	19927
Anil K. Kashyap, Dimitrios P. Tsomocos, Alexandros P. Vardoulakis	HOW DOES MACROPRUDENTIAL REGULATION CHANGE BANK CREDIT SUPPLY?	May 2014	E44, G01, G21, G28	20165
Alan Moreira, Alexi Savov	THE MACROECONOMICS OF SHADOW BANKING	July 2014	E44, E52, G01, G21, G23	20335
Robert J. Barro, Jesús Fernández-Villaverde, Oren Levintal, Andrew Mollerus	SAFE ASSETS	October 2014, Revised May 2017	G1, E0, E2	20652
Frédéric Boissay, Russell Cooper	THE COLLATERAL TRAP	November 2014, Revised March 2016	E44, E51, G21, G23	20703
Ricardo J. Caballero, Emmanuel Farhi, Pierre-Olivier Gourinchas	GLOBAL IMBALANCES AND POLICY WARS AT THE ZERO LOWER BOUND	October 2015, Revised January 2021	E0, F3, F4, G01	21670
Sebastian Edwards, Francis A. Longstaff, Alvaro Garcia Marin	THE U.S. DEBT RESTRUCTURING OF 1933: CONSEQUENCES AND LESSONS	November 2015	E43, E44, E65	21694
Shin-ichi Fukuda	STRONG STERLING POUND AND WEAK EUROPEAN CURRENCIES IN THE CRISES: EVIDENCE FROM COVERED INTEREST PARITY OF SECURED RATES	January 2016	F36, G12, G15	21938
Markus K. Brunnermeier, Luis Garicano, Philip Lane, Marco Pagano, Ricardo Reis, Tano Santos, David Thesmar, Stijn Van Nieuwerburgh, Dimitri Vayanos	THE SOVEREIGN-BANK DIABOLIC LOOP AND ESBIES	February 2016, Revised June 2016	E58, F34, G01, G15, G21, G23	21993
Zhiguo He, Arvind Krishnamurthy, Konstantin Milbradt	WHAT MAKES US GOVERNMENT BONDS SAFE ASSETS?	February 2016	E0, F0, F3, G0, G11	22017
Ricardo J. Caballero, Emmanuel Farhi, Pierre-Olivier Gourinchas	SAFE ASSET SCARCITY AND AGGREGATE DEMAND	February 2016	E0, F3, F4, G1	22044
Gary B. Gorton	THE HISTORY AND ECONOMICS OF SAFE ASSETS	April 2016	E3, E41, E42, E44, E5, G2	22210
Zhiguo He, Arvind Krishnamurthy, Konstantin Milbradt	A MODEL OF SAFE ASSET DETERMINATION	May 2016	E44, F33, G15, G28	22271
Jacob Boudoukh, Jordan Brooks, Matthew Richardson, Zhikai Xu	THE COMPLEXITY OF LIQUIDITY: THE EXTRAORDINARY CASE OF SOVEREIGN BONDS	August 2016	F3, G1, G12, G15	22576

Pierre-Olivier Gourinchas, Hélène Rey	REAL INTEREST RATES, IMBALANCES AND THE CURSE OF REGIONAL SAFE ASSET PROVIDERS AT THE ZERO LOWER BOUND	September 2016	E2, E4, F4	22618
Germán Gutiérrez, Thomas Philippon	INVESTMENT-LESS GROWTH: AN EMPIRICAL INVESTIGATION	December 2016, Revised January 2016	E22, G3	22897
Mark Egan, Stefan Lewellen, Adi Sunderam	THE CROSS SECTION OF BANK VALUE	March 2017, Revised July 2021	G2, G21	23291
Michael D. Bordo, Robert N. McCauley	TRIFFIN: DILEMMA OR MYTH?	January 2018	F32, F33, F34, F41, H63	24195
Zhengyang Jiang, Arvind Krishnamurthy, Hanno Lustig	FOREIGN SAFE ASSET DEMAND AND THE DOLLAR EXCHANGE RATE	March 2018, Revised in September 2020	G15	24439
Gita Gopinath, Jeremy C. Stein	BANKING, TRADE, AND THE MAKING OF A DOMINANT CURRENCY	April 2018	E0, F0, G0	24485
Marina Azzimonti, Pierre Yared	THE OPTIMAL PUBLIC AND PRIVATE PROVISION OF SAFE ASSETS	April 2018	E21, E25, E62, H21, H63	24534
Maarten Meeuwis, Jonathan A. Parker, Antoinette Schoar, Duncan I. Simester	BELIEF DISAGREEMENT AND PORTFOLIO CHOICE	September 2018, Revised June 2021	D14, D84, E71, G11, G12, G40	25108
Matthias Fleckenstein, Francis A. Longstaff	FLOATING RATE MONEY? THE STABILITY PREMIUM IN TREASURY FLOATING RATE NOTES	November 2018	G12, G18	25216
Markus K. Brunnermeier, Lunyang Huang	A GLOBAL SAFE ASSET FOR AND FROM EMERGING MARKET ECONOMIES	December 2018	E42, E43, F32, F33	25373
Gary Gorton, Toomas Laarits, Tyler Muir	1930: FIRST MODERN CRISIS	January 2019	E02, E3, G01	25452
Joshua Aizenman, Yin-Wong Cheung, Xingwang Qian	THE CURRENCY COMPOSITION OF INTERNATIONAL RESERVES, DEMAND FOR INTERNATIONAL RESERVES, AND GLOBAL SAFE ASSETS	June 2019	F15, F3, F31	25934
Jules H. van Binsbergen, William F. Diamond, Marco Grotteria	RISK-FREE INTEREST RATES	August 2019	E41, E43, E44, E52, E58, G12, G15	26138
Menzie D. Chinn, Hiro Ito	A REQUIEM FOR “BLAME IT ON BEIJING”: INTERPRETING ROTATING GLOBAL CURRENT ACCOUNT SURPLUSES	September 2019	F32, F41	26226
Carolin Pflueger, Emil Siriwardane, Adi Sunderam	FINANCIAL MARKET RISK PERCEPTIONS AND THE MACROECONOMY	September 2019	E03, E22, E44, G12	26290
Shai Bernstein, Richard R. Townsend, Ting Xu	FLIGHT TO SAFETY: HOW ECONOMIC DOWNTURNS AFFECT TALENT FLOWS TO STARTUPS	October 2020, Revised August 2021	E32, J22, J24, L26, M13	27907

