Red tape asset pricing

Thiago de Oliveira Souza

University of Southern Denmark;

Danish Finance Institute

August 23, 2019

I have nothing to disclose.

Abstract

The equity premium–risk-free rate puzzle in standard consumption-based asset pricing models disappears 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 increases, thereby systematically reducing individuals' utility levels. Government intervention is likely the key macro-finance variable linking asset prices and economic fluctuations.

1   Introduction

Every government restricts individual choice for reasons other than securing property rights. For example, they all penalize individuals that choose to consume goods produced in (certain) foreign countries with taxes. But among the restrictions on individual choice, regulations are particularly inefficient. The "Economists' statement on carbon dividends" in the Wall Street Journal recently tries to explain this and other points to the general public.[1] More formally, Dawson and Seater (2013) estimate that U.S. annual output by 2005 is a mere 28% of what it would have been had regulation remained at its 1949 level: They show that regulation forces the firms to choose suboptimal mixes of inputs. Indeed, regulations also force the consumption of suboptimal bundles directly. Andrew Birch, at the website *Greentech Media*, provides anecdotal evidence explaining why installed solar panels in the United States cost $3.25 per watt compared to $1.34 in Australia:[2] 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 is likely above 99%.[3]

Standard mathematical optimization arguments imply that the maximum utility achieved with a given consumption expenditure decreases with the addition of biding (regulation) constraints. Within a consumption-based asset pricing framework in particular, this implies that consumption expenditures alone cannot determine (marginal) utility levels and state prices. In fact, the apparent "puzzle" involving the equity premium and risk-free rate is exactly a consequence of ignoring the optimization restrictions imposed by the government:

---

[1] The statement first appeared in the Wall Street Journal on the 19 of January 2019, and it can also be found at http://www.econstatement.org.

[2] 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.

[3] 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.

Once we consider these restrictions, standard power utility asset pricing models generate the observed market Sharpe ratio, a low and stable risk-free rate, and predictability with realistic consumption expenditure, a positive subjective discount factor, and low risk aversion – as the equity premium–risk-free rate puzzle is currently defined (Cochrane, 2017).

The central idea of the present paper is to "clean" aggregate consumption expenditure of its unwanted part 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). Although for very different reasons, the 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 idea of replacing expenditures with garbage (Savov, 2011) (or not (Kroencke, 2017)).

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, voluntary consumption growth must be (i) sufficiently 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 increases (to correctly generate predictability). Hence, not *any* adjustment of the consumption series solves the puzzle. An important counter example is that, if the individuals in fact benefited from government intervention, items (i) to (iii) above would need to have the exact opposite signs to solve the puzzle. Otherwise, the hypothesis would be formally rejected in empirical tests because stocks would offer hedge and have negative equilibrium risk premiums. So what is the evidence?

Although the average regulation level cannot be measured, regulation volatility and its 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.

2
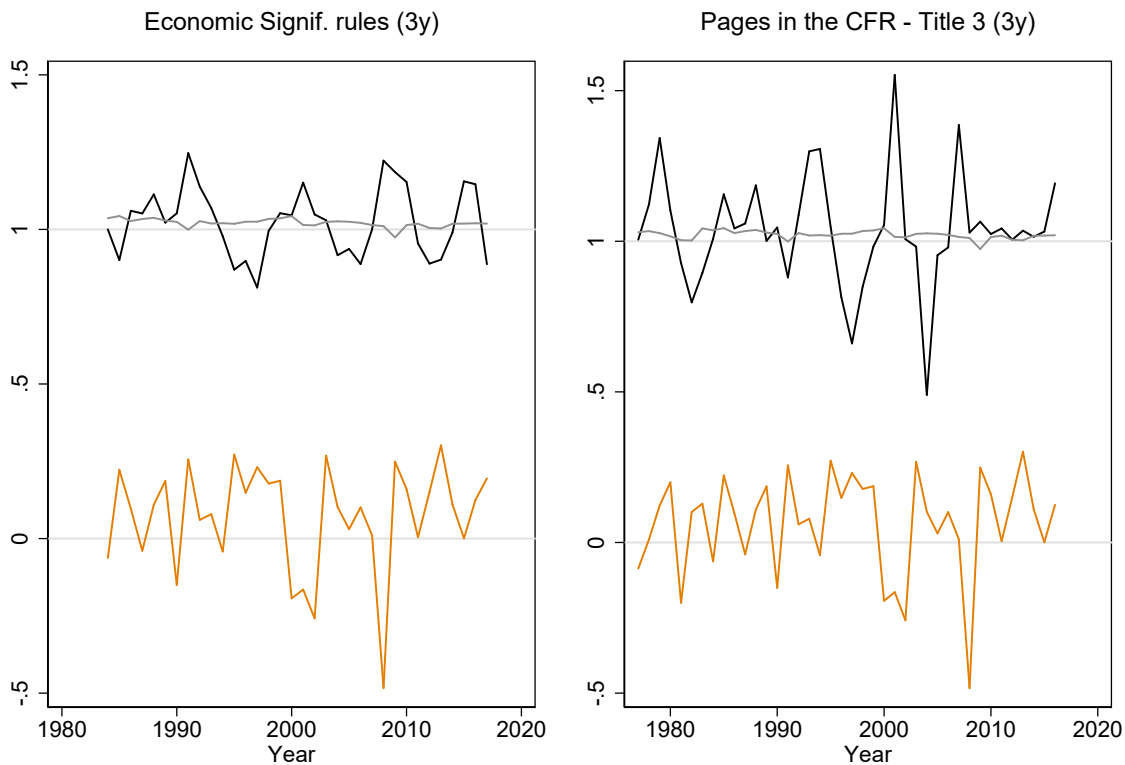
Figure 1: Yearly intervention growth, expenditure growth, and equity premium. In both graphs, the orange line at the bottom shows the equity premium, and the gray line at the top shows consumption expenditure growth. For the graph on the left, the black line at the top shows the yearly growth in the 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.

The CFR is the same (purely counting) proxy used by Dawson and Seater (2013), which I restrict to Title 3 to track government activity more closely.[4] 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).

---

[4]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.

