Consumption, government failure, and asset prices

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Abstract

The equity premium–risk-free rate level and predictability puzzles in standard power utility consumption-based asset pricing models disappear once we remove the government-imposed component from the consumption expenditure series. I calibrate this component based on the growth rates of two proxies for government intervention, which I also show to forecast the short- and long-term equity premiums between 1974 (or 1981) and 2017. In summary, investors require large premiums to hold stocks because stocks deliver poor returns when government intervention (failure) increases, systematically reducing individual utility levels. Government failure is likely the key macro-finance variable linking asset prices and economic fluctuations.

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1 Introduction

Government intervention forces individuals to change their consumption bundles (directly or indirectly, if the intervention happens in the firms). Individuals consume more of what the government mandates and less of what they choose. Irrespective of whether this solves market failures or creates government failures, it affects aggregate welfare. Hence, within a consumption-based asset pricing framework, (marginal) utilities, state prices, and equilibrium risk premiums are not only a function of consumption expenditures: Aggregate utility derived from consumption must either be adjusted up or down in the presence of more government intervention. Existing asset pricing theories involving governments, such as Pastor and Veronesi (2013, 2012), assume the former. They are built on the supposition that government intervention increases aggregate welfare. But a common empirical obstacle for any consumption-based asset pricing theory is the equity premium "puzzle": The quantitative predictions of all these theories are inconsistent with the level and variation of aggregate returns observed empirically (Cochrane, 2017).

The present paper contributes to this discussion. It investigates the effects of systematic government failures within a traditional consumption-based asset pricing framework. Under this assumption, a standard time-separable power utility asset pricing model generates the observed market Sharpe ratio, a low and stable risk-free rate, and predictability, based on realistic consumption expenditure, a positive subjective discount factor, and low risk aversion. This solves the equity premium–risk-free rate puzzle as currently defined (Cochrane, 2017). Put differently, the puzzle is a result of ignoring government failure.

The central idea of the paper is to "clean" aggregate consumption expenditure of its unwanted part, imposed by the government, and obtain state prices implied by the voluntary consumption process instead. More specifically, I remove the amount of unwanted consumption in aggregate expenditures that is imposed by government regulations (Dawson and Seater, 2013; Djankov et al., 2002; Goff, 1996; Friedman and Friedman, 1980). This procedure can be related to the standard practice in consumption-based asset pricing of removing durable goods from aggregate expenditures (Campbell, 2003, for example) or (to the less standard practice of) changing the consumption argument in the utility function (Kroencke, 2017; Savov, 2011). However, the theoretical reasons for these adjustments are very different from the one that I propose.

Apart from being large, the fraction of aggregate expenditures imposed by the government must also change significantly over time to make voluntary consumption substantially more volatile than expenditures for it to have any chance of solving the puzzle. In addition, government failure growth must be (i) sufficiently **negatively** correlated with the equity premium to explain its level, (ii) heteroskedastic to explain its time variation, and (iii) become **more** volatile precisely when the premium decreases to correctly generate predictability. Hence, not *any* adjustment of the consumption series solves the puzzle. An important counter example is that, under the assumption that individuals benefit from government intervention – if such intervention solves market failures, for example – items (i) and (iii) above need to have the exact opposite signs to solve the puzzle. Otherwise, the model would predict negative, pro-cyclical equilibrium risk premiums for stocks. So, is the evidence in line with all these restrictions?

Although the average level of government intervention cannot be measured, its volatility and correlation with the equity premium can be estimated from the growth rates of two empirical proxies described in detail in Section 3.2: The number of pages in Title 3 (Presidential orders) of the Code of Federal Regulations (CFR) and the number of economically significant rules (ESR) that underwent review by the Office of Information and Regulatory Affairs. The CFR is the same (purely counting) proxy used by Dawson and Seater (2013) to measure regulatory activity, which I restrict to Presidential orders (Title 3) to track the

Figure 1: Yearly intervention growth, consumption expenditure growth, and the equity premium. In both graphs, the orange line at the bottom shows the equity premium, and the gray line at the top shows consumption expenditure growth. For the graph on the left, the black line at the top shows the yearly growth in the number of economically significant rules passed by the federal government in the three years preceding year t (compared to the total in the three years preceding year $t-1$). The graph on the right shows an equivalent measure for the number of pages in Title 3 of the Code of Federal Regulations. Intervention growth is substantially more volatile than consumption expenditure growth.

source of government intervention more closely.[1] The ESR is a (counting) proxy that also includes a qualitative component. I accumulate these quantities over three years under the assumption that the initial effects of some government choices are delayed for that period (for example, until they are fully implemented in all sectors of the economy).

Figure 1 shows that the volatilities of the equity premium and intervention growth (based on these proxies) are both one order of magnitude larger than that of expenditures. Table 3, discussed in Section 3.3, confirms these results and shows that the two intervention proxies are even more volatile than the equity premium without the three-year aggregation. The table also shows that both measures of government intervention growth are negatively correlated with the equity premium. Indeed, this negative association between government

[1] For example, regulations imposed by the president in one period often authorize federal agencies to independently regulate the economy at a later date, and these further activities appear in the remaining chapters of the Code.

intervention and asset prices is already documented at a less macro level. One example is the significant loss of 3.52% – the same magnitude of the equity premium in a full year – over just a few days for the stocks affected by gender regulation imposed by the Norwegian government (Ahern and Dittmar, 2012).

Intuitively, stocks are undesirable and cheap because they provide poor returns exactly when government failure (intervention) increases, voluntary consumption decreases, and marginal utilities and state prices become large as a consequence. Increases in the ESR, in particular, are even correlated with decreases in expenditures: Individuals often learn about negative aggregate shocks to expenditures at the same time as they learn about increases in government failure, so that a larger fraction of their already reduced wealth must be used for government-mandated consumption.

Finally, the general results that I report are also consistent with others in the literature. For example, in practice government failure tends to be regressive because, at least in part, it imposes fixed costs on individuals. Hence, a larger fraction of the expenditures of poor individuals is used for consumption chosen by the government, whereas wealthy individuals have more control over their consumption bundles. This can explain why using the series of expenditures of (wealthy) stockholders as a proxy for the consumption of the representative agent alleviates the equity premium puzzle (Mankiw and Zeldes, 1991). Another example is the "dramatic change in the equity premium in the post 1933 period – the premium rose from 3.92% to 8.93%" (Mehra and Prescott, 2003) – which coincides with the post-war increase in regulations documented in Dawson and Seater (2013) and the associated increase in government size and failure risk (surplus volatility) based on the framework that I present, explaining the change.

A few quantitative solutions of the puzzle: Given that the baseline average fraction of government-mandated consumption of total expenditures is unobservable, I report several combinations of possible average surpluses (in excess of government-mandated consumption), Sharpe ratios, subjective discount rates, and risk aversion parameters supported by the model and the proxies. Importantly, the surplus in each period is a combination of the baseline mean surplus (unobservable and "reverse engineered") and the **observed** proxies: If the proxies were not closely related to the equity premium, no average surplus would solve the puzzle. Based on the two proxies, however, the Sharpe ratios and the subjective discount rate increase to very large numbers and easily match the equity premium, as the average surplus decreases.

One set of parameters that solves the puzzle, for example, is based on the ESR proxy, a relative risk aversion of five, and an average total surplus of 8% (or 60% in each of five consecutive sectors, as I explain in Section 2.2). In this case, the market Sharpe ratio is 0.5, the price of risk (the mean-variance frontier Sharpe ratio) is 1.5, and the difference between the continuously compounded risk-free and subjective discount rates is $r_{f,t} - \delta_t = -115\%$. In another example, based on the CFR, with the same risk aversion of five, and an average total surplus of 16% (or 70% in each of five consecutive sectors), the market Sharpe ratio is 0.5, the price of risk is 2.8, and the difference between the risk-free and subjective discount rates is $r_{f,t} - \delta_t = -437\%$. The difference in these values arises mostly due to the higher volatility of the CFR compared to the ESR.

To get some perspective about the magnitudes of these average surpluses, it is useful to compare these numbers with the 5.7% average surplus over the habit level in Campbell and Cochrane (1999) and to consider that regulation accumulates in the production line, as I explain in Section 2.2. In addition, Dawson and Seater (2013) estimate that the U.S. economy is so heavily regulated that annual output by 2005 is a mere 28% of what it would have been had regulation remained at its 1949 level: They estimate that regulation forces the firms to choose suboptimal mixes of inputs. This is equivalent to imposing suboptimal consumption bundles on individuals – as I model it – since individuals are the ones that ultimately consume these goods.

As shown, the model implies positive subjective discount rates, as required to solve the puzzle. However, rates of these magnitudes are unusual in the asset pricing literature because the typical calibrations of the models rely on consumption expenditures to calculate changes in marginal utilities. Based on consumption expenditures, the implied subjective discount rates tend to be negative instead, because the economy seems very safe. This is part of the original "puzzle" because independently documented estimates of the subjective discount rate only go from slightly negative to (positive) infinity (Frederick et al., 2002).[2]

The model also delivers counter-cyclical variation in the market price of risk, which is purely based on the behavior of both proxies, without any further modeling assumptions. I show this by calibrating the consumption process conditioned on the (observed) estimated surplus being above its median ("good times") or below ("bad times"): With the same parameters as above, the market prices of risk in bad and good times are, respectively, 1.69 and 1.23 based on the ESR, or 3.83 and 1.05 based on the CFR. The market Sharpe ratios also vary counter-cyclically for the CFR: 0.67 and 0.12.[3]

More importantly, the model delivers short- and long-term predictability of the equity premium based on both proxies. Therefore the variation in the market price of risk documented above happens precisely at the "right" time: Increases in the two proxies for government intervention (and failure) significantly forecast increases in the equity premiums calculated at every horizon from one to five years (marginally for the 1-year market premium based on the ESR proxy).

[2]This happens because the smooth series of expenditures suggests a very safe economy in which precautionary savings are negligible.

[3]They do seem pro-cyclical for the ESR, 0.44 and 0.55, but this happens because the (typically difficult to estimate) point estimate of the correlation between the equity premium and calibrated consumption is higher in "good times" for this proxy. This variation becomes counter-cyclical if we either ignore the conditional correlation estimates or reduce the surplus further.