Robert J. Barro	R MINUS G	October 2020, Revised June 2021	E21, G12, O4	28002
Susanto Basu, Giacomo Candian, Ryan Chahrour, Rosen Valchev	RISKY BUSINESS CYCLES	April 2021, Revised November 2021	E24, E32, G12	28693
J. Scott Davis, Eric van Wincoop	A THEORY OF THE GLOBAL FINANCIAL CYCLE	September 2021	F30, F40	29217
Rohan Kekre, Moritz Lenel	THE FLIGHT TO SAFETY AND INTERNATIONAL RISK SHARING	September 2021	E44, F44, G15	29238
Galina Hale, Luciana Juvenal	EXTERNAL BALANCE SHEETS AND THE COVID-19 CRISIS	September 2021	F32, F34, G15	29277

Table A2: Bigrams used for the construction of the full index

safe asset
public debt
convenience yield
risky asset
flight quality
risk premia
safety trap
risk premium
basis point
asset position
treasury basis
excess return
demand safe
supply safe
safe debt
gold clause
private asset
deposit productivity
equity premium
asset productivity
bond yield
periphery country
safe dollar
deposit rate
home bias
term trade
riskfree rate
sovereign debt
cash flow
currency composition
credit market
treasury yield
real rate
default risk
inflationindexed bond
valuation effect
market liquidity
sterling pound
equity share
home foreign
treasury security
probability disaster
financial autarky
hedge fund
commercial paper
interbank market
global imbalance
term structure
debt issuance
libor basis
domestic bond
position safe
safety shock
safe interest
treasury note
expect return
bond price
relative risk
bond return
treasury bond
shortterm debt
sovereign bond
liquidity shock
risk free
asset market
asset return
bank value
asset demand
wealth share
newly issue
euro crisis
global riskaversion
banking sector
asset provider
safe claim
danish krone
portfolio share
perceive risk
liquidity provision
bidask spread
float rate
value safe
save glut
basis swap
external finance
return equity
asset pricing
fiscal capacity
collateral trap
treasury bill
stock return
risk perception
credit quality
treasury agency
rate note
corporate bond
debt issue
collateral value
knightian uncertainty
riskaversion shock

Table A3: Summary of bond data used

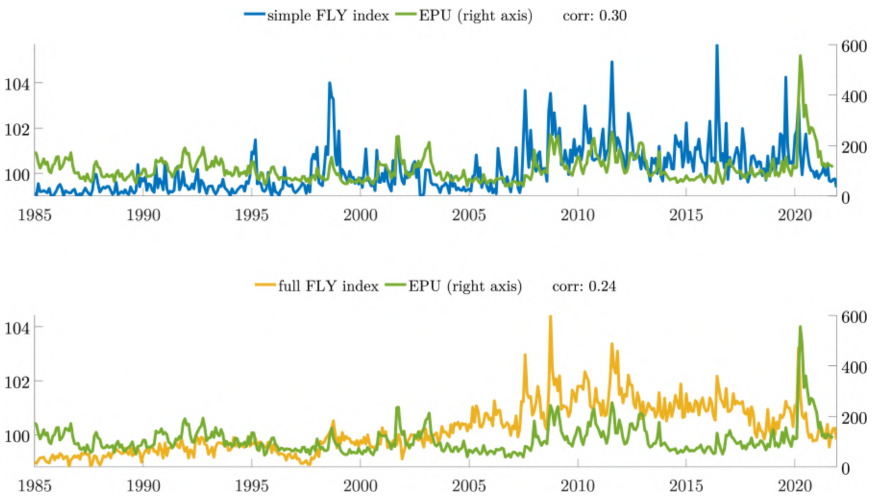
ISO 2 code	**Country**	**IMF classification**	**Time**	**Currencies**	**Maturities**
AT	Austria	advanced	Jan-1995 : Dec-2021	EUR	3M, 6M, 1Y, 2Y, 3Y, 5Y, 7Y, 10Y
AU	Australia	advanced	May-1991 : Dec-2021	AUD	3M, 1Y, 2Y, 3Y, 5Y, 7Y, 10Y
BE	Belgium	advanced	Jan-1995 : Dec-2021	EUR	3M, 6M, 1Y, 2Y, 3Y, 5Y, 7Y, 10Y
BR	Brazil	emerging	Apr-2007, Apr-1998 : Dec-2021	BRL, USD	3M, 1Y, 2Y, 3Y, 5Y, 7Y, 10Y
CA	Canada	advanced	Jul-1991 : Dec-2021	CAD	3M, 1Y, 2Y, 3Y, 7Y, 10Y
CH	Switzerland	advanced	Mar-1994 : Dec-2021	CHF	3M, 6M, 1Y, 2Y, 3Y, 5Y, 7Y, 10Y
CL	Chile	emerging	Nov-2005 : Dec-2021	CLP, USD	3M, 1Y, 2Y, 3Y, 5Y, 7Y
CN	China	emerging	Apr-2003 : Dec-2021	CNY	3M, 6M, 1Y, 2Y, 3Y, 5Y, 7Y, 10Y
CO	Colombia	emerging	Nov-2004, Jan-1998 : Dec-2021	COP, USD	3M, 6M, 1Y, 2Y, 3Y, 5Y, 7Y, 10Y
CZ	Czech Republic	advanced	Feb-1997 : Dec-2021	CZK	3M, 6M, 1Y, 2Y, 3Y, 5Y, 7Y, 10Y
DE	Germany	advanced	Nov-1991 : Dec-2021	EUR	3M, 1Y, 2Y, 3Y, 5Y, 7Y, 10Y
DK	Denmark	advanced	Mar-1994 : Dec-2021	DKK	3M, 6M, 1Y, 2Y, 3Y, 5Y, 7Y, 10Y
ES	Spain	advanced	Jul-1993 : Dec-2021	EUR	3M, 1Y, 2Y, 3Y, 7Y, 10Y
FI	Finland	advanced	Oct-1998 : Dec-2021	EUR	3M, 6M, 1Y, 2Y, 3Y, 5Y, 7Y, 10Y
FR	France	advanced	May-1992 : Dec-2021	EUR	3M, 6M, 1Y, 2Y, 3Y, 5Y, 7Y, 10Y
GB	United Kingdom	advanced	May-1991 : Dec-2021	GBP	3M, 1Y, 2Y, 3Y, 5Y, 7Y, 10Y
HU	Hungary	emerging	Feb-1999 : Dec-2021	HUF	3M, 1Y, 2Y, 3Y, 5Y, 7Y, 10Y
ID	Indonesia	emerging	Aug-2003 : Dec-2021	IDR	3M, 1Y, 2Y, 3Y, 7Y, 10Y
IE	Ireland	advanced	Mar-1994 : Dec-2021	EUR	3M, 6M, 1Y, 2Y, 3Y, 5Y, 7Y, 10Y
IL	Israel	advanced	Apr-2005 : Dec-2021	ILS	3M, 1Y, 2Y, 3Y, 5Y, 7Y, 10Y
IT	Italy	advanced	May-1997 : Dec-2021	EUR	3M, 6M, 1Y, 2Y, 3Y, 5Y, 7Y, 10Y
JP	Japan	advanced	Oct-1992 : Dec-2021	JPY	3M, 1Y, 2Y, 3Y, 5Y, 7Y, 10Y
KR	South Korea	advanced	Nov-2000, Jan-1998 : Dec-2021	KRW, USD	3M, 6M, 1Y, 2Y, 3Y, 7Y, 10Y
MX	Mexico	emerging	Mar-2003, Jan-1998 : Dec-2021	MXN, USD	3M, 6M, 1Y, 2Y, 3Y, 5Y, 7Y, 10Y
MY	Malaysia	emerging	Oct-1999 : Dec-2021	MYR	3M, 1Y, 2Y, 3Y, 5Y, 7Y, 10Y
NL	Netherlands	advanced	May-1991 : Dec-2021	EUR	3M, 6M, 1Y, 2Y, 3Y, 5Y, 7Y, 10Y
NO	Norway	advanced	Aug-1998 : Dec-2021	NOK	3M, 6M, 1Y, 2Y, 3Y, 5Y, 7Y, 10Y
NZ	New Zealand	advanced	Apr-1992 : Dec-2021	NZD	3M, 6M, 1Y, 2Y, 3Y, 5Y, 7Y, 10Y
PE	Peru	emerging	Sep-2007, Mar-2006 : Dec-2021	PEN, USD	3M, 1Y, 2Y, 3Y, 5Y, 7Y, 10Y
PH	Philippines	emerging	Sep-2001, Jan-2001 : Dec-2021	PHP, USD	3M, 1Y, 2Y, 3Y, 5Y, 7Y, 10Y
PL	Poland	emerging	Jun-1999 : Dec-2021	PLN	3M, 1Y, 2Y, 3Y, 5Y, 7Y, 10Y
PT	Portugal	advanced	Jan-1995 : Dec-2021	EUR	3M, 6M, 1Y, 2Y, 3Y, 5Y, 7Y, 10Y
RO	Romania	emerging	Dec-2010 : Dec-2021	RON	3M, 6M, 1Y, 2Y, 3Y, 5Y, 7Y, 10Y
RU	Russia	emerging	Jul-2007 : Dec-2021	RUB	3M, 1Y, 2Y, 3Y, 5Y, 7Y, 10Y
SE	Sweden	advanced	Mar-1994 : Dec-2021	SEK	1Y, 2Y, 3Y, 5Y, 7Y, 10Y
SK	Slovakia	advanced	May-2003 : Dec-2021	EUR	3M, 6M, 1Y, 2Y, 3Y, 5Y, 7Y, 10Y
TH	Thailand	emerging	Jul-1999 : Dec-2021	THB	3M, 1Y, 2Y, 3Y, 7Y, 10Y
TR	Turkey	emerging	Jul-2010, Aug-2000 : Dec-2021	TRY, USD, EUR	3M, 1Y, 2Y, 3Y, 5Y, 7Y, 10Y
US	United States	advanced	May-1991 : Dec-2021	USD	3M, 1Y, 2Y, 3Y, 7Y, 10Y
ZA	South Africa	emerging	Jan-1995 : Dec-2021	ZAR	3M, 6M, 1Y, 2Y, 3Y, 7Y, 10Y