Figure 1 shows that the volatilities of the equity premium and regulation 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 regulation 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 regulation 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 – in 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 regulation increases, voluntary consumption decreases, and marginal utilities (and state prices) become large as a consequence. Increases in the ESR are even correlated with decreases in expenditures: The individuals often learn about negative aggregate shocks to expenditures at the same time when they learn that a larger fraction of their (already reduced) wealth must be used for consumption imposed by the government.

Finally, the general results that I report are also consistent with others in the literature. For example, in practice government-imposed consumption tends to be regressive because, at least in part, it imposes fixed costs on the 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 bundle. 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 regulation risk (surplus volatility) based on the framework that I present, explaining the change.

Quantitative examples: Given that the baseline average fraction of government-mandated consumption in 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 surplus of 8%. In this case, the market Sharpe ratio is 0.5, the market price of risk 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 surplus of 16%, the market Sharpe ratio is 0.5, the market 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 due to the higher volatility of the CFR compared to the ESR.

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, which is problematic since their independently documented estimates go from slightly negative to (positive) infinity (Frederick et al., 2002).[5]

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

---

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

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.[6]

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 significantly forecast increases in the market premiums calculated at every horizon from one to five years (marginally for the 1-year market premium based on the ESR proxy).

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.[7] The change is even more pronounced for the discount of opioid.

---

[6]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.

[7]"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, pp. 180).

1.1 Contribution and related literature

The present paper relates primarily to the literature on the equity premium puzzle, which is extensively discussed in Cochrane (2017). In addition to explaining why the puzzle remains unresolved, Cochrane (2017) reveals that the existing tentative solutions of the puzzle typically need 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 (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, also relatively 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 only 5.7%, generates the (problematically large in the model) risk aversion necessary 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).

Therefore, the central contribution of the present paper is to offer the first complete solution for the equity premium puzzle, as defined by Cochrane (2017) earlier in this introduction. 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 study of government-induced changes in risk premiums is also part of a growing literature on policy uncertainty. The standard theoretical framework in this literature, 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. With all these assumptions, government intervention increases aggregate utility. As explained, this would be even less consistent with the observed equity premium.

In contrast, optimal consumption is only achieved under free markets within the framework that I present. In the model, this happens because the government acts in its own self-interest. This violates assumption (iii) above. However, violations of assumptions (i) or (ii) would also result in inefficient restrictions and lower welfare. The empirical proxies are fundamentally different, too. For example, the index for policy uncertainty in Baker et al. (2016) includes elections, wars, and national debt disputes. However, the proxies that I use only include direct measures of government overreach that negatively impact economic output, similar to the ones in Dawson and Seater (2013). Finally, the present paper is also fundamentally different from Pastor and Veronesi (2017) because its objective is exactly to explain risk premiums.

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 is such that it maximizes the government's own intertemporal objective function,

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

where $\mathbb{E}$ is the expectation operator and $u_G(X)$ is the government's utility function.

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,

$$\max_{c=(c_t)} \mathbb{E}\left[\int_0^T e^{-\delta t} \frac{1}{1-\gamma} c^{1-\gamma}\, dt\right], \tag{2}$$

subject to the budget constraint

$$\mathbb{E}\left[\int_0^T \zeta_t c_t\, dt\right] + \mathbb{E}\left[\int_0^T \zeta_t X_t\, dt\right] \le \mathbb{E}\left[\int_0^T \zeta_t e_t\, dt\right], \tag{3}$$

where the right-hand side is the present value of the endowment process, $e = (e_t)$, and the left-hand side is the present value of the expenditures on (i) the consumption good, c, and (ii) the state good, X. This optimization induces the SDF

$$\zeta_t = e^{-\delta t}\left(\frac{c_t}{c_0}\right)^{-\gamma}. \tag{4}$$

The optimal consumption process: Government-imposed consumption, X_t, provides no utility to the representative agent. Hence, it is possible to obtain the consumption series,

$$c_t = k_t - X_t = k_t s_t, \tag{5}$$

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 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 an improved measure of consumption which, in this sense, is closer to the procedures in Kroencke (2017) and Savov (2011), for example.

Let consumption expenditure, k_t, follow the diffusion process

$$dk_t = k_t \left[\mu_{k,t} \, dt + \sigma_{k,t} \, dz_{1,t} \right], \tag{6}$$

and let surplus consumption, s_t, follow the diffusion process

$$ds_t = s_t \left[\mu_{s,t} \, dt + \sigma_{s,t} \, dz_{2,t} \right], \tag{7}$$

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,

$$dc_t = c_t \left[\mu_{c,t} \, dt + \sigma_{c,t}^{\mathsf{T}} \, d\mathbf{z}_t \right], \tag{8}$$

$$\mu_{c,t} = \mu_{k,t} + \mu_{s,t}, \tag{9}$$

$$\sigma_{c,t} = \begin{pmatrix} \sigma_{k,t} \\ \sigma_{s,t} \end{pmatrix}, \tag{10}$$

where T 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. (4) and the consumption process in Eq. (8) gives the standard consumption-based SDF dynamics

$$d\zeta_t = -\zeta_t \left[\left(\delta + \gamma \mu_{c,t} - \frac{1}{2}\gamma(1+\gamma)\|\sigma_{c,t}\|^2 \right) dt + \gamma \sigma_{c,t}^\intercal d\mathbf{z}_t \right], \tag{11}$$

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

$$dP_{i,t} = P_{i,t} \left[\mu_{i,t} dt + \sigma_{i,t}^\intercal d\mathbf{z}_t \right], \tag{12}$$

is given by

$$SR_i \equiv \frac{\mu_{i,t} - r_{f,t}}{\|\sigma_{i,t}\|} = \rho_{ic,t} \gamma \|\sigma_{c,t}\|, \tag{13}$$

where $\rho_{ic,t}$ is the correlation between the risk premium of asset i and consumption growth. More specifically, Eq. (13) 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?

Let us assume that $\overline{S}_t$ is the market Sharpe ratio that we would like to generate. Substituting Eq. (10) in Eq. (13), we obtain

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

(14)

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. (14) is usually not enough 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. (11), together with Eq. (9) and Eq. (14) gives

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

(15)

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. (14), or directly connecting it to the market Sharpe ratio, $\overline{S}_t$ in Eq. (15).