Finally, the subjective discount rate also varies counter-cyclically: Based on these parameters, the differences between the risk-free and the subjective discount rates in bad and good times are, respectively, −143% and −95% for the ESR, or −764% and −99% for the CFR. This variation is in line with the results in Giordano et al. (2002), being quantitatively close to the values related to the ESR proxy in particular: The discount rates with respect to monetary payoffs of opioid addicts almost doubles from 58% to 109% in "bad times", when they are craving the drug with respect to "good times", when they are not.[4] The change is even more pronounced for the discount of opioid.

1.1 Contribution and related literature

The present paper relates primarily to the literature on (tentative) solutions of the equity premium puzzle, which is extensively discussed in Cochrane (2017). The paper also belongs to the literature on the relation between governments and risk premiums. However, this literature currently centers on government-induced *changes* in risk premiums, as in Pastor and Veronesi (2013, 2012, 2017) and Liu et al. (2017), for example. The present paper offers a general solution for the full equity premium–risk-free puzzle instead, including the levels of these returns.

In addition to explaining why the puzzle remains unresolved, Cochrane (2017) reveals that the currently proposed solutions typically require two separate unobservable (or difficult to measure) variables: One to explain the level and another to explain the predictability of the premium. For example, the following relatively difficult to measure variables are claimed to explain the **level** of the equity premium: (i) News about long-run consumption growth (with lots of positive serial correlation if the agents have low risk aversion) (Bansal and Yaron, 2004; Bansal et al., 2014); (ii) large cross-section consumption volatility

[4] "In the opioid satiated condition, opioid-dependent subjects discounted $1000 by 50% at the 62-week delay [...] In the opioid deprived condition, $1000 was discounted by 50% at the 33-week delay" (Giordano et al., 2002, p. 180).

(Constantinides and Duffie, 1996); (iii) a particular aggregation mechanism that generates higher risk aversion for the representative agent relative to individual agents, in addition to significantly larger losses for less risk averse investors in bad times (Garleanu and Panageas, 2015); (iv) institutional firms that become **more** risk averse as they approach bankruptcy (as opposed to risk seekers in the face of limited liability), in addition to unequal margins for lenders and borrowers because markets are segmented even at the business cycle frequency (Brunnermeier, 2009; He and Krishnamurthy, 2013); (v) large risk of rare disasters (Barro, 2006); or (vi) behavioral biases Shiller (1981, 2014).

The extra, often difficult to measure, variables that these models require to generate equity premium **predictability** are: (i) Precisely-timed exogenous changes in long-run consumption volatility (Bansal and Yaron, 2004; Bansal et al., 2014); (ii) precisely-timed exogenous changes in cross-section consumption volatility (Constantinides and Duffie, 1996); (iii) a representative agent aggregation mechanism that accounts quantitatively for predictability (Garleanu and Panageas, 2015); (iv) precisely-timed "fire sales" or "liquidity spirals" opportunities that originate at the intermediary sector and are not arbitraged away by the household sector (Brunnermeier, 2009; He and Krishnamurthy, 2013); (v) precisely-timed exogenous changes in the risk of rare disasters (Barro, 2006); or (vi) precisely-timed exogenous changes in behavioral biases Shiller (1981, 2014).

In fact, even Campbell and Cochrane (1999) need two separate degrees of freedom to explain the level and predictability of the equity premium: The unobserved average (steady-state) surplus over the habit level, which is reverse-engineered to 5.7%, generates the (unrealistically) large risk aversion necessary for their model to match the level of the equity premium. But only a second assumption, about the sensitivity of habits to consumption shocks, generates counter-cyclical predictability in this model (Munk, 2013, pp. 322-325).

The central contribution of the present paper is to offer the first complete solution for the equity premium puzzle, as defined by Cochrane (2017). An extra contribution is to rely on a single unobservable parameter (the average fraction of government-mandated consumption in expenditures) to deliver this solution. In particular, the counter-cyclical variation in the price of risk is a consequence of the empirically observed changes in government intervention, **not** a separate assumption.

Finally, the standard theoretical framework in the literature on the relation between governments and risk premiums, in Pastor and Veronesi (2013, 2012), is built on the supposition that governments (i) understand all trade-offs in the economy, (ii) are able to make optimal policy choices that maximize society's welfare, and (iii) are "quasi-benevolent", so that they tend to implement these policies. Given all these assumptions, government intervention increases aggregate welfare. Equivalently, less government intervention is associated with lower welfare, higher marginal utilities, and higher state prices if all else is kept constant. As I show, stock returns covary negatively with government intervention. Hence, under hypotheses (i) through (iii), stocks offer a hedge against an undesirable "lack of government intervention": They give high returns exactly when the government stops helping the economy with interventions and state prices become high. If so, stocks should have negative equilibrium risk premiums. This is inevitably inconsistent with the empirical evidence.

In contrast to the models above, optimal consumption is only achieved under free markets in the presence of government failure. In the model that I develop, government failure arises because the government acts in its own self-interest. This violates assumption (iii) above. However, violations of assumptions (i) or (ii) would generate similar failures. Hence, the contribution of the present paper to this literature is to give first order importance to the agency problem between governments and individuals.

This type of agency problem has been studied in the corporate governance literature since at least Hart (1995). So the present paper is also intuitively related to the corporate governance literature. However, there is one important caveat: The potentially unlimited trading incentives for the marginal investor to screen good firms from bad firms are non-existent for the marginal voter for screening good politicians from bad politicians. There is no clear reason for "market discipline" (Fama, 1980) to exist. The problem is accentuated because individual votes are irrelevant to determine election results. The individual has no private benefits from monitoring the government, only private costs. Hence, (close to) no monitoring is provided as a public good in equilibrium.

Finally, the empirical proxies that follow from the two frameworks are fundamentally different, too. For example, the index for policy uncertainty in Baker et al. (2016) includes elections, wars, and national debt disputes. This is consistent with the ideas in Pastor and Veronesi (2013, 2012). On the other hand, the proxies that I use only include direct measures of government intervention (failure), similar to the ones in Dawson and Seater (2013). Yet, one important similarity is that higher intervention volatility increases the risk of the economy according to both Pastor and Veronesi (2013, 2012) and the framework that I develop: Governments make the economy riskier within both frameworks.

2 The economy

A representative agent lives in a continuous time economy with complete markets, and a unique and positive stochastic discount factor (SDF), $\zeta = (\zeta_t)$, prices every asset. There are two goods with exogenous production and equal prices in every period: The *consumption good* and the *state good*. The government chooses the optimal amount of the state good, $X = (X_t)$, by controlling how much of the state good the agent must acquire bundled with the consumption good. This choice maximizes the government's own intertemporal objective function,

$$\max_{X=(X_t)} \quad \mathbb{E}\left[\int_0^T e^{-\delta t} u_G(X)\, dt\right], \tag{1}$$

where $\mathbb{E}$ is the expectation operator and $u_G(X)$ is the government's utility function (not necessarily increasing in X), subject to the feasibility constraint

$$\mathbb{E}\left[\int_0^T \zeta_t X_t\, dt\right] \leq \mathbb{E}\left[\int_0^T \zeta_t e_t\, dt\right], \tag{2}$$

where the right-hand side of the equation is the present value of the economy's (in fact the agent's) endowment process, $e = (e_t)$, and the left-hand side is the present value of the expenditures on the state good, X.

Given the restriction imposed by the government, the representative agent then chooses the amount of consumption good (or simply "consumption"), c, that maximizes his time-separable expected utility,

$$\max_{c=(c_t)} \quad \mathbb{E}\left[\int_0^T e^{-\delta t} \frac{1}{1-\gamma} c^{1-\gamma}\, dt\right], \tag{3}$$

subject to the budget constraint

$$\mathbb{E}\left[\int_0^T \zeta_t c_t\, dt\right] + \mathbb{E}\left[\int_0^T \zeta_t X_t\, dt\right] \leq \mathbb{E}\left[\int_0^T \zeta_t e_t\, dt\right], \tag{4}$$

where the new term on the left-hand side relative to Eq. (2) is the present value of the agent's expenditures on the consumption good, c.

The anecdotal evidence at the website *Greentech Media*, explaining why installed solar panels cost \$3.25 per watt in the United States compared to \$1.34 in Australia, offers some intuition about the model above:[5] In the United States, in contrast to Australia, the government imposes permit and licensing restrictions for the installation companies, paid visits to government bureaus, other layers of red tape, and requires the solar panels to be bundled with expensive incremental hardware and services that the consumers do not appear to value. If the typical consumption item passes through only five sequential sectors as regulated as this one, the fraction of its final price imposed by regulations (corresponding to the government good) is likely above 99%.[6]

The agent's optimization induces the SDF

$$\zeta_t = e^{-\delta t} \left(\frac{c_t}{c_0} \right)^{-\gamma}, \tag{5}$$

and since government-imposed consumption, X_t, provides no utility to the representative agent, it is possible to obtain the consumption series

$$c_t = k_t - X_t = k_t s_t \tag{6}$$

by multiplying the expenditure series, k_t, by the (modeled) surplus series, s_t, defined as the fraction of voluntary consumption in total expenditure. The mathematical definition of s_t resembles that of the surplus over an external habit level in Campbell and Cochrane (1999). However, instead of being the result of non-standard preferences, as in Campbell and Cochrane (1999), the surplus is actually a more relevant measure of consumption, net of government failure.

[5] Andrew Birch, "How to Halve the Cost of Residential Solar in the US," Greentech Media, January 5, 2018, https://www.greentechmedia.com/amp/article/how-to-halve-the-cost-of-residential-solar-in-the-us.

[6] For example, the five sequential sectors could be natural resource extraction, manufacturing, distribution, retailing, and consumer. This implies that the fraction of regulation in the final price is $1 - \left(\frac{1.34}{3.25}\right)^5 \approx 99\%$, which is likely understated because it assumes no regulations for solar panels in Australia.