B Additional figures

Figure B1: Wordcloud summarizing the relative frequency of the bigrams in Mankiw's *Principles of Economics*

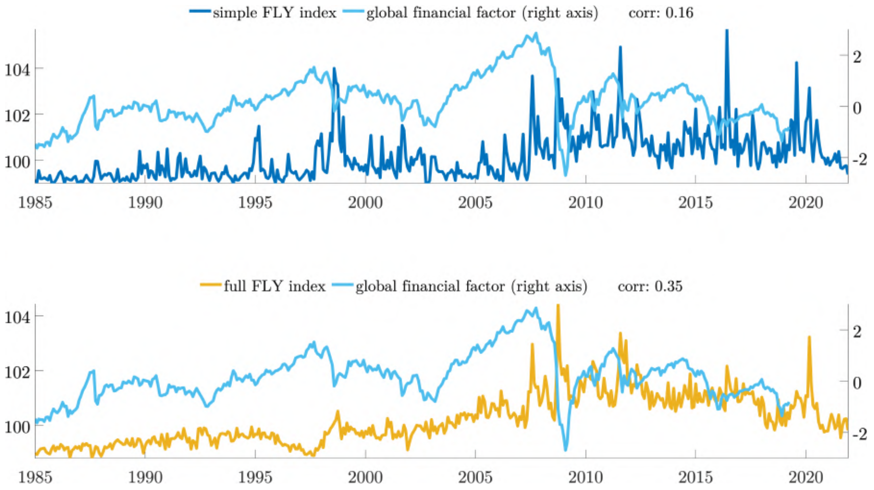
Note: The figure shows the list of the top 100 bigrams in the economics library, $\mathscr{L}^{econ}$, which is based on the eighth edition of Greg Mankiw's *Principles of Economics* (Mankiw, 2017); the size of each bigram k is proportional to its frequency $f_k(\mathscr{L}^{econ})$; the construction of the library and frequencies is described in section III.1.

