Cash Flows in Equilibrium Asset Pricing Models

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Abstract

Market clearing requires that aggregate consumption equals the sum of capital and labor income. Yet, dividend processes in leading asset pricing models ignore this constraint. I propose to model the labor share of consumption and obtain dividends from market clearing, rather than modeling dividends directly. The approach is parsimonious, tractable, delivers cointegration between consumption and dividends, and captures the effect of labor market frictions on equity payout. When embedded into the habit and long-run risks models, the cash flow process allows the models to capture otherwise puzzling facts about the term structures of cash flow risk and equity risk premia.

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1 Introduction

Finance theory suggests an asset's price is determined by the joint properties of its cash flows and the pricing kernel. Naturally, an asset pricing model requires a correct description of both to be relevant. Modern consumption-based asset pricing models have had success at matching high and time-varying risk premia with low and stable risk free rates.[1] However, they do so with largely counterfactual cash flow properties, such as a lack of cointegration and poor empirical fit.[2] I argue that these counterfactual properties of cash flows arise primarily from the models failing to respect the aggregate market clearing relationship that states consumption is the sum of labor income and capital income. I propose a tractable way to model cash flows that respects this market clearing condition, matches many stylized facts about cash flow growth rates, delivers cointegration between macroeconomic quantities, and is applicable to a broad class of models.

An abundance of recent macrofinance theories stress the importance of labor market frictions for aggregate risk premia.[3] Indeed, in their original study of the equity premium Mehra and Prescott (1985) suggest that labor contracts may provide one explanation for the puzzle. The primary reason that labor market frictions impact asset prices is through their effects on cash flows, and these effects arise because of equilibrium resource constraints. If aggregate labor income is afforded some insulation from the full brunt of economic shocks, as

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[1] Examples include the external habit model (Campbell & Cochrane, 1999; Bekaert & Engstrom, 2017), the long run risks model (Bansal & Yaron, 2004; Bollerslev et al., 2009; Drechsler & Yaron, 2011), and the rare disasters model (Rietz, 1988; Barro, 2006, 2009; Wachter, 2013).

[2] In particular, as I show in Section 3, and as was shown in Beeler and Campbell (2012) and Belo et al. (2015), the term structure of volatility of dividend growth rates is robustly downward sloping in the data, but not in the habit and long run risk models, for example.

[3] Danthine and Donaldson (2002) and Marfè (2017) examine the effects of income insurance. Favilukis and Lin (2016b) and Favilukis et al. (2020) study production economies with wage rigidity. Petrosky-Nadeau et al. (2018) and Bai and Zhang (2020) embed a standard search model of unemployment into a production economy.

the aforementioned theories suggest, capital income must absorb more than its fair share of economic shocks. Because labor income makes up the bulk of consumption, this leads to a concentration of macroeconomic risk in capital income. That is, labor market frictions act as operating leverage which makes equity payout riskier.

While the primary goal in the field of macrofinance is to have one theory that explains a multitude of macroeconomic and financial facts simultaneously, attaining such a theory has proven elusive. Because of this, many papers in the asset pricing domain rely on more tractable exchange economies. Existing representative agent endowment economy asset pricing models do not provide a laboratory for studying the pricing implications of labor market frictions relationships because labor income is not a meaningful component of the model. My approach changes this by explicitly modeling the labor income share of consumption by a stationary process and obtaining dividends from the market clearing condition. In this spirit, my paper can be considered a bridge between general equilibrium production economies and endowment economies.

An important feature of my proposed cash flow modeling approach is that it operates independently of the specific stochastic process for consumption growth and of preferences. Thus, it truly is only a cash flow model – the pricing kernel is unaffected. The link between the cash flow model and pricing kernel happens through the relationship between the innovations to consumption growth and to the share of labor income in consumption. Labor market frictions dictate the direction of this relationship, which is negative or countercyclical.

I embed the model for cash flows into the Campbell and Cochrane (1999) external habit model and the Bansal and Yaron (2004) long run risks model to examine its performance and also its implications for asset prices. Taking the equilibrium market clearing condition as given and conditional on the existence of labor market frictions, my method produces dividend growth rates that are volatile, not very persistent, have low correlations with consumption growth, and display downward sloping term structures of volatility. Because labor income is only insulated in the short-run, dividends become more exposed to transitory risk which increases the volatility of near-term dividend growth. However, because of its transitory nature, this risk dissipates over time. Therefore, the volatility of long-term dividend growth is lower relative to the short-run volatility, which gives rise to variance ratios that decrease with horizon. This pattern has proven to be a robust empirical finding, and one that many leading consumption-based asset pricing models fail to replicate (Beeler & Campbell, 2012; Belo et al., 2015; Marfè, 2017).

In addition to matching stylized facts about dividend growth, the cash flow model simultaneously matches a number of stylized facts about labor income growth. Empirically, labor income growth behaves very similarly to consumption growth. In contrast to dividend growth, the term structure of volatility for labor income growth is upward sloping. This is consistent with labor market frictions providing some insurance against transitory risks.