Let consumption expenditure, k_t, follow the diffusion process

$$dk_t = k_t\left[\mu_{k,t}\,dt + \sigma_{k,t}\,dz_{1,t}\right], \tag{7}$$

and let surplus consumption, s_t, follow the diffusion process

$$ds_t = s_t\left[\mu_{s,t}\,dt + \sigma_{s,t}\,dz_{2,t}\right], \tag{8}$$

where $dz_{1,t}$ and $dz_{2,t}$ are independent one-dimensional standard Brownian motions, and μ_t and σ_t are stochastic processes in both equations. An application of Itô's Lemma based on the definition of s_t and the two diffusions above gives the diffusion process for consumption,

$$dc_t = c_t\left[\mu_{c,t}\,dt + \sigma_{c,t}^{\intercal}\,d\mathbf{z}_t\right], \tag{9}$$

$$\mu_{c,t} = \mu_{k,t} + \mu_{s,t}, \tag{10}$$

$$\sigma_{c,t} = \begin{pmatrix} \sigma_{k,t} \\ \sigma_{s,t} \end{pmatrix}, \tag{11}$$

where $^{\intercal}$ is the transposition sign and $d\mathbf{z}_t$ is a two-dimensional standard Brownian motion.

The SDF dynamics and equilibrium returns: A second application of Itô's Lemma based on Eq. (5) and the consumption process in Eq. (9) gives the standard consumption-based SDF dynamics

$$d\zeta_t = -\zeta_t\left[\left(\delta + \gamma\mu_{c,t} - \frac{1}{2}\gamma(1+\gamma)\|\sigma_{c,t}\|^2\right)dt + \gamma\sigma_{c,t}^{\intercal}\,d\mathbf{z}_t\right], \tag{12}$$

where $\|.\|$ is the Euclidean norm. The drift term corresponds to the continuously compounded risk-free interest rate, $r_{f,t}$, and the volatility term gives the market price of risk, $\lambda_t = \gamma\sigma_{c,t}$.

The Sharpe ratio of asset i, which pays no dividends and has price dynamics

$$dP_{i,t} = P_{i,t}\left[\mu_{i,t}\,dt + \sigma_{i,t}^{\intercal} d\mathbf{z}_t\right], \tag{13}$$

is given by

$$SR_i \equiv \frac{\mu_{i,t} - r_{f,t}}{\|\sigma_{i,t}\|} = \rho_{ic,t}\,\gamma\,\|\sigma_{c,t}\|, \tag{14}$$

where $\rho_{ic,t}$ is the correlation between the risk premium of asset i and consumption growth. More specifically, Eq. (14) gives the market Sharpe ratio with $\rho_{ic,t} = \rho_{mc,t}$ or the market price of risk, $\|\lambda_t\|$, for $\rho_{ic,t} = 1$.

2.1 What happens if the surplus parameters are freely chosen?

Cochrane (2017) argues that one of the main contributions of Constantinides and Duffie (1996) is that the framework provides directions to "reverse-engineer any asset pricing results".[7] This section shows that the framework that I offer provides the same type of directions if the parameters are completely freely chosen. However, this also means that the model can be too flexible unless we can relate the surplus consumption to observable quantities, as I do in Section 2.2.

Let us assume that $\overline{S}_t$ is the market Sharpe ratio that we would like to generate. Substituting Eq. (11) in Eq. (14), we obtain

$$\sigma_{s,t} = \sqrt{\left(\frac{\overline{S}_t}{\gamma\rho_{mc,t}}\right)^2 - \sigma_{k,t}^2}, \tag{15}$$

for which the solution is a real number for any standard set of parameters and given that $\rho_{mc,t} \neq 0$. This condition highlights that a large $\sigma_{s,t}$ in Eq. (15) is usually not enough

[7] In Constantinides and Duffie (1996), this is achieved by assuming the desired cross-sectional variance in consumption. I achieve the same by choosing the desired surplus consumption process in Eq. (8), instead.

to generate the desired Sharpe ratio because the correlation could approach zero if s_t is uncorrelated with the market premium. If the surplus consumption is heteroskedastic, even if aggregate expenditure is homoskedastic, the model generates time-varying Sharpe ratios that also vary counter-cyclically if the surplus volatility, $\sigma_{s,t}$, decreases with the surplus consumption level.

Under the same assumption of $\rho_{mc,t} \neq 0$, the model also jointly generates any choice of risk-free rate: The restriction of a positive subjective discount rate, $\delta > 0$, on the drift term in Eq. (12), together with Eq. (10) and Eq. (15) gives

$$\mu_{s,t} < \frac{r_{f,t}}{\gamma} - \mu_{k,t} + \frac{1}{2}(1+\gamma)\left(\frac{\overline{S}_t}{\gamma\rho_{mc,t}}\right)^2, \tag{16}$$

which, again, has a solution in the real numbers for any standard set of parameters. The risk-free rate can be made constant with an assumption similar to the one in Campbell and Cochrane (1999), explicitly connecting the drift, $\mu_{s,t}$, to the volatility of the surplus process indicated in Eq. (15), or directly connecting it to the market Sharpe ratio, $\overline{S}_t$ in Eq. (16).

2.2 Surplus as a function of government intervention

The economy has Q sectors/stages, indexed by $q = \{1, ..., Q\}$, through which the consumption good must pass before it can be consumed. The government imposes the same (time-varying) restrictions, r_t, on all sectors: Each sector processes the goods for one period by continuously adding r_t units of the state good to each unit of the total being processed before passing everything to the next sector. Hence, the cost of regulation accumulates as the good passes through the production chain.

The state good and the consumption good have a price of one, so the total cost of the goods that reach sector Q at time t (expenditures) is

$$k_t = c_t e^{\sum_{q=1}^{Q} r_{q,t}} = c_t e^{\theta_t}, \tag{17}$$

where $r_{q,t}$ is the prevailing rate of state goods production in each sector when the goods were (previously) processed in sector q; c_t is the value of the consumption goods; and $\theta_t = Q\overline{r}_t$ can be interpreted as the product between the average rate of the state goods production in the previous sectors at time t, $\overline{r}_t$, and the number of sectors, Q. This implies that surplus consumption, $s_t = \frac{c_t}{k_t}$, is

$$s_t = e^{-\theta_t}, \quad \theta_t = \sum_{q=1}^{Q} r_{q,t}. \tag{18}$$

The fraction of expenditure from which the agent derives utility, s_t, decreases with the production rate of the state good, $\overline{r}_t$, which is magnified by the existence of multiple Q sectors. It is important to have this multiplicative effect in mind when later analyzing the magnitudes of the average surpluses obtained in the calibration exercise. In addition, Eq. (18) suggests that lagged intervention levels are relevant to describe s_t: The choices of r_t that were in place when the goods were previously processed in each sector q, $r_{q,t}$, still affect the relation between consumption and expenditure at time t.

3 Data and proxy construction

3.1 Market and consumption data

All returns are continuously compounded. I calculate the market premium (MP) and the nominal risk-free rate from the data on Kenneth French's website. The inflation rate from December to December is from the annual CPI (all urban consumers) in the FRED database.

Consumption expenditure growth, k_g, follows the end of year convention and uses the data in NIPA Table 7.1 from the Bureau of Economic Analysis. I use the GDP deflator (from lines 1 and 10) to obtain the real per capita expenditures on nondurables (line 8) and services (line 9). The sum of these two numbers gives real per capita consumption expenditure, k_t, from which I calculate growth as

$$k_{g,t} = \ln\left(\frac{k_t}{k_{t-1}}\right). \tag{19}$$

3.2 The two proxies for government intervention

The main empirical issue related to realistically calibrating and evaluating the model is to obtain measures of the restrictions placed by the government on individual consumption choices. Early on, in a different but related context, Friedman and Friedman (1980) use the number of pages in the Federal Register to measure the growth of regulation. More recently, Dawson and Seater (2013) provide a comprehensive discussion about the total number of pages in the Code of Federal Regulation as a measure of federal regulation of the economy. Dawson and Seater (2013) discuss its issues and how it compares favorably with other measures and, more importantly, they show that increases in this measure are associated with reduced output growth because regulations force the firms to use suboptimal combinations of inputs.

I use the number of pages in Title 3 of the Code of Federal Regulations (CFR), which concerns all presidential orders, as one of the proxies for government intervention. The number of Presidential orders is a direct measure of how active the government is regarding intervention (and failure). The number of pages in the remaining titles often changes when different federal agencies further regulate the economy with power obtained from previous government decisions, for example. Yet, these agencies are not the direct sources of interventions.

I obtain the number of pages in the CFR for the (yearly) editions between 1975 and 2017. The data regarding the editions until 2016 are from the Regulatory Studies Center, Columbian College of Arts and Sciences, George Washington University and I hand collect the data for 2017 from the U.S. Government Publishing Office.[8] Title 3 of the CFR is published every January 1; therefore, these data correspond to the years between 1974 and 2016, in fact.

One of the issues with the CFR is that it is purely a counting measure. Different pages can have different types of regulations and, even regulations of the same type, can have different stringency (Dawson and Seater, 2013). Therefore, I also consider the number of **economically significant rules** (ESR) that underwent review by the Office of Information and Regulatory Affairs each year as a second measure containing a qualitative component. I hand collect these yearly data from their website as of December 31, between 1981 and 2017.[9]

[8]These data can be found at, respectively, https://regulatorystudies.columbian.gwu.edu/reg-stats and https://www.gpo.gov.

[9]A regulatory action is determined to be "economically significant" by the Office of Information and Regulatory Affairs "if it is likely to have an annual effect on the economy of $100 million or more or adversely affect in a material way the economy, a sector of the economy, productivity, competition, jobs, the environment, public health or safety, or State, local, or tribal governments or communities." More information about the Office at https://www.reginfo.gov/. Select "Regulatory review", then "Review counts" on the header menu to find the data, or directly at https://www.reginfo.gov/public/do/eoCountsSearchInit?action=init. The data need to be hand collected for different dates.