Figure B2: Simple FLY index and Full FLY index compared with the EPU



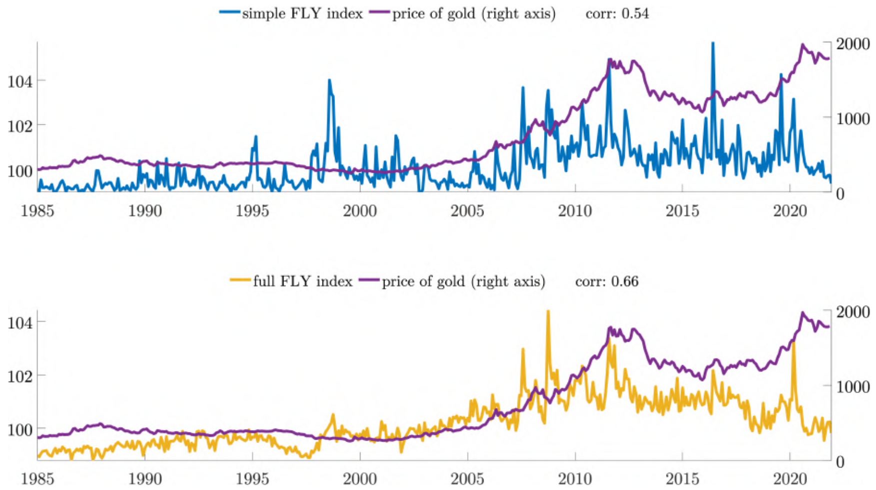
Note: the figure plots the simple version of the FLY index, based on the simple safe assets library $\mathscr{L}^0$, and the full version of the FLY index, based on the full safe assets library $\mathscr{L}$, and compares each of them to the Economic Policy Uncertainty Index (EPU, with units on the right axis); details on the construction of the FLY are described in section III.1; the EPU is from Baker et al. (2016); the correlation between each version of the index and the EPU is shown at the top of each graph; the frequency is monthly.

Figure B3: Simple FLY index and Full FLY index compared with the global financial factor



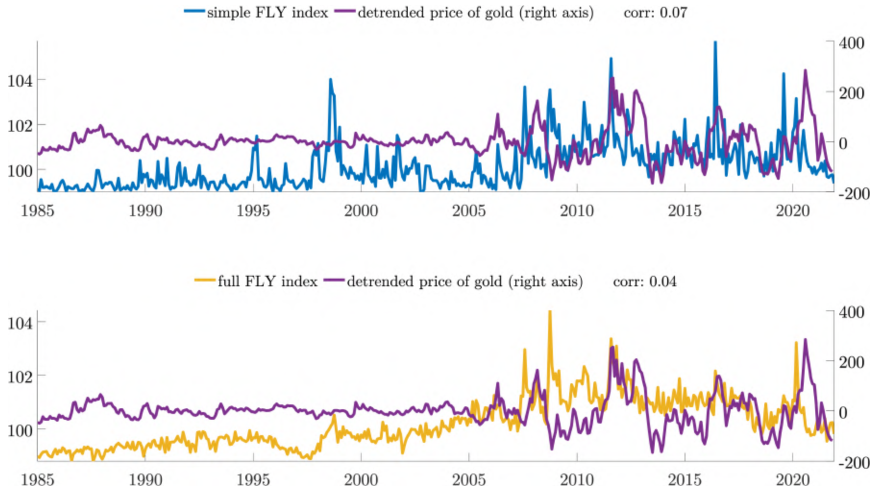
Note: the figure plots the simple version of the FLY index, based on the simple safe assets library $\mathscr{L}^0$, and the full version of the FLY index, based on the full safe assets library $\mathscr{L}$, and compares each of them to the Global Financial Factor (GFF, with units on the right axis); details on the construction of the FLY are described in section III.1; the GFF is from Miranda-Agrippino and Rey (2021); the correlation between each version of the index and the GFF is shown at the top of each graph; the frequency is monthly.

Figure B4: Simple FLY index and Full FLY index compared with the price of gold



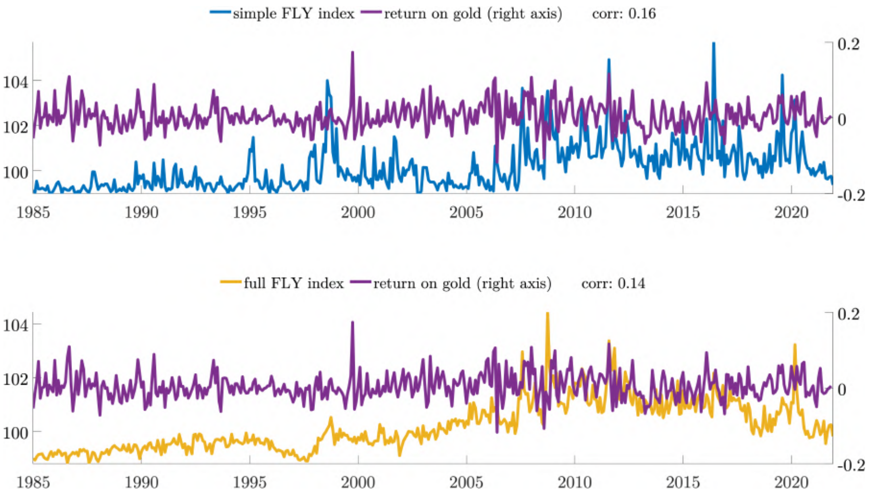
Note: the figure plots the simple version of the FLY index, based on the simple safe assets library $\mathscr{L}^0$, and the full version of the FLY index, based on the full safe assets library $\mathscr{L}$, and compares each of them to the price of gold (with units on the right axis); details on the construction of the FLY are described in section III.1; the price of gold is from the Federal Reserve Economic Data; the correlation between each version of the index and the price of gold is shown at the top of each graph; the frequency is monthly.

Figure B5: Simple FLY index and Full FLY index compared with the detrended price of gold



Note: the figure plots the simple version of the FLY index, based on the simple safe assets library $\mathscr{L}^0$, and the full version of the FLY index, based on the full safe assets library $\mathscr{L}$, and compares each of them to the detrended (HP-filtered) price of gold (with units on the right axis); details on the construction of the FLY are described in section III.1; the price of gold is from the Federal Reserve Economic Data; the correlation between each version of the index and the detrended price of gold is shown at the top of each graph; the frequency is monthly.

Figure B6: Simple FLY index and Full FLY index compared with the return of gold



Note: the figure plots the simple version of the FLY index, based on the simple safe assets library $\mathscr{L}^0$, and the full version of the FLY index, based on the full safe assets library $\mathscr{L}$, and compares each of them to the return of gold (with units on the right axis); details on the construction of the FLY are described in section III.1; the price of gold is from the Federal Reserve Economic Data; the correlation between each version of the index and the return of gold is shown at the top of each graph; the frequency is monthly.