In summary, the framework provides directions to "reverse-engineer any asset pricing results", which is what Cochrane (2017) describes as one of the main contributions of Constantinides and Duffie (1996), for example.[8] However, this also means that the model can be too flexible unless we can relate the surplus consumption to the data, as I do next.

---

[8] 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. (7), instead.

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

$$k_t = c_t \, e^{\sum_{q=1}^{Q} r_{q,t}} = c_t \, e^{\theta_t}, \tag{16}$$

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 $\theta_t = Q\bar{r}_t$ can be interpreted as the product between the average rate of the state goods production in the previous sectors at time t, $\bar{r}_t$, and the number of sectors, Q. This implies that surplus consumption, $s_t = \frac{c_t}{k_t}$, is

$$s_t = e^{-\theta_t}, \quad \theta_t = \sum_{q=1}^{Q} r_{q,t}. \tag{17}$$

The fraction of expenditure from which the agent derives utility, s_t, decreases with the production rate of the state good, $\bar{r}_t$, 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. (17) 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

$$k_{g,t} = \ln\left(\frac{k_t}{k_{t-1}}\right). \tag{18}$$

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 the 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. 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. There are two main reasons to consider only Title 3: The first is that it reflects the posture of

the government regarding intervention more directly. The underlying assumption is that a more active government makes more choices and leaves less alternatives available for the individuals. Hence, government activity in general is detrimental to the individual.[9] The second reason is one of timing: The regulations (subsequently) created by the federal agencies also appear in the remaining chapters of the Code. These regulations tend to arise from previous government choices, not necessarily from the ones currently being made. Forward looking agents should anticipate most of this second wave of regulations.

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.[10] 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, so "two identical values may comprise regulations of different types and, even within a given type, may represent regulations of different stringency" (Dawson and Seater, 2013). Therefore, I 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.[11]

---

[9]This contrasts, for example, with the assumptions in standard models of political uncertainty, such as Pastor and Veronesi (2013, 2012), in which government intervention can increase individual welfare.

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

[11]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/.

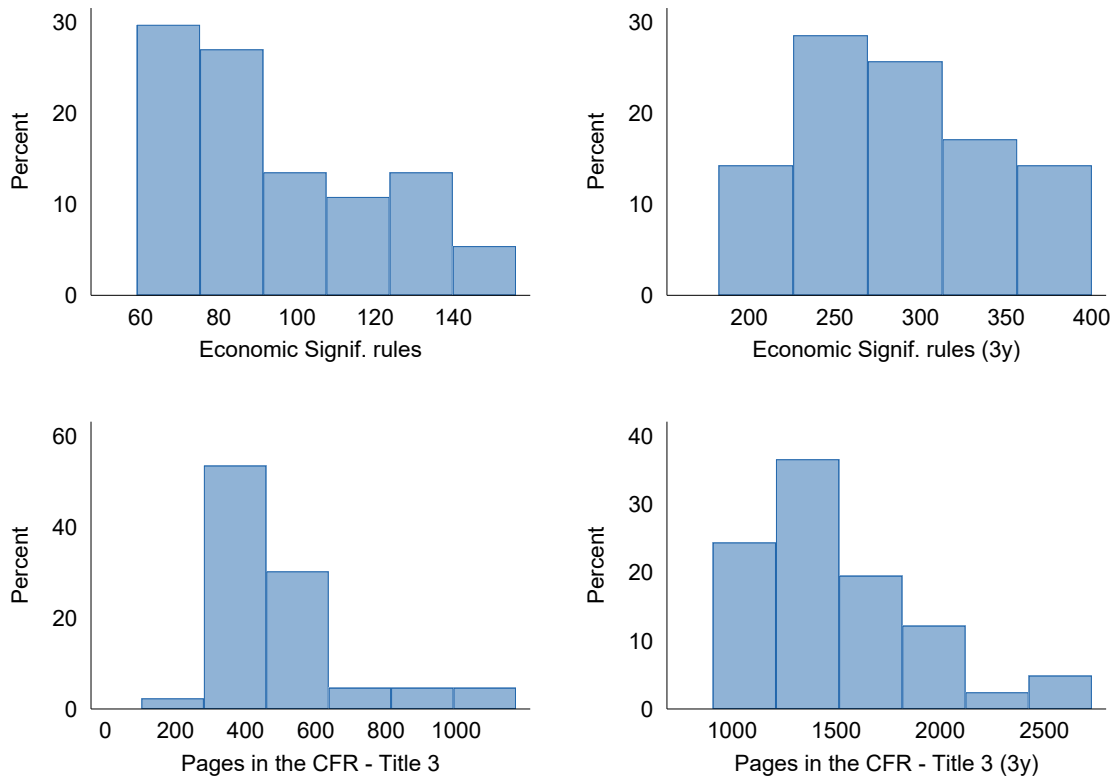### 3.2.1 Lagged measures of government intervention

As explained before and shown in Eq. (17), 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. In addition, as also explained, several regulatory choices give federal agencies the power to further regulate the economy at a later point in time. 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 regulation proxies in year t, $r_{p,t} = ESR_t$ or $r_{p,t} = CFR_t$, and their two lags, as

$$r_{3y,t} = \sum_{l=0}^{2} r_{p,t-l}. \tag{19}$$

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.

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.

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).

3.3 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 regulation 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

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

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

comovement between (voluntary) consumption growth and risk premiums, as we would expect if voluntary consumption really explains the equity premium.