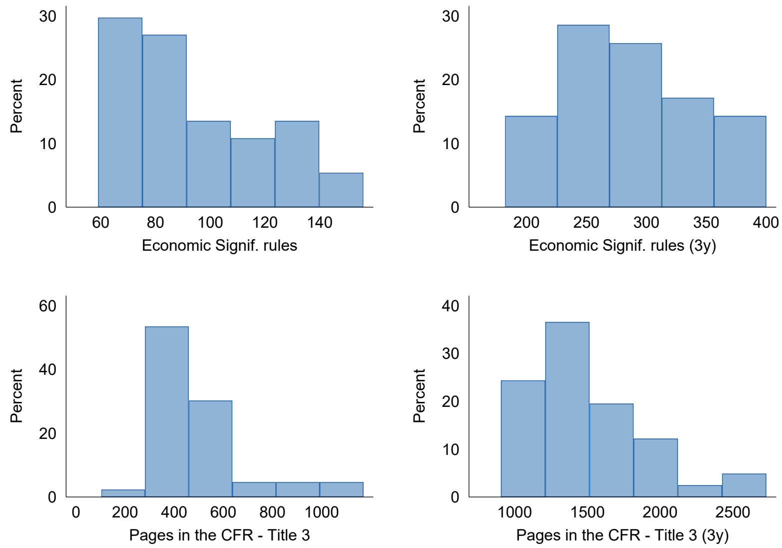

Figure 2: Two measures of government intervention. The top two graphs show the number of economically significant rules passed by the federal government each year (on the left) and the totals accumulated over three years (on the right). The lower graphs show equivalent measures for the number of pages in Title 3 of the Code of Federal Regulations (concerning presidential orders).

3.2.1 Lagged measures of government intervention

As explained before and shown in Eq. (18), the assumption of multiple economic sectors implies that the restrictions in place in previous periods (when the goods were processed in a given sector q) also affect the surplus consumption at time t. This suggests that some lagged measures of government intervention can be relevant. Hence, in most of the analysis I consider three-year accumulated proxies, $ESR_{3y,t}$ or $CFR_{3y,t}$, which are the sum of the intervention proxies in year t, $r_{p,t} = ESR_t$ or $r_{p,t} = CFR_t$, and their two lags, as

$$r_{3y,t} = \sum_{l=0}^{2} r_{p,t-l}. \tag{20}$$

3.2.2 Statistical description

Figure 2 shows the histogram of the ESR and CFR proxies, both in individual years and accumulated over three years. The number of ESR (in individual years or accumulated over three years) tends to be more evenly distributed than the number of pages in the CFR, especially in individual years. On the other hand, in relation to the mean of the respective proxy, the first five columns of Table 1 show that the CFR is more volatile than the ESR (accumulated or not), and the accumulated proxies are less volatile in general. The proxy's volatility is important because it connects to the volatility of the calibrated consumption process later on.

Table 1: **Descriptive statistics of the proxies for government intervention.** The first five columns show the mean (μ), standard-deviation (σ), number of years (Obs), minimum (Min), and maximum values (Max), of the variables. The next columns show their pairwise correlations. The variables are the number of economically significant rules each year (ESR) or accumulated in the three years preceding that year (ESR_{3y}), and the number of pages in Title 3 of the Code of Federal Regulations each year (CFR) or accumulated in the three years preceding that year (CFR_{3y}).

	μ	σ	Obs	Min	Max	ESR	ESR_{3y}	CFR	CFR_{3y}
ESR	95	26	37	59	156	1.00	0.75	0.49	0.33
ESR_{3y}	286	62	35	182	400	0.75	1.00	0.44	0.50
CFR	490	206	43	103	1170	0.49	0.44	1.00	0.67
CFR_{3y}	1465	432	41	907	2728	0.33	0.50	0.67	1.00

The last four columns in Table 1 also show that the measures are positively correlated, but not by much. In particular, the two main variables in the analysis, $ESR_{3y,t}$ and $CFR_{3y,t}$, have correlations of only 0.5 and seem to capture partially different aspects of government intervention. Regarding stationarity, the results of the Augmented Dickey-Fuller tests reported in Table 2 reject the hypotheses of unit roots, based on the number of lags (one for all series) suggested by the correlograms in Figure 3.

Table 2: **Augmented Dickey-Fuller unit-root tests.** The table shows the number of lags used in the test (Lags), number of years (Obs), the test statistics (Z_t), and the MacKinnon approximate p-value for Z_t, (p). The variables are the number of economically significant rules each year (ESR) or accumulated in the three years preceding that year (ESR_{3y}), and the number of pages in Title 3 of the Code of Federal Regulations each year (CFR) or accumulated in the three years preceding that year (CFR_{3y}).

	Lags	Obs	Z_t	p
ESR	1	35	-2.78	0.061
ESR_{3y}	1	33	-3.44	0.010
CFR	1	41	-3.61	0.006
CFR_{3y}	1	39	-3.88	0.002

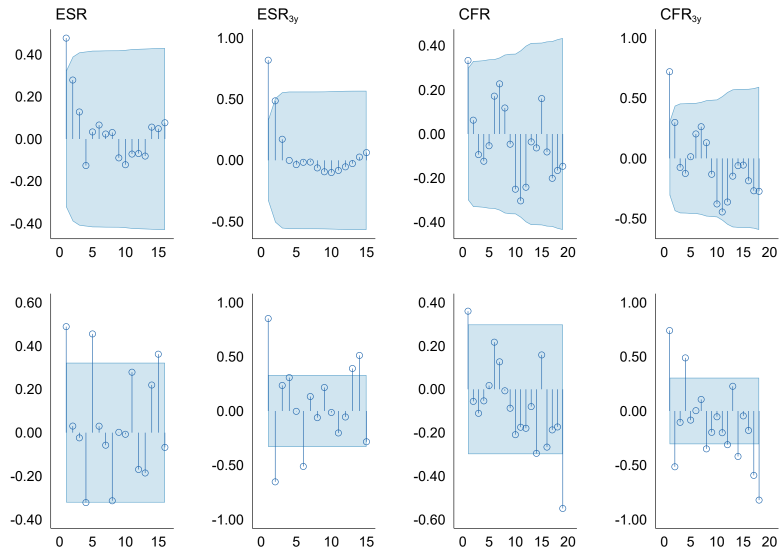

Figure 3: Correlograms for the number of economically significant rules and number of pages in the Code of Federal Regulation. The top graphs display the autocorrelation plots; the lower graphs display the partial autocorrelation plots. The columns correspond to the number of economically significant rules in (i) a given year (ESR) or in (ii) the preceding three years (ESR_{3y}), and to the number of pages in Title 3 of the Code of Federal Regulations in (iii) a given year (CFR), or in (iv) the preceding three years (CFR_{3y}). The shaded blue areas correspond to the 95% confidence interval.

3.3 Regulation growth rates and the market premium

The relatively low volatility of consumption expenditure growth is at the heart of the equity premium puzzle as we infer from Hansen and Jagannathan (1991). Therefore, the ability of government intervention to quantitatively explain the observed equity premium also depends on how volatile the growth rate in intervention is. Figure 1 (at the introduction) shows that the volatility in intervention growth (considering either CFR_{3y} or ESR_{3y}) is of the same order of magnitude as the market premium volatility, while consumption expenditure growth varies considerably less. There also seems to be a negative correlation between intervention growth and the equity premium. This is important because it suggests positive comovement between (voluntary) consumption growth and risk premiums, as we would expect if voluntary consumption really explains the equity premium within a consumption-based asset pricing framework.

Columns 2, 4, and 5 in Table 3 provide more details: For example, Column 2 shows that intervention growth measured as $CFR_{g,3y}$ has almost the same volatility as the market premium, MP. The volatility of intervention growth measured as $ESR_{g,3y}$ is lower but still one order of magnitude larger than the volatility of consumption expenditure growth, k_g. In addition, the last six columns in row 5 show that these two proxies are more correlated with the market premium than consumption expenditure is. The relation between the two proxies and expenditure is different: The correlation is negative for $ESR_{g,3y}$ and essentially zero for $CFR_{g,3y}$, even though the two proxies are positively correlated with each other.[10] Measured by ESR, government failure affects the agents at particularly bad times: The agents tend to learn about negative shocks to expenditures at the same time when they learn that the government decided to control an even larger part of this lower consumption. For the individual year proxies, ESR_g or CFR_g, the volatilities are considerably larger, but the correlations with the market premium (and expenditure growth) are lower.

Table 3: Descriptive statistics of the yearly growth rates in government intervention, consumption expenditure, and the market premium. The first five columns show the mean (μ), standard-deviation (σ), number of years (Obs), minimum (Min), and maximum values (Max), of the variables. The next columns show their pairwise correlations. The variables are the market premium (MP), the growth in consumption expenditure ($K_g = \frac{k_t}{k_{t-1}}$), the growth in the number of economically significant rules each year (ESR_g), and the growth in the number of pages in Title 3 of the Code of Federal Regulations each year (CFR_g). The last two measures have 3-year cumulative counterparts: The growth in the number of rules (pages in the CFR) accumulated in the three years preceding year t compared to the total in the three years preceding year $t-1$ ($ESR_{g,3y}$ and $CFR_{g,3y}$).

	μ	σ	Obs	Min	Max	ESR_g	$ESR_{g,3y}$	CFR_g	$CFR_{g,3y}$	MP	K_g
ESR_g	1.03	0.25	36	0.44	1.73	1.00	0.58	0.12	0.12	-0.24	-0.21
$ESR_{g,3y}$	1.02	0.11	34	0.81	1.25	0.58	1.00	0.11	0.35	-0.35	-0.27
CFR_g	1.13	0.55	42	0.23	3.65	0.12	0.11	1.00	0.42	-0.07	0.05
$CFR_{g,3y}$	1.04	0.19	40	0.49	1.55	0.12	0.35	0.42	1.00	-0.21	-0.02
MP	0.06	0.20	91	-0.60	0.45	-0.24	-0.35	-0.07	-0.21	1.00	0.20
K_g	1.02	0.02	88	0.92	1.08	-0.21	-0.27	0.05	-0.02	0.20	1.00

[10]Note that the periods are different because the $ESR_{g,3y}$ sample is shorter.

4 Model calibration: The equity premium–risk-free rate puzzle

In this section, I calibrate the consumption process in Eq. (9) based on the observed time series of consumption expenditure that gives the parameters for Eq. (7), and a grid for the average levels of intervention together with the observed growth in the intervention proxy that give the parameters for Eq. (8). Next, I obtain the respective Sharpe ratios and risk-free rate for a few relative risk aversion coefficients: $\gamma \in \{1, 2, 3, 4, 5\}$. The risk-free rate is a function of the estimates of $\mu_{c,t}$ and $\sigma_{c,t}$ and is given by the drift of the SDF process in Eq. (12). The Sharpe ratio is a function of $\sigma_{c,t}$ (and the correlation term) in Eq. (14). I report unconditional and conditional estimates of these quantities.