C Model derivations

I follow the derivation in Brunnermeier et al. (2022a), adapted to accommodate the extensions involving multiple countries, country-specific risk, and time-varying convenience yields. First, let us recap the equations from the setup in the main text. On the production side, output is produced linearly from capital, $y_{it} = a_t k_{it}^j$, and the law of motion of individual capital is

$$\frac{\mathrm{d}k_{it}^j}{k_{it}^j} = \Big(\Phi(\iota_{it}^j) - \delta\Big)\mathrm{d}t + \tilde{\sigma}_t \mathrm{d}\widetilde{Z}_{it}^j \ , \tag{C1}$$

where $\Phi(\iota_{it}) = \frac{1}{\phi}\ln(1+\phi\iota_{it})$. On the consumption side, preferences are given by

$$U_{i0}^j = \mathbb{E}\left[\int_0^\infty e^{-\rho t}\Big\{\ln c_{it}^j + \int_0^1 v_t^{j'} \ln b_{it}^{j,j'} \mathrm{d}j\Big\}\right] \ . \tag{C2}$$

On the government side, nominal debt follows an exogenous process

$$\frac{\mathrm{d}B_t^j}{B_t^j} = \mu_t^{B,j}\mathrm{d}t \ , \tag{C3}$$

and the government faces the budget constraint

$$i_t^j B_t^j + P_t^j g K_t^j = \mu_t^{B,j} B_t^j + P_t^j \tau_t^j a_t K_t^j \ . \tag{C4}$$

We are going to focus on the price of capital and, for simplicity, scaled real value of bond holdings

$$q_t^{B,j'} = \frac{B_t^{j'}/P_t^{j'}}{K_t^{j'}} \ . \tag{C5}$$

Bond and capital prices are assumed to follow standard Ito processes

$$\frac{\mathrm{d}q_t^{B,j'}}{q_t^{B,j'}} = \mu_t^{q^B,j'}\mathrm{d}t + \sigma_t^{q^B,j'}\mathrm{d}Z_t + \tilde{\omega}_t^{q^B}\mathrm{d}\widetilde{W}_t^j \ . \tag{C6}$$

$$\frac{\mathrm{d}q_t^{K,j}}{q_t^{K,j}} = \mu_t^{q^K,j}\mathrm{d}t + \sigma_t^{q^K,j}\mathrm{d}Z_t \ . \tag{C7}$$

Applying Ito's lemma, bond returns are given by

$$
\begin{aligned}
\mathrm{d}r_t^{B,j'} &= i_t^{j'}\mathrm{d}t + \frac{\mathrm{d}(1/P_t^{j'})}{1/P_t^{j'}} = i_t^{j'}\mathrm{d}t + \frac{\mathrm{d}(q_t^{B,j'}K_t^{j'}/B_t^{j'})}{q_t^{B,j'}K_t^{j'}/B_t^{j'}} \\
&= \Big[\Phi(\iota_{it}^{j'}) - \delta + \mu_t^{q^B,j'} - \check{\mu}_t^{B,j'}\Big]\mathrm{d}t + \sigma_t^{q^B,j'}\mathrm{d}Z_t + \tilde{\omega}_t^{q^B}\mathrm{d}\widetilde{W}_t^{j'} \ , \qquad \text{(C8)}
\end{aligned}
$$

and the diversified bond portfolio return is

$$
\begin{aligned}
\mathrm{d}r_t^{\bar{B}} &= \int \mathrm{d}r_t^{B,j'}\mathrm{d}j' \\
&= \mathbb{E}_t\big[\mathrm{d}r_t^{\bar{B}}\big] + \bigg(\int \sigma_t^{q^B,j'}\mathrm{d}j'\bigg)\mathrm{d}Z_t \ . \qquad \text{(C9)}
\end{aligned}
$$

Similarly, the capital return is

$$
\begin{aligned}
\mathrm{d}r_{it}^{K,j} &= \frac{(1-\tau_t^j)a_t - \iota_{it}^j}{q_t^{K,j}} + \frac{\mathrm{d}(q_t^{K,j}k_{it}^j)}{q_t^{K,j}k_{it}^j} \\
&= \bigg[\frac{(1-\tau_t^j)a_t - \iota_{it}^j}{q_t^{K,j}} + \Phi(\iota_{it}^j) - \delta + \mu_t^{q^K,j}\bigg]\mathrm{d}t + \sigma_t^{q^K,j}\mathrm{d}Z_t + \tilde{\sigma}_t\mathrm{d}\widetilde{Z}_{it} \ . \qquad \text{(C10)}
\end{aligned}
$$

Finally, the equity return is

$$
\mathrm{d}r_{it}^{E,j} = \mathbb{E}_t\big[\mathrm{d}r_{it}^{E,j}\big] + \sigma_t^{q^K,j}\mathrm{d}Z_t + \tilde{\sigma}_t\mathrm{d}\widetilde{Z}_{it} \ , \qquad \text{(C11)}
$$

and the diversified equity portfolio return

$$
\mathrm{d}\bar{r}_t^{E,j} = \int \mathrm{d}r_{it}^{E,j}\mathrm{d}i \ . \qquad \text{(C12)}
$$

Net worth evolves as

$$
\frac{\mathrm{d}n_{it}^j}{n_{it}^j} = -\frac{c_{it}^j}{n_{it}^j} + \theta_{it}^{j,j}\mathrm{d}r_t^{B,j} + \theta_{it}^{\bar{B},j}\mathrm{d}r_t^{\bar{B}} + \theta_{it}^{K,j}\mathrm{d}r_{it}^{K,j} - \theta_{it}^{E,j}\mathrm{d}r_{it}^{E,j} + \theta_{it}^{\bar{E},j}\mathrm{d}\bar{r}_t^{E,j} \ . \qquad \text{(C13)}
$$

Portfolio choices are limited by two constraints: a home bias constraint

$$
\theta_{it}^{j,j} = \hslash\big(\theta_{it}^{j,j} + \theta_{it}^{\bar{B},j}\big) = \hslash\uptheta_{it}^j \ , \qquad \text{(C14)}
$$

and a skin-in-the-game constraint

$$\theta_{it}^{E,j} \leq (1-\chi)\theta_{it}^{K,j} \ . \tag{C15}$$

The total portfolio weight on bonds is

$$\uptheta_{it}^{j} = \theta_{it}^{j,j} + \theta_{it}^{\bar{B},j} \ . \tag{C16}$$

Portfolio weights must also add up to 1:

$$\theta_{it}^{j,j} + \theta_{it}^{\bar{B},j} + \theta_{it}^{K,j} - \theta_{it}^{E,j} + \theta_{it}^{\bar{E},j} = 1 \ . \tag{C17}$$