Columns 2, 4, and 5 in Table 3 provide more details: For example, Column 2 shows that regulation growth measured as $CFR_{g,3y}$ has almost the same volatility as the market premium, MP. The volatility of regulation 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
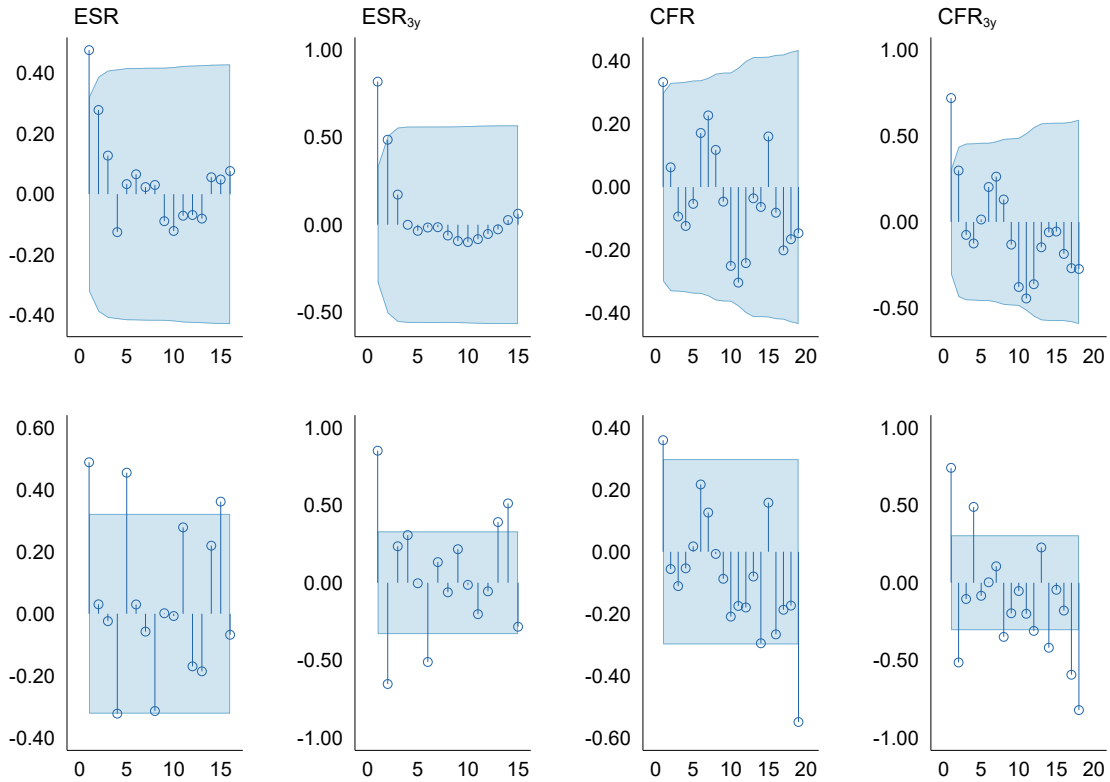
Figure 3: Correlograms for the number of economically significant rules and number of pages in the Code of Federal Regulation. The top graphs display the autocorrelation plots; the lower graphs display the partial autocorrelation plots. The columns correspond to the number of economically significant 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.

zero for $CFR_{g,3y}$, even though the two proxies are positively correlated with each other.[12] Measured by ESR, government control damages 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.

---

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

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

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

In this section, I calibrate the consumption process in Eq. (8) based on the observed time series of consumption expenditure that gives the parameters for Eq. (6), and a grid for the average levels of intervention together with the observed growth in the intervention proxy that give the parameters for Eq. (7). 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. (11). The Sharpe ratio is a function of $\sigma_{c,t}$ (and the correlation term) in Eq. (13). 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, $\bar{r}$, 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

$$\bar{r}_t = \bar{r}\left(\frac{r_{p,t}}{\bar{r}_p}\right), \tag{20}$$

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

$$r_{g,t} = \frac{r_{p,t} - r_{p,t-1}}{\bar{r}_p}. \tag{21}$$

Substituting Eq. (20) in $\theta_t = Q\bar{r}_t$, we can rewrite Eq. (17) as a function of each proxy to obtain

$$s_t = \exp\left(-\bar{\theta}\,\frac{r_{p,t}}{\bar{r}_p}\right), \tag{22}$$

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

$$c_{g,t} \equiv \frac{c_t}{c_{t-1}} = \exp\left(k_{g,t} - \bar{\theta}\,r_{g,t}\right), \tag{23}$$

where c_t is defined in Eq. (5), $k_{g,t}$ is defined in Eq. (18), and $r_{g,t}$ is defined in Eq. (21). Consumption growth now becomes a function of the – observable – values of consumption expenditure and the intervention growth, given $\bar{\theta}$. This equation shows that the choice of $\bar{\theta}$ is crucial because it controls the weights on the growth rates in expenditure and regulation that are used to calculate consumption growth.

However, there are two main issues related to determining $\bar{\theta} = Q\bar{r}$ 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 $\bar{r}$. In addition to that, it is not clear how to obtain an estimate for the number of separate sectors involved

21

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 most of the analysis.

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.

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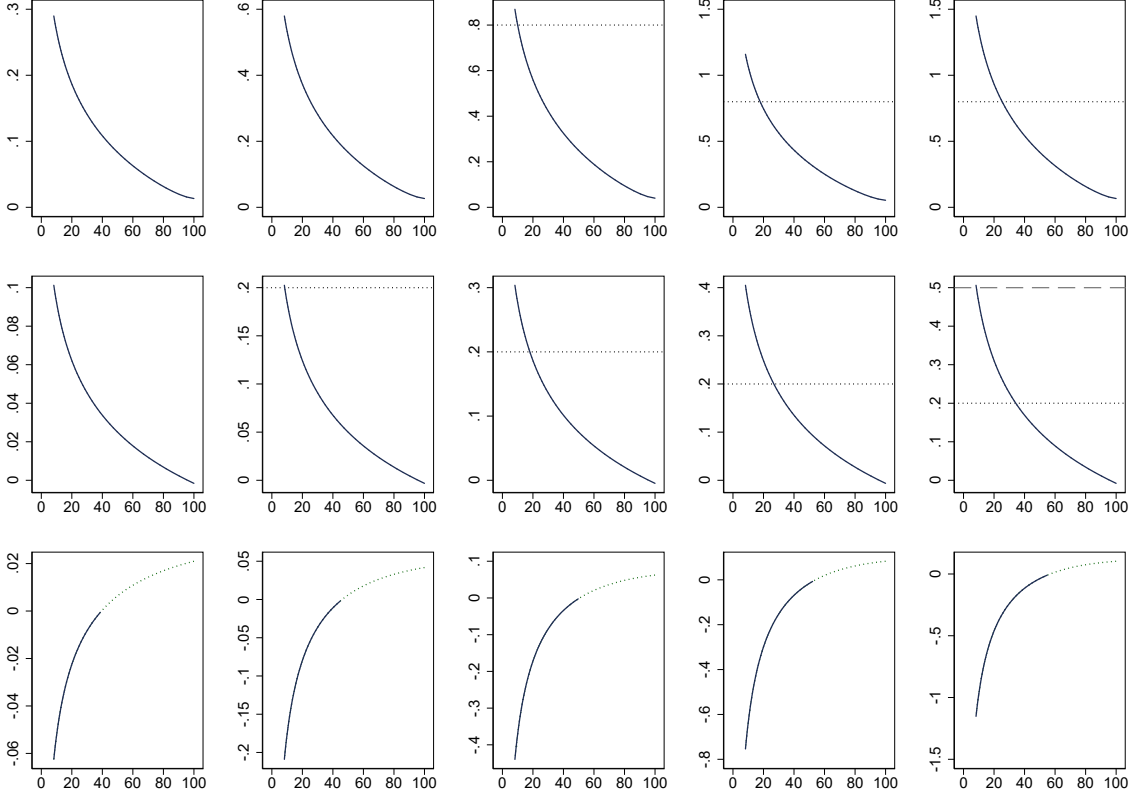
Figure 4: *ESR*-**based unconditional market prices of risk (top), market Sharpe ratios (middle), and subjective discount rate subtracted from the risk-free rate (bottom).** Consumption growth is calibrated as