4.1 Calibrating the consumption process, $c = c(t)$

Let us assume that government intervention fluctuates over time around a certain exogenous value, $\overline{r}$, and that the fluctuation happens in proportion to the value of the proxy at time t, $r_{p,t} = ESR_{3y,t}$ or $r_{p,t} = CFR_{3y,t}$, as

$$\overline{r}_t = \overline{r}\left(\frac{r_{p,t}}{\overline{r}_p}\right), \tag{21}$$

where $\overline{r}_p$ is the proxy average. In addition, define the (proportional) intervention growth as

$$r_{g,t} = \frac{r_{p,t} - r_{p,t-1}}{\overline{r}_p}. \tag{22}$$

Substituting Eq. (21) in $\theta_t = Q\overline{r}_t$, we can rewrite Eq. (18) as a function of each proxy to obtain

$$s_t = \exp\left(-\overline{\theta}\,\frac{r_{p,t}}{\overline{r}_p}\right), \tag{23}$$

where $\overline{\theta} = Q\,\overline{r}$, and obtain consumption growth as

$$c_{g,t} \equiv \frac{c_t}{c_{t-1}} = \exp\left(k_{g,t} - \overline{\theta}\,r_{g,t}\right), \tag{24}$$

where c_t is defined in Eq. (6), $k_{g,t}$ is defined in Eq. (19), and $r_{g,t}$ is defined in Eq. (22). Consumption growth now becomes a function of the – observable – values of consumption expenditure and the intervention growth, given $\overline{\theta}$. The choice of $\overline{\theta}$ scales intervention growth in the calculation of consumption growth.

There are two main issues related to determining $\overline{\theta} = Q\,\overline{r}$ empirically. The first, as discussed before, is that explicit measures of government intervention do not exist (Dawson and Seater, 2013), so it is not possible to obtain an estimate for $\overline{r}$. In addition to that, it is not clear how to obtain an estimate for the number of separate sectors involved in the production of the typical good in the economy, Q. So instead of selecting a value, I investigate a range of possibilities for $\overline{\theta}$: I consider values from zero to $\overline{\theta}_{max} = 2.5$, which corresponds to average surpluses from 100% to around 8% in total (or 60% in five consecutive sectors, as I explain in Section 2.2), in most of the analysis.

Mapping proxy growth to government intervention growth: I assume that the mapping between the growth rate of each proxy and unwanted consumption is 1:1 in Eq. (22). Naturally, the mapping could be 1:10, 10:1, or any other. The effect of a different mapping is to multiply the resulting $r_{g,t}$ series in Eq. (22) by a constant. This would change the average (unobservable) surpluses that solve the puzzle, $\overline{\theta}$ in Eq. (24). However, a different mapping would have no effect on the observed correlations between proxy growth and stock returns. These correlations (not the levels) determine whether government intervention (failure) increases with and explains the expected equity premium qualitatively. Arguably, any one unobservable parameter is undesirable in a quantitative explanation. However, existing theories of the equity premium achieve less in terms of resolving the puzzle, while requiring not only one, but two unobservable variables, as discussed in the introduction and by Cochrane (2017) in more detail.

4.2 The original (unconditional) equity premium puzzle

Under the assumption that consumption expenditure, k_t, is equivalent to the optimal consumption that solves, for example, the standard problem in Mehra and Prescott (1985), c_t, the puzzle arises from the impossibility of finding a reasonably low value for the coefficient of relative risk aversion, $\gamma \leq 5$, that generates a market Sharpe ratio similar to what has been historically observed (for example, between 0.2 and 0.5) and also generates a small or negative difference between the risk-free and subjective discount rates, $r_{f,t} - \delta$, which is the case for a positive subjective discount rate.

Figure 4 and Figure 5 (respectively with ESR_{3y} or CFR_{3y} as the proxies for intervention) show that there is no puzzle for several calibrated values of government intervention according to the framework that I present. The graphs display the market prices of risk on the top row, the market Sharpe ratios in the middle, and the difference between the risk-free and the subjective discount rates, $r_{f,t} - \delta$, at the bottom. From left to right, the coefficient of relative risk aversion that generates the graphs increases: $\gamma \in \{1, 2, 3, 4, 5\}$. All of these values vary (via $\overline{\theta}$) with the average consumption surplus that appears on the horizontal axis in each graph.

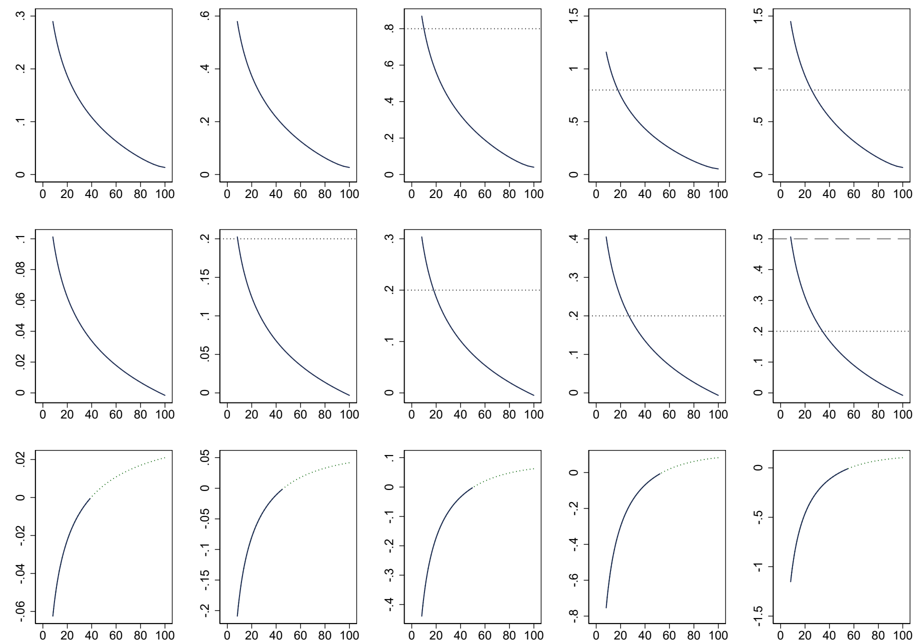

Figure 4: ***ESR*-based unconditional market prices of risk (top), market Sharpe ratios (middle), and subjective discount rate subtracted from the risk-free rate (bottom).** Consumption growth is calibrated as

$$c_{g,t} = \exp\left(k_{g,t} - \overline{\theta}\, r_{g,t}\right), \quad r_{g,t} = \frac{ESR_{3y,t} - ESR_{3y,t-1}}{\overline{ESR}_{3y}},$$

where $k_{g,t}$ is expenditure growth, $ESR_{3y,t}$ is the intervention proxy at time t (the number of economically significant rules passed in the preceding three years), $\overline{ESR}_{3y}$ is its average, and $\bar{s}_t = e^{-\overline{\theta}}$ is the assumed average surplus appearing in the horizontal axis in every graph. The graphs from left to right are each obtained under the assumption of a different value for the relative risk aversion parameter, $\gamma = 1, \ldots, 5$. On the vertical axis, the top graphs display the market prices of risk, the middle ones display the market Sharpe ratios, and the lower ones show the subjective discount rate subtracted from the risk-free rate, $r_{f,t} - \delta$, with a solid line exclusively for $r_{f,t} - \delta \leq 0$. The reference dotted lines in the top graphs correspond to 0.8. The dotted (dashed) lines in the middle graphs correspond to 0.2 (0.5).

The graphs confirm that consumption expenditure alone, which corresponds to a surplus of 100%, is unable to generate either reasonable Sharpe ratios or positive values for the subjective discount rate. However, they also show that the puzzles eventually disappear as the average surplus decreases based on both proxies: The two figures contain graphs that show a region in which the market Sharpe ratio is between 0.2 and 0.5 or the market price of risk is between 0.8 and 2, for example. In these regions, the difference between

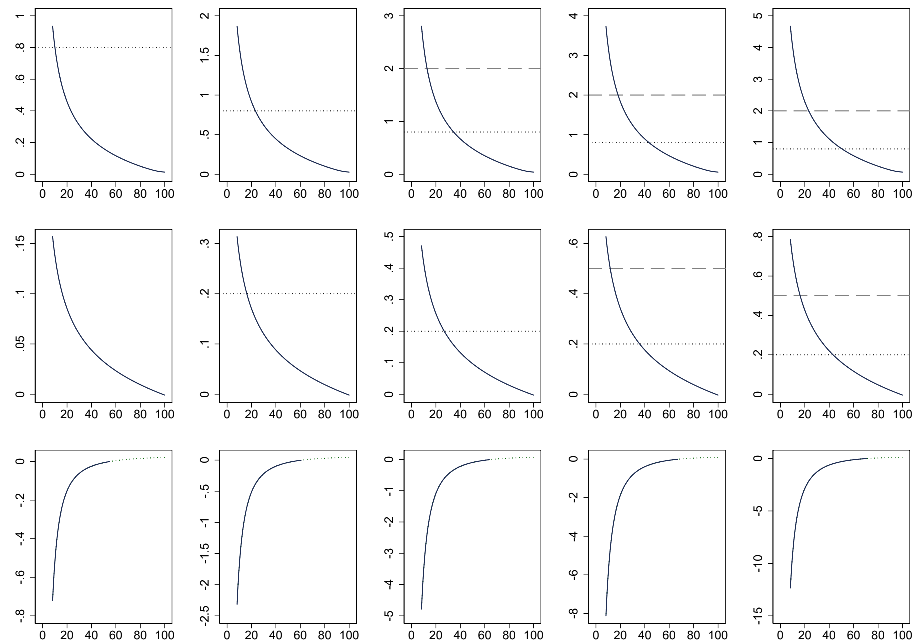

Figure 5: **CFR-based unconditional market prices of risk (top), market Sharpe ratios (middle), and subjective discount rate subtracted from the risk-free rate (bottom).** Consumption growth is calibrated as

$$c_{g,t} = \exp\left(k_{g,t} - \overline{\theta}\, r_{g,t}\right), \quad r_{g,t} = \frac{CFR_{3y,t} - CFR_{3y,t-1}}{\overline{CFR}_{3y}},$$

where $k_{g,t}$ is expenditure growth, $CFR_{3y,t}$ is the intervention proxy at time t (the number of pages in Title 3 of the Code of Federal Regulations in the preceding three years), $\overline{CFR}_{3y}$ is its average, and $\bar{s}_t = e^{-\overline{\theta}}$ is the assumed average surplus appearing in the horizontal axis in every graph. The graphs from left to right are each obtained under the assumption of a different value for the relative risk aversion parameter, $\gamma = 1, ..., 5$. On the vertical axis, the top graphs display the market prices of risk, the middle ones display the market Sharpe ratios, and the lower ones show the subjective discount rate subtracted from the risk-free rate, $r_{f,t} - \delta$, with a solid line exclusively for $r_{f,t} - \delta \leq 0$. The reference dotted (dashed) lines in the top graphs correspond to 0.8 (2) and they correspond to 0.2 (0.5) in the middle graphs.