Finally, productivity, volatility of idiosyncratic risk, nominal interest rates, and convenience benefits follow exogenous processes:

$$\frac{\mathrm{d}a_t}{a_t} = \mu_t^a \mathrm{d}t + \sigma_t^a \mathrm{d}Z_t \ , \tag{C18}$$

$$\frac{\mathrm{d}\tilde{\sigma}_t}{\tilde{\sigma}_t} = \mu_t^{\tilde{\sigma}} \mathrm{d}t + \sigma_t^{\tilde{\sigma}} \mathrm{d}Z_t \ , \tag{C19}$$

$$\frac{\mathrm{d}i_t^j}{i_t^j} = \mu_t^{i,j} \mathrm{d}t + \tilde{\omega}_t^i \mathrm{d}\widetilde{W}_t^j \ , \tag{C20}$$

$$\frac{\mathrm{d}v_t^j}{v_t^j} = \mu_t^{v,j} \mathrm{d}t + \tilde{\omega}_t^v \mathrm{d}\widetilde{W}_t^j \ . \tag{C21}$$

C.1 Hamiltonian

Before writing down the Hamiltonian, use the home bias constraint to rewrite the portfolio weights on domestic bonds and diversified bond portfolio as $\theta_{it}^{j,j} = \hslash \uptheta_{it}^{j}$ and $\theta_{it}^{\bar{B},j} = (1-\hslash)\uptheta_{it}^{j}$. In addition, use the fact that the portfolio weights have to sum up to one to get rid of the portfolio weight on the diversified bond portfolio. Finally, let $\bar{\sigma}_t^{q^B} = \int \sigma_t^{q^B,j'} \mathrm{d}j'$ and let $\bar{v}_t = \int v_t^{j'} \mathrm{d}j'$. Notice the non-pecuniary benefits from holding bonds can be split between the holding of domestic and diversified portfolio, and in the diversified portfolio each bond receives an equal infinitesimal weight, so that $\int v_t^{j'} \ln \theta_{it}^{j,j'} n_{it}^{j} \mathrm{d}j' = v_t^{j} \ln \theta_{it}^{j,j} n_{it}^{j} + \bar{v}_t \ln \theta_{it}^{\bar{B},j} n_{it}^{j}$.

Therefore the Hamiltonian for the problem is

$$
\begin{aligned}
\mathscr{H}_{it}^{j} = {} & e^{-\rho t} \ln c_{it}^{j} + e^{-\rho t} v_t^j \ln \hbar \uptheta_{it}^{j} n_{it}^{j} + e^{-\rho t} \bar{v}_t \ln(1-\hbar)\uptheta_{it}^{j} n_{it}^{j} + \xi_{it}^{j} \Bigg\{ - {c_{it}}^{j} \\
& + n_{it}^{j} \frac{\mathbb{E}_t[\mathrm{d}r_t^{\bar{B}}]}{\mathrm{d}t} + n_{it}^{j} \hbar \uptheta_{it}^{j} \left(\frac{\mathbb{E}_t[\mathrm{d}r_t^{B,j}]}{\mathrm{d}t} - \frac{\mathbb{E}_t[\mathrm{d}r_t^{\bar{B}}]}{\mathrm{d}t} \right) + n_{it}^{j} \theta_{it}^{K,j} \left(\frac{\mathbb{E}_t[\mathrm{d}r_{it}^{K,j}]}{\mathrm{d}t} - \frac{\mathbb{E}_t[\mathrm{d}r_t^{\bar{B}}]}{\mathrm{d}t} \right) \\
& - n_{it}^{j} \theta_{it}^{E,j} \left(\frac{\mathbb{E}_t[\mathrm{d}r_{it}^{E,j}]}{\mathrm{d}t} - \frac{\mathbb{E}_t[\mathrm{d}r_t^{\bar{B}}]}{\mathrm{d}t} \right) + n_{it}^{j} \theta_{it}^{\bar{E},j} \left(\frac{\mathbb{E}_t[\mathrm{d}r_t^{\bar{E},j}]}{\mathrm{d}t} - \frac{\mathbb{E}_t[\mathrm{d}r_t^{\bar{B}}]}{\mathrm{d}t} \right) \Bigg\} \\
& - \varsigma_{it}^{j} \xi_{it}^{j} n_{it}^{j} \left(\bar{\sigma}_t^{q^B} - \hbar \uptheta_{it}^{j} \big(\sigma_t^{q^B,j} - \bar{\sigma}_t^{q^B} \big) - \big(\theta_{it}^{K,j} - \theta_{it}^{E,j} + \theta_{it}^{\bar{E},j}\big)\big(\sigma_t^{q^K,j} - \bar{\sigma}_t^{q^B}\big) \right) \\
& - \tilde{\varsigma}_{it}^{j} \xi_{it}^{j} \big(\theta_{it}^{K,j} - \theta_{it}^{E,j}\big) \tilde{\sigma}_t - \tilde{\varpi}_{it}^{j} \xi_{it}^{j} n_{it}^{j} \hbar \uptheta_{it}^{j} \tilde{\omega}_t^{q^B} \ ,
\end{aligned}
$$

where ξ_{it}^{j} is the costate (which corresponds to the stochastic discount factor), and $\varsigma_{it}\xi_{it}, \tilde{\varsigma}_{it}\xi_{it}$, and $\tilde{\varpi}_{it}\xi_{it}$ are its loadings on the Brownian motions $\mathrm{d}Z_t, \mathrm{d}\widetilde{Z}_{it}$, and $\mathrm{d}\widetilde{W}_t^j$, respectively. In addition, remember the skin-in-the game constraint when taking first-order conditions with respect to the capital and equity portfolio weights.

C.2 Deriving equilibrium prices and investment

FOCs for consumption and investment give

$$c_{it}^{j} = \rho n_{it}^{j} \ , \tag{C22}$$

$$q_t^{K,j} = 1 + \phi \iota_t^j \ . \tag{C23}$$

Aggregating consumption within each country gives

$$C_t^j = \rho N_t^j = \rho \frac{q_t^{K,j}}{1 - \uptheta_t^j} \ , \tag{C24}$$

where $\uptheta_t^j = \int \uptheta_{it}^j \mathrm{d}i$ and we have used the fact that $q_t^{K,j} = \theta_t^{K,j} N_t^j = (1 - \uptheta_t^j) N_t^j$ because equity is in zero net supply and $\theta_t^{E,j} = \theta_t^{\bar{E},j}$.