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

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, $\gamma = 1, ..., 5$. 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).

23
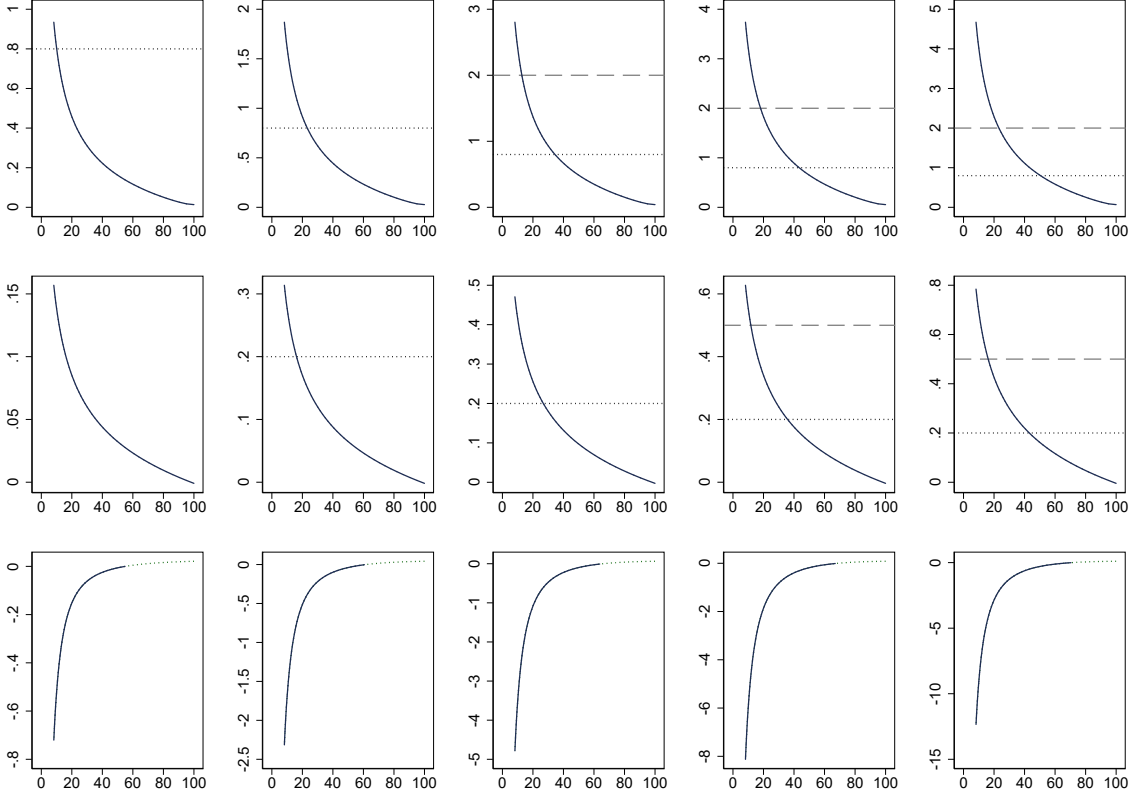
Figure 5: CFR**-based unconditional market prices of risk (top), market Sharpe ratios (middle), and subjective discount rate subtracted from the risk-free rate (bottom).** Consumption growth is calibrated as

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

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.

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.

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.[13]

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), $(\hat{\mu}_{c,t}^h, \hat{\sigma}_{c,t}^h, \hat{\rho}_{mc,t}^h)$, and another one found when intervention is low (good