the risk-free rate and the subjective discount rate tends to be very negative, $r_{f,t} - \delta << 0$. Given an estimate for the risk-free rate of $r_{f,t} \approx 1\%$, the subjective discount rate, δ, is positive but often much larger than the usual assumption in previous calibrations of asset pricing models. This is especially the case because the previous models tend to imply negative subjective discount rates. However, Frederick et al. (2002) also mention very large estimates for the subjective discount rate, from slightly negative to infinity in their survey of the literature.

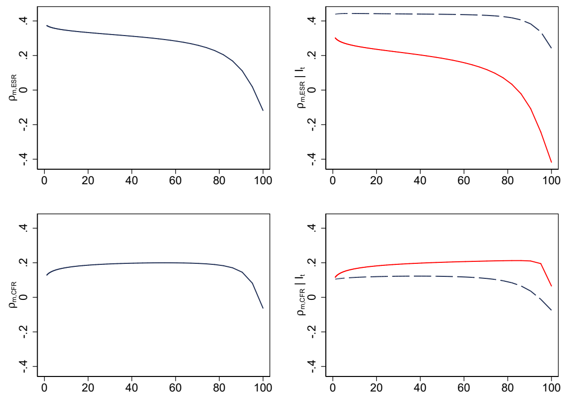

Figure 6: Conditional (right) and unconditional (left) estimates of the yearly correlation between the equity premium and consumption growth. Consumption growth is calibrated as

$$c_{g,t} = \exp\left(k_{g,t} - \overline{\theta}\, r_{g,t}\right), \quad r_{g,t} = \frac{r_{p,t} - r_{p,t-1}}{\overline{r}_p},$$

where $k_{g,t}$ is expenditure growth, $r_{p,t}$ is the proxy value at time t, $\overline{r}_p$ is its average, and $\bar{s}_t = e^{-\overline{\theta}}$ is the assumed average surplus appearing in the horizontal axis in every graph. The proxies are the number of economically significant rules in the preceding three years (resulting in $\rho_{m,ESR}$ in the top graphs), or the number of pages in Title 3 of the Code of Federal Regulations in the preceding three years (resulting in $\rho_{m,CFR}$ in the bottom graphs). The solid red lines in the graphs on the right display the correlation conditioned on $r_{p,t-1}$ being above its respective median (the dashed navy lines display it otherwise).

A comparison of the two proxies reveals that the consumption growth series created from the more volatile CFR_{3y} proxy (Table 3) generates higher Sharpe ratios for a given level of government intervention. On the other hand, the correlation between the market premium and consumption growth calculated from ESR_{3y} is larger (as shown in the graphs on the left-hand side of Figure 6). This implies that the ESR-based series generates larger and often reasonable market Sharpe ratios even with lower market prices of risk.

4.3 Counter-cyclical variation in the market price of risk

A second question is whether the **conditional** equity premium is still a puzzle. Cochrane (2011), among others, documents that risk premiums vary counter-cyclically over time, which means that the SDF volatility must vary over time. The problem is that under the hypothesis that consumption expenditure, k_t, is equivalent to optimal consumption, most consumption-based asset pricing models imply that the SDF volatility is constant because k_t is homoskedastic. Even some advanced models that generate time variation in the market price of risk, such as Campbell and Cochrane (1999), can only achieve this by assumption.[11]

I answer this question based on conditional estimates of the parameters in the model that I present. In particular, I condition the set of parameter estimates on whether, at the beginning of the period, the proxy for government intervention, $r_{p,t} = ESR_{3y,t}$ or $r_{p,t} = CFR_{3y,t}$, is above or below its respective median. Therefore, I analyze the predictions of the model based on two sets of parameters: One estimated when government intervention is high (bad times), $(\hat{\mu}^h_{c,t}, \hat{\sigma}^h_{c,t}, \hat{\rho}^h_{mc,t})$, and another one found when intervention is low (good times), $(\hat{\mu}^l_{c,t}, \hat{\sigma}^l_{c,t}, \hat{\rho}^l_{mc,t})$. As given by Eq. (14), the model delivers counter-cyclical variation in risk premiums if the volatility of the surplus consumption increases when the surplus declines (given that expenditures are homoskedastic). Indeed, this is what we observe in the data.

The plots in Figure 7 (based on ESR_{3y}) and Figure 8 (based on CFR_{3y}) show the same quantities as Figure 4 and Figure 5, but conditioned on the level of intervention. For a given average surplus on the horizontal axis, the red solid lines in the graphs correspond to the periods in which the intervention level is above its median ("bad times" and low consumption surplus). The navy dashed lines correspond to the remaining periods ("good times").

[11] Campbell and Cochrane (1999) explicitly assume that their "sensitivity function" is such that the volatility of surplus consumption (as they define it, over an external habit level) increases when the surplus declines, which generates the counter-cyclical variation in the market price of risk that they document.

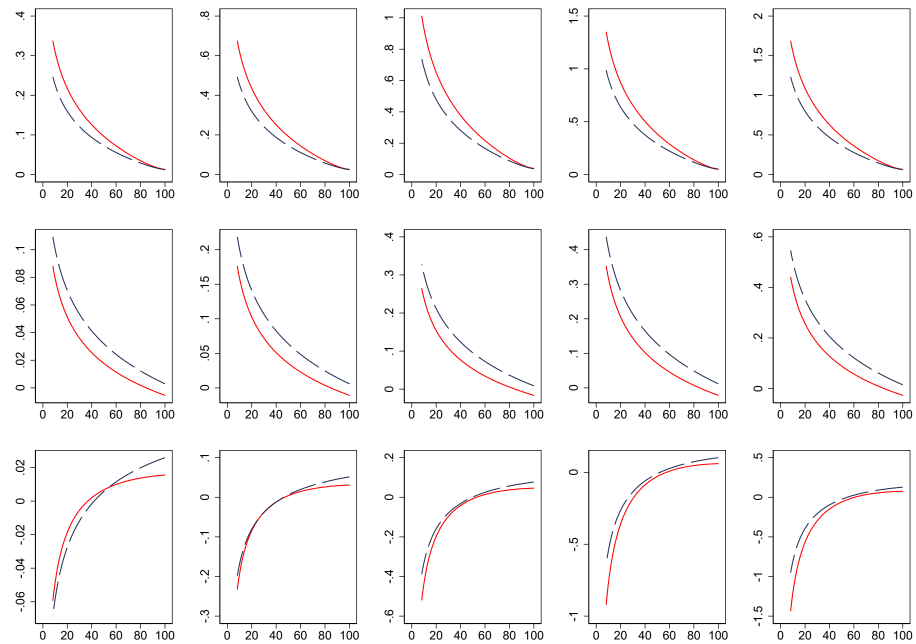

Figure 7: ***ESR*-based conditional market prices of risk (top), market Sharpe ratios (middle), and subjective discount rate subtracted from the risk-free rate (bottom).** Consumption growth is calibrated as

$$c_{g,t} = \exp\left(k_{g,t} - \overline{\theta}\, r_{g,t}\right), \quad r_{g,t} = \frac{ESR_{3y,t} - ESR_{3y,t-1}}{\overline{ESR}_{3y}},$$

where $k_{g,t}$ is expenditure growth, $ESR_{3y,t}$ is the intervention proxy at time t (the number of economically significant rules passed in the preceding three years), $\overline{ESR}_{3y}$ is its average, and $\bar{s}_t = e^{-\overline{\theta}}$ is the assumed average surplus appearing in the horizontal axis in every graph. The graphs from left to right are each obtained under the assumption of a different value for the relative risk aversion parameter, $\gamma = 1, ..., 5$. On the vertical axis, the top graphs display the market prices of risk, the middle ones display the market Sharpe ratios, and the lower ones show the subjective discount rate subtracted from the risk-free rate, $r_{f,t} - \delta$, with a solid line exclusively for $r_{f,t} - \delta \leq 0$. The red solid lines correspond to the periods in which the number of economically significant rules (over the previous 3 years) is above its median. The navy dashed line corresponds to the remaining periods.