Combining this with the investment FOC and substituting it into the goods market clearing condition gives

$$\rho \frac{1 + \phi \iota_t^j}{1 - \uptheta_t^j} + g + \iota_t^j = a_t \ . \tag{C25}$$

Solving for ι_t^j gives

$$\iota_t^j = \frac{(1-\uptheta_t^j)(a_t - g) - \rho}{1 - \uptheta_t^j + \phi\rho} \ . \tag{C26}$$

Substituting this back into (C23) gives

$$q_t^K = \left(1 - \uptheta_t^j\right) \frac{1 + \phi(a_t - g)}{1 - \uptheta_t^j + \phi\rho} \ . \tag{C27}$$

By the definition of $\theta_t^{j,j}$

$$q_t^{B,j} = \frac{\theta_t^{j,j}}{1 - \uptheta_t^j} q_t^K \ , \tag{C28}$$

so

$$q_t^{B,j} = \theta_t^{j,j} \frac{1 + \phi(a_t - g)}{1 - \uptheta_t^j + \phi\rho} \ . \tag{C29}$$

Using the home bias constraint

$$q_t^{B,j} = \hbar \uptheta_t^j \frac{1 + \phi(a_t - g)}{1 - \uptheta_t^j + \phi\rho} \ . \tag{C30}$$

C.3 Deriving the equilibrium process for asset demand

FOCs for portfolio shares give

$$\frac{\mathbb{E}_t[\mathrm{d}r_t^{B,j}]}{\mathrm{d}t} - \frac{\mathbb{E}_t[\mathrm{d}r_t^{\bar{B}}]}{\mathrm{d}t} = \varsigma_{it}^j\left(\sigma_t^{q^B,j} - \bar{\sigma}_t^{q^B}\right) + \tilde{\varpi}_{it}^j \tilde{\omega}_t^{q^B} - \frac{\rho v_t^j}{\hbar \uptheta_t^j} \ , \tag{C31}$$

$$\frac{\mathbb{E}_t[\mathrm{d}r_{it}^{K,j}]}{\mathrm{d}t} - \frac{\mathbb{E}_t[\mathrm{d}r_t^{\bar{B}}]}{\mathrm{d}t} = \varsigma_{it}^j\left(\sigma_t^{q^K,j} - \bar{\sigma}_t^{q^B}\right) + \tilde{\varsigma}_{it}^j \tilde{\sigma}_t - \ell_{it}^{\chi,j}(1-\chi) \ , \tag{C32}$$

$$\frac{\mathbb{E}_t[\mathrm{d}r_{it}^{E,j}]}{\mathrm{d}t} - \frac{\mathbb{E}_t[\mathrm{d}r_t^{\bar{B}}]}{\mathrm{d}t} = \varsigma_{it}^j\left(\sigma_t^{q^K,j} - \bar{\sigma}_t^{q^B}\right) + \tilde{\varsigma}_{it}^j \tilde{\sigma}_t - \ell_{it}^{\chi,j} \ , \tag{C33}$$

$$\frac{\mathbb{E}_t[\mathrm{d}r_{it}^{\bar{E},j}]}{\mathrm{d}t} - \frac{\mathbb{E}_t[\mathrm{d}r_t^{\bar{B}}]}{\mathrm{d}t} = \varsigma_{it}^j\left(\sigma_t^{q^K,j} - \bar{\sigma}_t^{q^B}\right) \ , \tag{C34}$$

where $\ell_{it}^{\chi,j}$ is the Lagrange multiplier on the skin-in-the-game constraint, and we have used the fact that $\xi_{it}^j = \frac{e^{-\rho t}}{\rho n_{it}^j}$. Since in equilibrium $\frac{\mathbb{E}_t[\mathrm{d}r_{it}^{E,j}]}{\mathrm{d}t} = \frac{\mathbb{E}_t[\mathrm{d}r_t^{\bar{E},j}]}{\mathrm{d}t}$, the last two equations immediately imply

$$\ell_{it}^{\chi,j} = \tilde{\varsigma}_{it}^j \tilde{\sigma}_t \ , \tag{C35}$$

meaning the skin-in-the-game constraint always binds, as the RHS of this equation is always strictly positive (as confirmed below). Since $\xi_{it}^j = \frac{e^{-\rho t}}{\rho n_{it}^j}$ we have that the loadings of the costate correspond to the loadings of net worth on each of the Brownian motions

$$\varsigma_{it}^{j} = \sigma_{it}^{n,j} = \theta_{it}^{j,j}\sigma_t^{q^B,j} + \theta_{it}^{\bar{B},j}\bar{\sigma}_t^{q^B} + (\theta_{it}^{K,j} - \theta_{it}^{E,j} + \theta_t^{\bar{E},j})\sigma_t^{q^K,j} \ , \tag{C36}$$

$$\tilde{\varsigma}_{it}^{j} = \tilde{\sigma}_{it}^{n,j} = (\theta_{it}^{K,j} - \theta_{it}^{E,j})\tilde{\sigma}_t \ , \tag{C37}$$

$$\tilde{\varpi}_{it}^{j} = \tilde{\omega}_{it}^{n,j} = \theta_{it}^{j,j}\tilde{\omega}_t^{q^B} \ . \tag{C38}$$

Now use a few more conditions to simplify: because the skin-in-the-game constraint binds, $\theta_{it}^{E,j} = (1-\chi)\theta_{it}^{K,j}$; because the home-bias constraint binds, $\theta_{it}^{j,j} = \hbar\uptheta_t^j$; and in equilibrium, $\theta_{it}^{E,j} = \theta_t^{\bar{E},j}$ and $\theta_{it}^{K,j} = 1 - \uptheta_t^j$ as portfolio choices are symmetric. So we can rewrite the conditions as

$$\varsigma_{it}^{j} = \uptheta_t^j\hbar\sigma_t^{q^B,j} + \uptheta_t^j(1-\hbar)\bar{\sigma}_t^{q^B} + (1-\uptheta_t^j)\sigma_t^{q^K,j} \ , \tag{C39}$$

$$\tilde{\varsigma}_{it}^{j} = (1-\uptheta_t^j)\chi\tilde{\sigma}_t \ , \tag{C40}$$

$$\tilde{\varpi}_{it}^{j} = \uptheta_t^j\hbar\tilde{\omega}_t^{q^B} \ . \tag{C41}$$