---

[13]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.
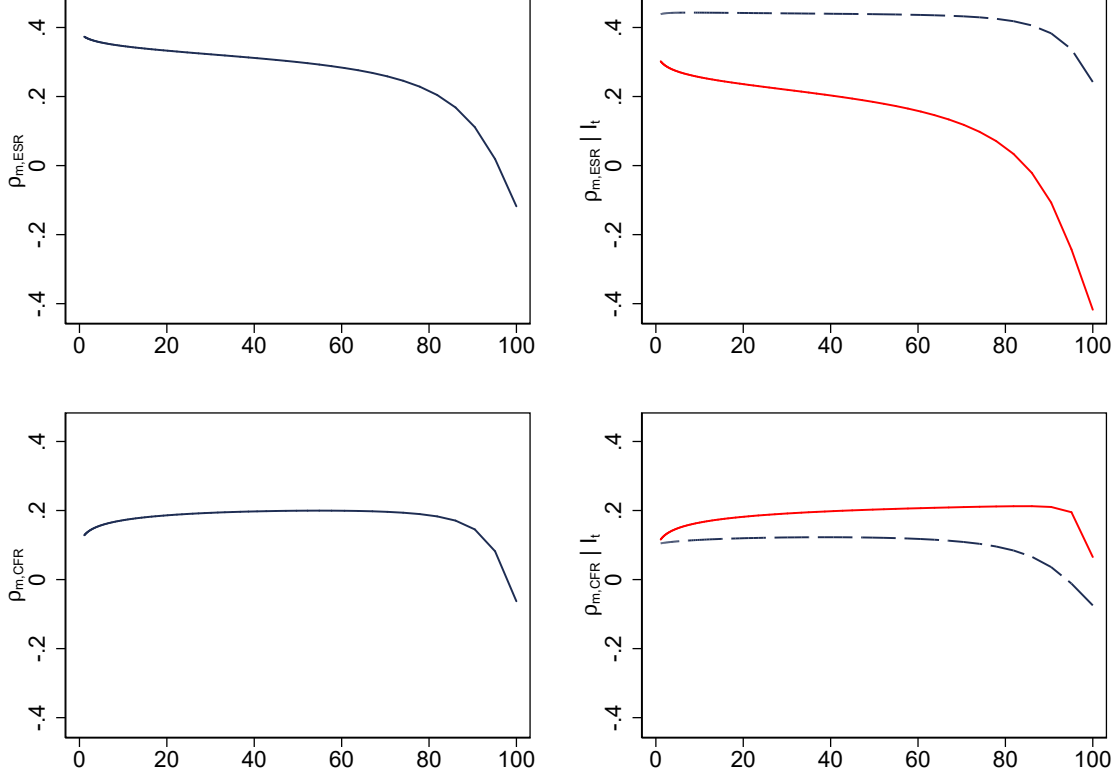
Figure 6: Conditional (right) and unconditional (left) estimates of the yearly correlation between the equity premium and consumption growth. Consumption growth is calibrated as

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

where $k_{g,t}$ is expenditure growth, $r_{p,t}$ is the proxy value at time t, $\overline{r}_p$ is its average, and $\overline{s}_t = e^{-\overline{\theta}}$ 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).

times), $(\hat{\mu}_{c,t}^{l}, \hat{\sigma}_{c,t}^{l}, \hat{\rho}_{mc,t}^{l})$. As given by Eq. (13), 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). However, instead of assuming that

this happens, as in Campbell and Cochrane (1999), I check whether we observe this 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").

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 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), so the solution makes sense especially in such a small sample. Another alternative is to assume even lower values of average surplus (not shown in the graph) because they also generate counter-cyclical market Sharpe ratios.
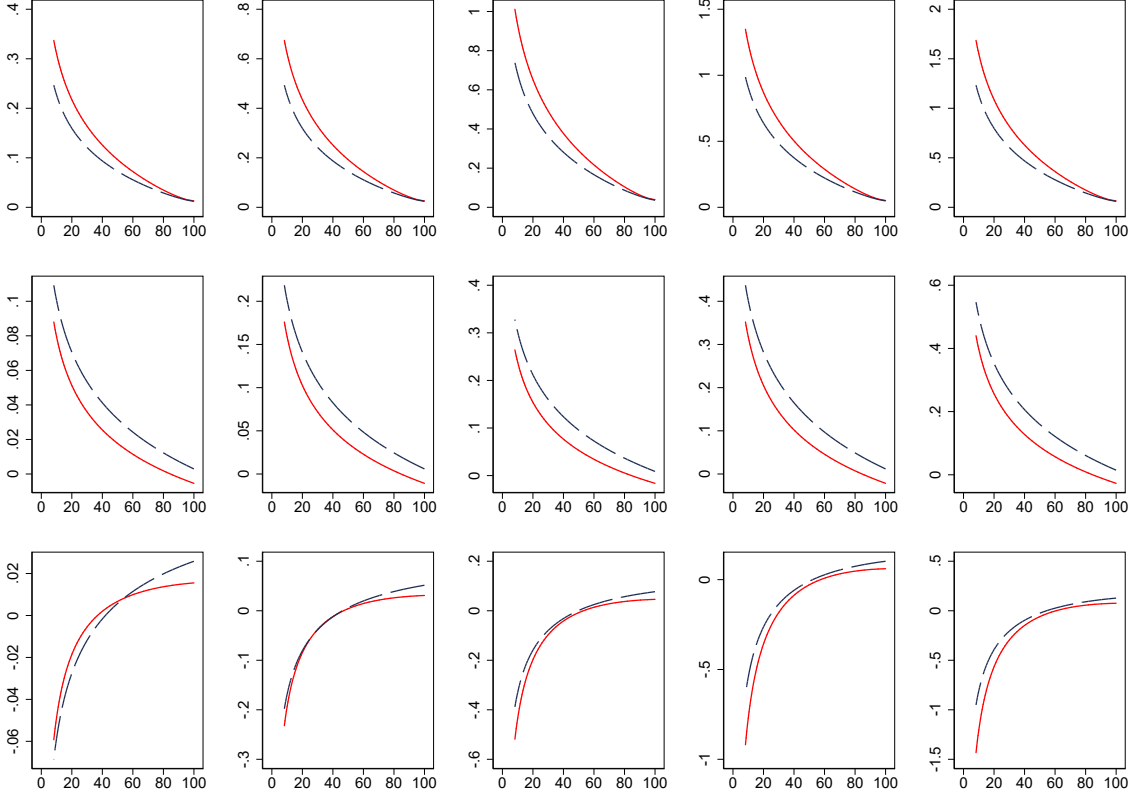
Figure 7: *ESR*-**based conditional market prices of risk (top), market Sharpe ratios (middle), and subjective discount rate subtracted from the risk-free rate (bottom).** Consumption growth is calibrated as