The market prices of risk increase in bad times based on both proxies (top rows in Figure 7 and Figure 8), meaning that the model also delivers a counter-cyclical market price of risk despite the constant volatility of consumption expenditure and without any model assumption driving this result. The calibration based on CFR_{3y}, in Figure 8, also delivers the conditional equity premium (the graphs in the second row), but the one based on ESR_{3y}, in Figure 7, seems to imply pro-cyclical market Sharpe ratios, instead. The

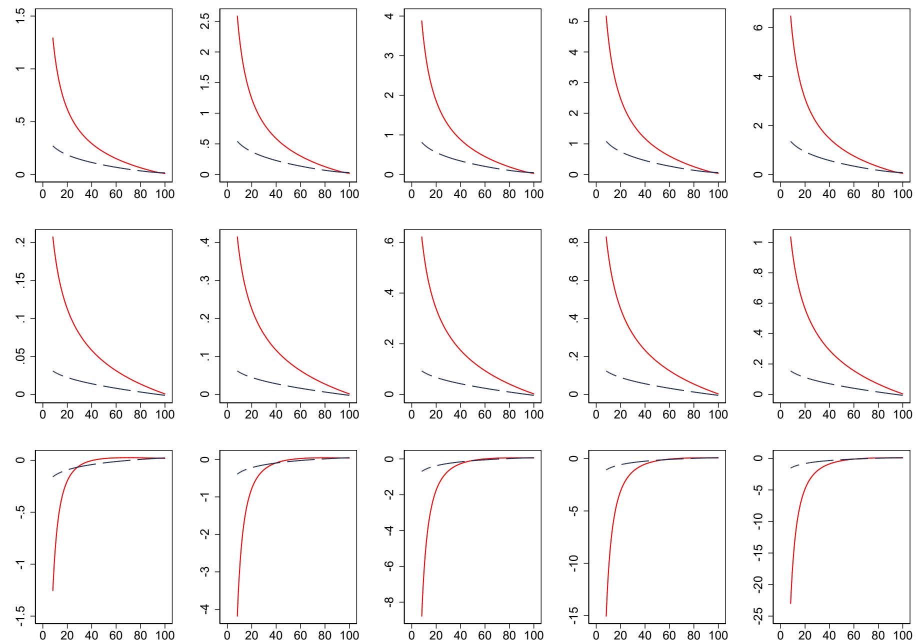

Figure 8: ***CFR*-based conditional market prices of risk (top), market Sharpe ratios (middle), and subjective discount rate subtracted from the risk-free rate (bottom).** Consumption growth is calibrated as

$$c_{g,t} = \exp\left(k_{g,t} - \overline{\theta}\, r_{g,t}\right), \quad r_{g,t} = \frac{CFR_{3y,t} - CFR_{3y,t-1}}{\overline{CFR}_{3y}},$$

where $k_{g,t}$ is expenditure growth, $\overline{r}$ is the assumed average level of government intervention, $CFR_{3y,t}$ is the intervention proxy at time t (the number of pages in Title 3 of the Code of Federal Regulations in the preceding three years), $\overline{CFR}_{3y}$ is its average, and $\bar{s}_t = e^{-\overline{\theta}}$ is the assumed average surplus appearing in the horizontal axis in every graph. The graphs from left to right are each obtained under the assumption of a different value for the relative risk aversion parameter, $\gamma = 1, ..., 5$. On the vertical axis, the top graphs display the market prices of risk, the middle ones display the market Sharpe ratios, and the lower ones show the subjective discount rate subtracted from the risk-free rate, $r_{f,t} - \delta$, with a solid line exclusively for $r_{f,t} - \delta \leq 0$. The red solid lines correspond to the periods in which the number of pages in Title 3 of the Code of Federal Regulations (over the previous three years) is above its median. The navy dashed line corresponds to the remaining periods.

graphs on the right-hand side in Figure 6 show why this happens: The correlation between the market premium and consumption growth seems to be smaller in bad times for the ESR_{3y}. However, ignoring these conditional estimates generates counter-cyclical market Sharpe ratios based on this proxy, too. And, in fact, correlations are particularly difficult to measure (Campbell and Cochrane, 1999), especially in such a small sample. Another solution is to assume even lower values of average surplus (not shown in the graph). These values also generate counter-cyclical market Sharpe ratios.

4.3.1 Stability of the risk-free rate

The bottom graphs in Figure 7 and Figure 8 suggest that there are big differences in the risk-free rate parameters estimated in good and bad times for the average surplus values that generate reasonable Sharpe ratios. More specifically, Table 4 shows conditional and unconditional market Sharpe ratios, market prices of risk, and differences between the risk-free and subjective discount rates, $r_{f,t} - \delta_t$, for selected average surplus levels, $\bar{s}_t$. These choices are such that, for each proxy, the market Sharpe ratio is close to 0.2 or 0.5, or the market price of risk is close to 0.8 or 2.

Table 4: **Calibration using selected average surplus levels.** Calibrated consumption is

$$c_{g,t} = \exp\left(k_{g,t} - \overline{\theta}\, r_{g,t}\right), \quad r_{g,t} = \frac{r_{p,t} - r_{p,t-1}}{\overline{r}_p},$$

where $r_{p,t}$ is the proxy value at time t, and $\overline{r}_p$ is its average. The average surplus, in the second column, is $\bar{s}_t = e^{-\overline{\theta}}$. The proxies are the number of economically significant rules accumulated for three years ($r_{p,t} = ESR_{3y,t}$), or the number of pages in Title 3 of the Code of Federal Regulations accumulated for three years ($r_{p,t} = CFR_{3y,t}$) and appear in the first column. The other results follow from that: SR is the market portfolio Sharpe ratio, λ is the market price of risk, and $r_f - \delta$ is the difference between the continuously compounded risk-free and subjective discount rates, all obtained unconditionally. The superscripts indicate their equivalents conditioned on the (previous period) level of government intervention, in which the proxies are above (h) or below (l) their medians. All values, except the Sharpe ratios and the market prices of risk, are in percentage terms. The choices of average surplus correspond to SR around 0.2 or 0.5, or λ around 0.8 or 2.

	$\bar{s}_t$	SR	SR^h	SR^l	λ	λ^h	λ^l	$r_f - \delta$	$r_f^h - \delta^h$	$r_f^l - \delta^l$
ESR_{3y}	33	0.21	0.16	0.24	0.65	0.75	0.56	-19	-24	-16
ESR_{3y}	8	0.51	0.44	0.55	1.45	1.69	1.23	-115	-143	-95
ESR_{3y}	25	0.27	0.22	0.31	0.82	0.95	0.70	-34	-42	-29
ESR_{3y}	3	0.73	0.66	0.76	2.03	2.35	1.73	-225	-282	-182
CFR_{3y}	43	0.20	0.27	0.07	1.02	1.34	0.54	-51	-70	-30
CFR_{3y}	16	0.51	0.67	0.12	2.81	3.83	1.05	-437	-764	-99
CFR_{3y}	50	0.16	0.22	0.05	0.82	1.07	0.45	-30	-38	-21
CFR_{3y}	22	0.39	0.52	0.11	2.08	2.80	0.88	-233	-386	-73

What these graphs and Table 4 imply is that the subjective discount rate, δ_t, must vary counter-cyclically, given that the risk-free rate does not change much. Under this assumption, the changes in $r_{f,t} - \delta_t$ observed in the last columns of Table 4 are almost entirely due to changes in δ_t. This type of preference shock means that the agents become more impatient in bad times, $\delta^h > \delta^l$. And, indeed, there is evidence that this happens. For example, the mechanism could be similar to what causes opioid addicts to discount both opioid and money more steeply when they are craving the drug ("bad times") than when they are not ("good times") (Giordano et al., 2002), as described in the introduction.

Finally, based on the ESR_{3y}, the subjective discount rate would need to increase close to 25% on average in bad times, and reduce close to 17% on average in good times for the average surplus values reported in Table 4. For the estimates based on the CFR_{3y}, these numbers would change to 51% and 54%, respectively. Although uncommon in the asset pricing literature, these values are in line with the estimates in Giordano et al. (2002), for example.

5 The predictability puzzle

A final aspect of the equity premium is that we suspect, at least since Fama and French (1988), that the variation in the equity premium is predictable, especially at longer horizons (Cochrane, 2011). The conditional results in the previous section show that, within the framework that I present, the market price of risk increases with intervention. Hence, the proxies for intervention should ideally forecast the equity premium, which is the question that I address in this section.

Figure 9 gives an overview of the predictive relation between each intervention proxy and the market premium at 1- to 5-year horizons. The scatter plots show the market premiums at different horizons going forward from time t on the vertical axis and the

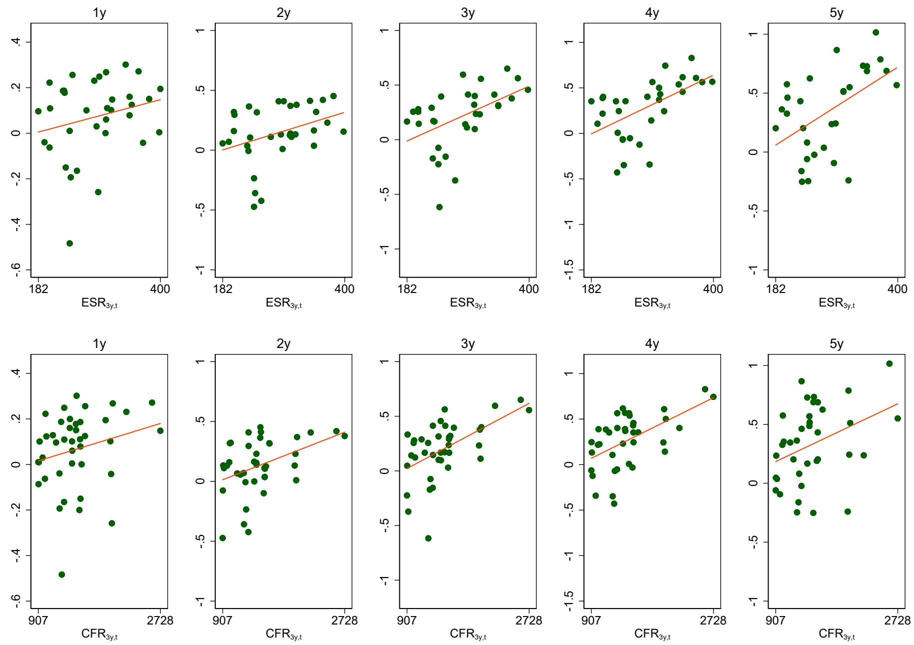

Figure 9: Illustration of the predictive relation between the market premium and government intervention. The graphs plot pairs of the form MP_{t+h} vs. $r_{p,t}$, where the proxy for intervention, $r_{p,t}$, is either the number of economically significant rules in the preceding three years, ESR_{3y} (at the top), or the number of pages in Title 3 of the Code of Federal Regulations in the preceding three years, CFR_{3y} (at the bottom), and MP_{t+h} is the market premium compounded over h years starting at time t, $h \in \{1, 2, 3, 4, 5\}$ (from left to right). The OLS fitted regression line in each case is in red.

proxies at time t on the horizontal axis. They suggest that there is, indeed, a clear, positive relation between intervention and risk premiums. Table 5 confirms the results suggested by Figure 9 and reports the estimated slope coefficients, β_{rh}, in predictive regressions of the form

$$MP_{t+h} = \alpha_{rh} + \beta_{rh} r_{p,t} + \epsilon_{t+h}, \tag{25}$$

where $r_{p,t} = ESR_{3y,t}$ or $r_{p,t} = CFR_{3y,t}$ is the proxy for intervention at time t and MP_{t+h} is the market premium compounded over h years, $h \in \{1, 2, 3, 4, 5\}$, starting at time t. The slope coefficients, β_{rh}, are significantly positive for every horizon and for both proxies, even if only being marginally significant for the 1-year horizon based on ESR_{3y}.