Now, we can take the difference between (C10) and (C8), and take the expectations of this difference to get:

$$\frac{\mathbb{E}_t[\mathrm{d}r_{it}^{K,j}]}{\mathrm{d}t} - \frac{\mathbb{E}_t[\mathrm{d}r_t^{B,j}]}{\mathrm{d}t} = \frac{(1-\tau_t^j)a_t - \iota_t^j}{q_t^{K,j}} + \mu_t^{q^K,j} - \mu_t^{q^B,j} + \breve{\mu}_t^{B,j'} \ . \tag{C42}$$

If instead we take the difference between (C32) and (C31), we get

$$\frac{\mathbb{E}_t[\mathrm{d}r_{it}^{K,j}]}{\mathrm{d}t} - \frac{\mathbb{E}_t[\mathrm{d}r_t^{B,j}]}{\mathrm{d}t} = \tilde{\varsigma}_{it}^{j}\tilde{\sigma}_t - \ell_{it}^{\chi,j}(1-\chi) - \varsigma_{it}^{j}\big(\sigma_t^{q^B,j} - \sigma_t^{q^K,j}\big) - \tilde{\varpi}_{it}^{j}\hbar\tilde{\omega}_t^{q^B} + \frac{\rho v_t^j}{\hbar\uptheta_t^j} \ . \tag{C43}$$

Combining them, and substiting the expressions we derived for (C35) and (C39)-(C41), we get

$$\begin{aligned}\frac{(1-\tau_t^j)a_t - \iota_t^j}{q_t^{K,j}} + \mu_t^{q^K,j} - \mu_t^{q^B,j} + \breve{\mu}_t^{B,j'} &= (1-\uptheta_t^j)\chi^2\tilde{\sigma}_t^2 \\ &- \Big[\uptheta_t^j\hbar\sigma_t^{q^B,j} + \uptheta_t^j(1-\hbar)\bar{\sigma}_t^{q^B} + (1-\uptheta_t^j)\sigma_t^{q^K,j}\Big]\big(\sigma_t^{q^B,j} - \sigma_t^{q^K,j}\big) \\ &- \uptheta_t^j\hbar(\tilde{\omega}_t^{q^B})^2 + \frac{\rho v_t^j}{\hbar\uptheta_t^j} \ .\end{aligned} \tag{C44}$$

From the government budget constraint, $\tau_t^j = g - q_t^{B,j}\breve{\mu}_t^{B,j}$, and use $q_t^{K,j} = (1-\uptheta_t^j)N_t^j$ and $q_t^{B,j} = \hbar\uptheta_t^j N_t^j$ to rewrite the LHS as

$$\begin{aligned}
\frac{(1-\tau_t^j)a_t - \iota_t^j}{q_t^{K,j}} + \mu_t^{q^K,j} - \mu_t^{q^B,j} + \breve{\mu}_t^{B,j\prime} &= \frac{a_t - g + q_t^{B,j}\breve{\mu}_t^{B,j} - \iota_t^j}{(1-\uptheta_t^j)N_t^j} + \mu_t^{q^K,j} - \mu_t^{q^B,j} + \breve{\mu}_t^{B,j\prime} \\
&= \frac{1}{1-\uptheta_t^j}\frac{a_t - g - \iota_t^j}{N_t^j} + \breve{\mu}_t^{B,j} + \frac{\hbar\uptheta_t^j}{1-\uptheta_t^j}\breve{\mu}_t^{B,j} + \mu_t^{q^K,j} - \mu_t^{q^B,j} \\
&= \frac{\rho}{1-\uptheta_t^j} + \breve{\mu}_t^{B,j}\frac{1-\uptheta_t^j + \hbar\uptheta_t^j}{1-\uptheta_t^j} + \mu_t^{q^K,j} - \mu_t^{q^B,j} \ , \qquad \text{(C45)}
\end{aligned}$$

where the last equality follows from good market clearing and (C24). Now, apply Ito's lemma to $1 - \uptheta_t^j = \frac{q_t^{K,j}}{N_t^j}$ and $\theta_t^{j,j} = \frac{q_t^{B,j}}{N_t^j}$ to obtain

$$-\mu_t^{\theta,j}/\hbar = \mu_t^{q^K,j} - \mu_t^{N,j} + (\sigma_t^{N,j})^2 - \sigma_t^{q^K,j}\sigma_t^{N,j} \ , \qquad \text{(C46)}$$

$$\mu_t^{\theta,j} = \mu_t^{q^B,j} - \mu_t^{N,j} + (\sigma_t^{N,j})^2 - \sigma_t^{q^B,j}\sigma_t^{N,j} + (\tilde{\omega}_t^N)^2 - \tilde{\omega}_t^{q^B}\tilde{\omega}_t^N \ . \qquad \text{(C47)}$$

Combine them to obtain an expression for $\mu_t^{q^K,j} - \mu_t^{q^B,j}$, use (C41), and substitute the result into (C45) to get

$$\frac{\rho}{1-\uptheta_t^j} + \breve{\mu}_t^{B,j}\frac{1-\uptheta_t^j + \hbar\uptheta_t^j}{1-\uptheta_t^j} - \mu_t^{\theta,j}\frac{1+\hbar}{\hbar} - \sigma_t^{N,j}(\sigma_t^{q^B,j} - \sigma_t^{q^K,j}) + (\uptheta_t^j)^2\hbar^2(\tilde{\omega}_t^{q^B})^2 - \uptheta_t^j\hbar(\tilde{\omega}_t^{q^B})^2 \ . \qquad \text{(C48)}$$

Finally, replace this as the LHS of (C44) and rearrange to get

$$\mu_t^{\theta,j}\frac{1+\hbar}{\hbar} = \frac{\rho}{1-\uptheta_t^j} + \breve{\mu}_t^{B,j}\left(1 + \frac{\hbar\uptheta_t^j}{1-\uptheta_t^j}\right) - (1-\uptheta_t^j)\chi^2\tilde{\sigma}_t^2 + (\uptheta_t^j)^2\hbar^2(\tilde{\omega}_t^{q^B})^2 - \frac{\rho v_t^j}{\hbar\uptheta_t^j} \ . \qquad \text{(C49)}$$

Write $\mu_t^{\theta,j}$ as $\frac{\mathbb{E}_t[\mathrm{d}\theta_t^{j,j}]}{\theta_t^{j,j}}$ to obtain equation (20) in the main text.