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

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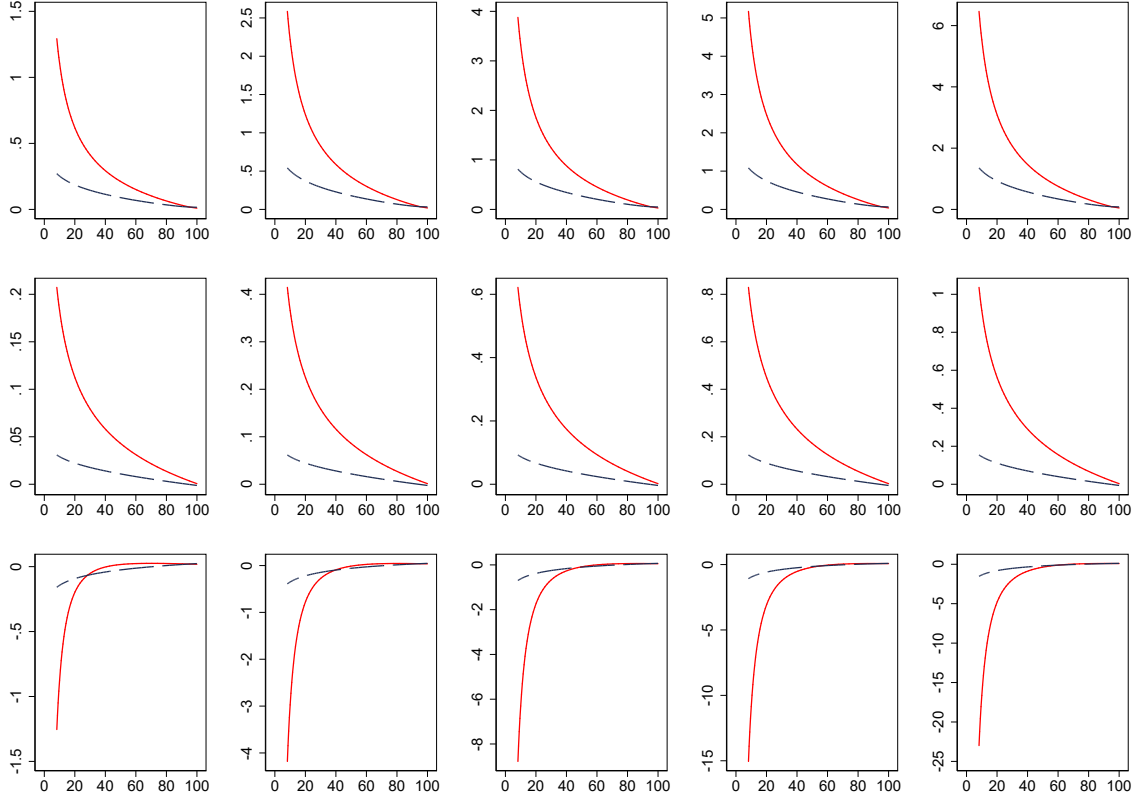
Figure 8: CFR-**based conditional market prices of risk (top), market Sharpe ratios (middle), and subjective discount rate subtracted from the risk-free rate (bottom).** Consumption growth is calibrated as

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

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 $\overline{s}_t = e^{-\overline{\theta}}$ 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.

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 heroin addicts to discount both drugs 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, the magnitude of this change must be substantial in some cases. For example, 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. These values, however, seem in line with the estimates in Giordano et al. (2002), mentioned in the introduction.
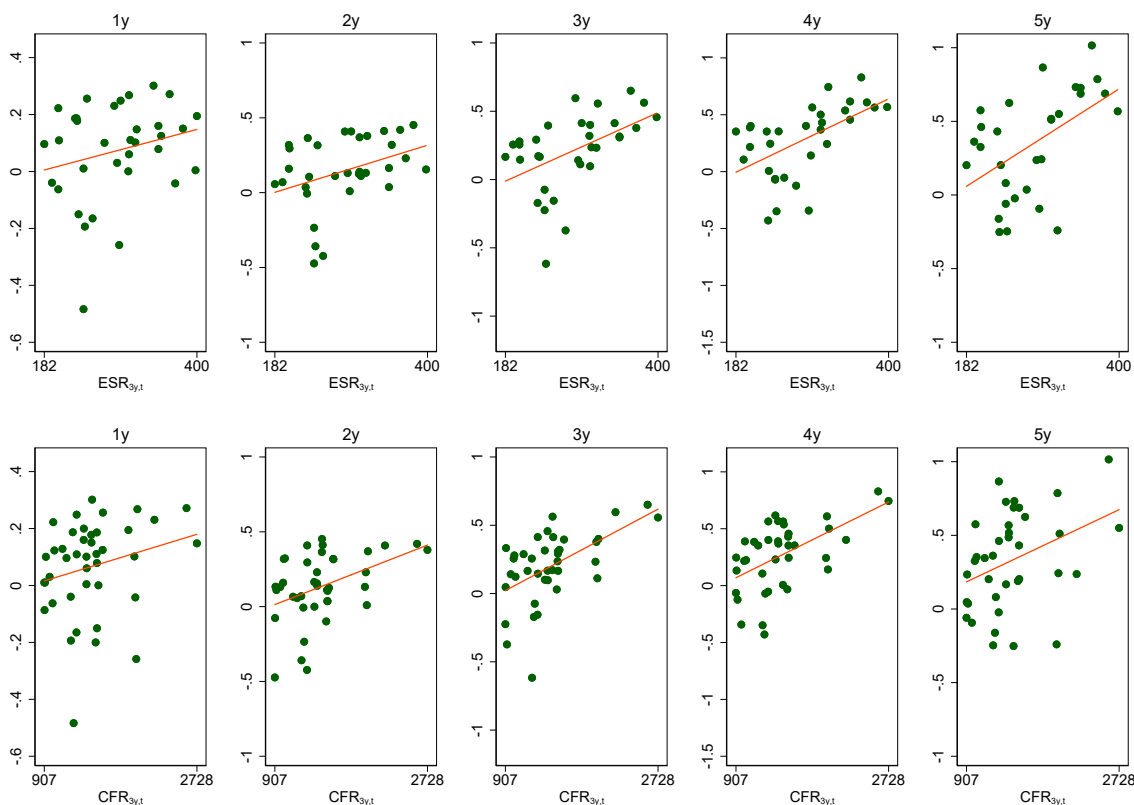
Figure 9: Illustration of the predictive relation between the market premium and government intervention. The graphs plot pairs of the form MP_{t+h} vs. $r_{p,t}$, where the proxy for intervention, $r_{p,t}$, is either the number of economically significant rules in the preceding three years, ESR_{3y} (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.

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 regulation. 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 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

$$MP_{t+h} = \alpha_{rh} + \beta_{rh} r_{p,t} + \epsilon_{t+h}, \tag{24}$$

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}.