Table 5: Predictive regressions of the market premium based on accumulated intervention. The predictive regressions have the form

$$MP_{t+h} = \alpha_{rh} + \beta_{rh} r_{p,t} + \epsilon_{t+h},$$

where the proxy for intervention ($r_{p,t}$) is either the number of economically significant rules accumulated for three years ($r_{p,t} = ESR_{3y,t}$), or the number of pages in Title 3 of the Code of Federal Regulations accumulated for three years ($r_{p,t} = CFR_{3y,t}$). MP_{t+h} is the market premium (in %) compounded over h years, $h \in \{1, 2, 3, 4, 5\}$, starting at time t. The table reports the estimated β_{rh} coefficients of the intervention proxy in each case (next to the respective proxy, in thousands), the number of years (Obs.), and the coefficient of determination (R^2). The t statistics in parentheses has OLS standard errors and the one in brackets has Newey-West standard errors with h lags. The significance is given by the latter: $^{*}p < 0.05$, $^{**}p < 0.01$, $^{***}p < 0.001$.

	MP_{t+1}	MP_{t+2}	MP_{t+3}	MP_{t+4}	MP_{t+5}
$ESR_{3y,t}$	65.3	144.2*	230.3*	295.7*	303.5*
	(1.37)	(2.13)	(3.00)	(3.51)	(3.14)
	[1.72]	[2.23]	[2.60]	[2.48]	[2.25]
Obs.	34	33	32	31	30
R^2	0.026	0.100	0.205	0.274	0.234
$CFR_{3y,t}$	9.0*	21.8***	32.7***	36.5***	26.9**
	(1.50)	(2.81)	(3.98)	(3.86)	(2.31)
	[2.53]	[3.89]	[4.47]	[5.30]	[3.52]
Obs.	41	40	39	38	37
R^2	0.031	0.150	0.281	0.274	0.108

Intuitively, the consumer surplus decreases (economic conditions deteriorate) and risk premiums increase with government intervention. This is similar to the conclusion in Fama and French (1989) based on consumer expenditure. In summary, it shows that the framework that I present also delivers predictability of the equity premium.

5.1 The individual yearly components in the three-year proxies

As a robustness check, I investigate the forecasting properties of the individual yearly values that are accumulated to build the proxy for government intervention. Eq. (20) shows that the series CFR_{3y} and ESR_{3y} correspond to the values of each proxy in a given year, t, added to their values in the two previous years. In this section, I run predictive regressions of the market premium based on each of these three components individually. The regressions, similar to the ones in Eq. (25) and for the same horizons, h, have the form

$$MP_{t+h} = \alpha_{hl} + \beta_{hl} r_{p,t-l} + \epsilon_{l,t+h}, \tag{26}$$

where, now, the proxies for intervention at time t are $r_{p,t} = ESR_{y,t}$ or $r_{p,t} = CFR_{y,t}$, which are, respectively, the number of economically significant rules (ESR) or pages in Title 3 of the Code of Federal Regulations (CFR) in each **individual** year, t. I consider these values at time $t-l$, where $l \in \{0,1,2\}$ indicates the number of lags (and translates to one of the three components of the accumulated proxy, as described in Eq. (20)).

Table 6: Predictive regressions of the market premium based on the yearly number of economically significant rules, ESR, at different lags. The predictive regressions have the form

$$MP_{t+h} = \alpha_{hl} + \beta_{hl} ESR_{y,t-l} + \epsilon_{l,t+h},$$

where the proxy for intervention is the number of economically significant rules (ESR_y) in the (individual) year $t-l$, with $l \in \{0,1,2\}$. MP_{t+h} is the market premium (in %) compounded over h years, $h \in \{1,2,3,4,5\}$, starting in year t. The table reports the estimated β_{hl} coefficients of the proxy (in thousands) for each lag (l), the number of years (Obs.), and the coefficient of determination (R^2). The t statistics in parentheses has OLS standard errors and the one in brackets has Newey-West standard errors with h lags. The significance is given by the latter: $^{*}p < 0.05$, $^{**}p < 0.01$, $^{***}p < 0.001$.

	MP_{t+1}	MP_{t+2}	MP_{t+3}	MP_{t+4}	MP_{t+5}
$ESR_{y,t}$	60.1	172.5	335.3*	517.8*	645.7*
	(0.56)	(1.07)	(1.75)	(2.43)	(2.78)
	[0.80]	[1.32]	[2.17]	[2.67]	[2.61]
Obs.	36	35	34	33	32
R^2	-0.020	0.004	0.059	0.132	0.179
$ESR_{y,t-1}$	137.8	308.6*	482.3**	612.8**	651.2**
	(1.17)	(1.88)	(2.57)	(2.93)	(2.77)
	[1.50]	[2.16]	[2.99]	[2.96]	[2.81]
Obs.	35	34	33	32	31
R^2	0.011	0.072	0.149	0.196	0.182
$ESR_{y,t-2}$	184.6	361.7**	486.1**	522.2*	431.9
	(1.52)	(2.19)	(2.54)	(2.36)	(1.65)
	[1.96]	[2.88]	[2.86]	[2.54]	[1.84]
Obs.	34	33	32	31	30
R^2	0.038	0.106	0.150	0.132	0.056

Table 6 and Table 7 show that each of the three components of both proxies significantly forecasts the market premium for at least two of the five different horizons. In line with the previous literature on equity premium predictability, the proxies tend to have better forecasting power at longer horizons. However, this seems to be negatively related to the number of lags: None of the proxies measured with two lags forecasts the 5-year market premium. On the other hand, both proxies forecast the 4- and 5-year market premiums when the proxies are measured without lags, while failing to forecast the 1-year premium. Finally, lagged values of CFR_y seem to forecast the market premium better than lagged values of ESR_y, and the opposite seems to happen for their values at time t.

Table 7: Predictive regressions of the market premium based on the number of pages in Title 3 of the Code of Federal Regulations, CFR, at different lags. The predictive regressions have the form

$$MP_{t+h} = \alpha_{hl} + \beta_{hl} CFR_{y,t-l} + \epsilon_{l,t+h},$$

where the proxy for intervention is the number of pages in Title 3 of the Code of Federal Regulations (CFR_y) in the (individual) year $t-l$, with $l \in \{0,1,2\}$. MP_{t+h} is the market premium (in %) compounded over h years, $h \in \{1,2,3,4,5\}$, starting in year t. The table reports the estimated β_{hl} coefficients of the proxy (in thousands) for each lag (l), the number of years (Obs.), and the coefficient of determination (R^2). The t statistics in parentheses has OLS standard errors, and the one in brackets has Newey-West standard errors with h lags. The significance is given by the latter: $^{*}p < 0.05$, $^{**}p < 0.01$, $^{***}p < 0.001$.

	MP_{t+1}	MP_{t+2}	MP_{t+3}	MP_{t+4}	MP_{t+5}
$CFR_{y,t}$	0.7	8.5	31.8	57.9*	59.4*
	(0.05)	(0.48)	(1.62)	(2.76)	(2.51)
	[0.04]	[0.57]	[1.82]	[2.60]	[2.31]
Obs.	43	42	41	40	39
R^2	-0.024	-0.019	0.039	0.145	0.122
$CFR_{y,t-1}$	10.5	34.0**	60.0***	61.7**	50.0**
	(0.81)	(2.02)	(3.36)	(2.95)	(2.04)
	[1.04]	[3.46]	[3.85]	[3.53]	[3.58]
Obs.	42	41	40	39	38
R^2	-0.008	0.072	0.209	0.168	0.079
$CFR_{y,t-2}$	24.2**	50.3**	51.7***	40.1***	4.5
	(1.93)	(3.15)	(2.75)	(1.77)	(0.17)
	[3.27]	[2.81]	[3.62]	[3.92]	[0.23]
Obs.	41	40	39	38	37
R^2	0.064	0.186	0.147	0.054	-0.028

Intuitively and in line with the model, the delayed effect of intervention on the market premium is consistent with the existence of several consecutive sectors in the economy and the assumption that the intervention costs are accumulated as the goods pass from one sector to the next.

6 Summary

In this paper we learn that the equity premium–risk-free rate puzzle seems to arise in consumption-based asset pricing theories because we ignore government failure and use changes in consumption expenditure directly to calculate changes in the marginal utility of consumption. By failing to remove the part of consumption expenditure that is imposed by government failure, we miscalculate utility levels, changes in marginal utility, state prices, and equilibrium risk premiums as a consequence.

We also learn how to "clean" the expenditure series of government-imposed consumption, based on two observable proxies for government intervention. For several of the calibrated series using this method there are no puzzling aspects associated with the equity premium or risk-free rate. The framework also explains the predictability puzzle and the counter-cyclical variation in risk premiums that we observe in the data without any further assumption. Finally, we learn that the subjective discount rates vary counter-cyclically and are a lot larger than previously assumed in the asset pricing literature but still in line with independent empirical evidence on subjective discount rates.

The paper also provides an intuitive explanation for the large equity premium observed in the data: People avoid stocks because stocks tend to deliver bad returns exactly when government failure increases. When government intervention increases, the individual must consume more of what the government mandates and, as a consequence, less of what he actually chooses. His marginal utility increases. Stocks are therefore undesirable for everyone in the economy, which reduces the demand for them. This drives the price of stocks down, inevitably increasing their expected returns. In terms of the discussion in Cochrane (2017), government intervention (failure) seems to be the fundamental source of macroeconomic fluctuations through the risk premium and risk bearing capacity channels.

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