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.

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

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. (19) 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. (24) and for the same horizons, h, have the form

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

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. (19)).

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.

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 regulation costs are accumulated as the goods pass from one sector to the next.

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

6 Summary

In this paper we learn that the equity premium puzzle seems to arise because we use changes in consumption expenditure to calculate changes in the marginal utility of consumption. By failing to remove the part of consumption expenditure that is imposed by the government, we miscalculate utility levels and changes in marginal utility. Just as we remove durable

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

goods expenditures from the consumption series, we should also remove government-imposed consumption.

We also learn how to "clean" the expenditure series of this type of 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. 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 observed equity premium: People avoid stocks because stocks tend to deliver bad returns exactly when the government decides to increase intervention in the economy. When intervention increases, the consumers must consume more of what the government wants and, as a consequence, less of what they actually want. So their marginal utilities increase. Stocks are therefore undesirable for everyone in the economy, which reduces their demand. This drives the price of stocks down, inevitably increasing their expected returns. In terms of the discussion in Cochrane (2017), government intervention could be the fundamental source of macroeconomic fluctuations, at least through the risk premium and risk bearing capacity channels.

References

Ahern, Kenneth R., and Amy K. Dittmar, 2012, The changing of the boards: The impact on firm valuation of mandated female board representation, *Quarterly Journal of Economics* 127, 137–197.

Baker, Scott R., Nicholas Bloom, and Steven J. Davis, 2016, Measuring economic policy uncertainty, *Quarterly Journal of Economics* 131, 1593–1636.

Bansal, Ravi, Dana Kiku, Ivan Shaliastovich, and Amir Yaron, 2014, Volatility, the macroeconomy, and asset prices, *Journal of Finance* 69, 2471–2511.

Bansal, Ravi, and Amir Yaron, 2004, Risks for the long run: A potential resolution of asset pricing puzzles, *Journal of Finance* 59, 1481–1509.

Barro, Robert J., 2006, Rare disasters and asset markets in the twentieth century, *Quarterly Journal of Economics* 121, 823–866.

Brunnermeier, Markus K., 2009, Deciphering the liquidity and credit crunch 2007-2008, *Journal of Economic Perspectives* 23, 77–100.

Campbell, John Y., 2003, Consumption-based asset pricing, *Handbook of the Economics of Finance* 1, 803–887.

Campbell, John Y., and John H. Cochrane, 1999, By force of habit: A consumption-based explanation of aggregate stock market behavior, *Journal of Political Economy* 107, 205–251.

Cochrane, John H., 2011, Presidential Address: Discount rates, *Journal of Finance* 66, 1047–1108.

Cochrane, John H., 2017, Macro-finance, *Review of Finance* 21, 945–985.

Constantinides, George M., and Darrell Duffie, 1996, Asset pricing with heterogeneous consumers, *Journal of Political Economy* 104, 219–240.

Dawson, John W., and John J. Seater, 2013, Federal regulation and aggregate economic growth, *Journal of Economic Growth* 18, 137–177.

Djankov, Simeon, Rafael La Porta, Florencio Lopez-de Silanes, and Andrei Shleifer, 2002, The regulation of entry, *Quarterly Journal of Economics* 117, 1–37.

Fama, Eugene F., and Kenneth R. French, 1988, Dividend yields and expected stock returns, *Journal of Financial Economics* 22, 3–25.

Fama, Eugene F., and Kenneth R. French, 1989, Business conditions and expected returns on stocks and bonds, *Journal of Financial Economics* 25, 23–49.

Frederick, Shane, George Loewenstein, and Ted O'Donoghue, 2002, Time discounting and time preference: A critical review, *Journal of Economic Literature* 40, 351–401.

Friedman, Milton, and Rose D. Friedman, 1980, *Free to choose* (London: Secker and Warburg).

Garleanu, Nicolae, and Stavros Panageas, 2015, Young, old, conservative, and bold: The implications of heterogeneity and finite lives for asset pricing, *Journal of Political Economy* 123, 670–685.

Giordano, Louis A., Warren K. Bickel, George Loewenstein, Eric A. Jacobs, Lisa Marsch, and Gary J. Badger, 2002, Mild opioid deprivation increases the degree that opioid-dependent outpatients discount delayed heroin and money, *Psychopharmacology* 163, 174–182.

Goff, Brian, 1996, *Regulation and macroeconomic performance*, volume 21 (Springer Science & Business Media).

Hansen, Lars P., and Ravi Jagannathan, 1991, Implications of security market data for models of dynamic economies, *Journal of Political Economy* 99, 225–262.

He, Zhiguo, and Arvind Krishnamurthy, 2013, Intermediary asset pricing, *American Economic Review* 103, 732–70.

Kroencke, Tim A., 2017, Asset pricing without garbage, *Journal of Finance* 72, 47–98.

Mankiw, N. Gregory, and Stephen P. Zeldes, 1991, The consumption of stockholders and nonstockholders, *Journal of Financial Economics* 29, 97 – 112.

Mehra, Rajnish, and Edward C. Prescott, 1985, The equity premium: A puzzle, *Journal of Monetary Economics* 15, 145–161.

Mehra, Rajnish, and Edward C. Prescott, 2003, The equity premium in retrospect, *Handbook of the Economics of Finance* 1, 889–938.

Munk, Claus, 2013, *Financial asset pricing theory* (Oxford University Press).

Pastor, Lubos, and Pietro Veronesi, 2012, Uncertainty about government policy and stock prices, *Journal of Finance* 67, 1219–1264.

Pastor, Lubos, and Pietro Veronesi, 2013, Political uncertainty and risk premia, *Journal of Financial Economics* 110, 520–545.

Pastor, Lubos, and Pietro Veronesi, 2017, Political cycles and stock returns, Working Paper 23184, National Bureau of Economic Research.

Savov, Alexi, 2011, Asset pricing with garbage, *Journal of Finance* 66, 177–201.

Shiller, Robert J., 1981, Do stock prices move too much to be justified by subsequent changes in dividends?, *American Economic Review* 71, 421–436.

Shiller, Robert J., 2014, Speculative asset prices, *American Economic Review* 104, 1486–1517.