My paper relates to the literature using new empirical moments to discipline economic models. A prominent example of this is using moments computed across horizons, commonly referred to as a term structure.[4] Van Binsbergen et al. (2012) use data on dividend strips to document that the term structure of equity risk premia is downward sloping. They show that leading asset pricing models based on habits, long run risks, and disasters predict the opposite. Backus et al. (2014) and Dew-Becker et al. (2017) use term structures of interest rates and returns on variance swaps, respectively, to further inform about the pricing of risk across horizons. Backus et al. (2018) connect the term structure of excess returns on an asset

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[4] Examples from other areas of finance include Giglio and Kelly (2018) who use term structures to examine violations of the law of iterated expectations and Conrad and Wahal (2020) who study the term structure of liquidity provision at short horizons.

to the term structure of its cash flow risk and its cash flow co-movement with the pricing kernel.

Particularly related to my work here, Belo et al. (2015) show correcting the term structure of dividend volatility in the habit and long run risk models allows the models to generate a term structure of risk premia that is downward sloping, as in the data. Ultimately, my method for modeling cash flows also corrects the term structure of dividend volatility in these models and generates a downward sloping term structure of risk premia. While the mathematical concept that underpins each of our approaches, cointegration, is the same, the economic mechanisms are quite distinct. Their approach rests on incorporating stationary aggregate financial leverage policies. My focus is on aggregate market clearing conditions that must hold in equilibrium, and their approach continues to ignore these adding-up constraints.[5] The two approaches are not mutually exclusive, and would potentially reinforce each other if considered simultaneously.

I am not the first to study the tension between labor and capital payments in endowment economies. Santos and Veronesi (2006) propose a model for why the share of labor income in consumption should forecast stock returns and provide empirical evidence for their mechanism. Marfè (2017) develops a model highlighting the importance of labor frictions for asset prices that also rests somewhere between general equilibrium production economies and the simpler endowment economies. He proposes a continuous time model with limited market participation in which wage contracts between workers and shareholders contain some degree of income insurance. The result is exactly channel that I am exploring in this paper: labor market frictions act as operating leverage, increasing equity risk. He provides an extensive array of

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[5] Further differences include that I introduce cointegration between all macroeconomic quantities, where they do not introduce cointegration between consumption and dividends, and that they employ loglinear approximate model solutions whereas I find it to be important to consider the fully nonlinear model.

empirical evidence supporting the mechanism. While his paper and mine focus on the same economic mechanism, my aim is to propose a simple method for modeling cash flows that can be used to incorporate this mechanism into a large class of models, rather than developing a specific new asset pricing model as he does.

My paper contributes to the growing literature at the intersection of labor and finance. There are a plethora of empirical asset pricing papers showing the cross-sectional pricing implications of labor frictions among publicly-traded firms (Chen et al., 2011; Belo et al., 2014; Favilukis & Lin, 2016a; Kuehn et al., 2017; Donangelo, 2018; Donangelo et al., 2019). I take this as additional evidence that these frictions matter for investors and are important to consider at the aggregate level.

A separate strand of the labor and finance literature focuses on heterogeneity and incomplete markets, such as Constantinides and Duffie (1996) and Schmidt (2016). These papers propose *idiosyncratic* labor market risk as key drivers of asset prices, while I focus on the impacts of aggregate labor market frictions, in particular the quantity dynamics. A relatively smooth labor income series in aggregate and highly variable labor income at the individual or household level, as documented by Guvenen et al. (2014), Guvenen et al. (2019), and Pruitt and Turner (2020), are not inconsistent observations. In fact, incomplete markets models often take aggregate labor income as given and specify individual risk as redistribution shocks, which indicates that my cash flow model could also be used in these contexts. I leave this connection for future work.

Finally, my paper is related to the literature on human capital and the importance of non-financial wealth in the pricing of financial assets. In many theories, the return on aggregate wealth plays a central role in pricing assets. Despite this, leading consumption-based asset pricing theories remain conspicuously silent on the role that non-financial wealth, which is estimated to be as much as 90% of aggregate wealth (Lustig et al., 2013), plays in determining asset prices. By directly modeling the share of consumption financed by labor income, human capital becomes a component of the model, which allows me to examine the relationship between non-financial and financial wealth in models where this was otherwise not possible.

2 Cash Flows in Equilibrium Asset Pricing Models

The economy follows the setup of Campbell (1996) and Lettau and Ludvigson (2001), and which is implicit in consumption-based asset pricing models like Campbell and Cochrane (1999) and Bansal and Yaron (2004).

Time is discrete. There is a representative agent whose consumption bundle in each period, C_t, is composed of period labor income, L_t, and dividends from financial asset holdings, D_t.[6] Labor income should be thought of as representing all payments made for provision of human capital, H_t.[7] All wealth, including human capital, is tradable, so that aggregate wealth, W_t, is human capital plus financial asset holdings, A_t. The share of aggregate wealth composed of financial assets is A_t/W_t. The gross return on aggregate wealth is defined

$$R^w_{t+1} = \frac{A_t}{W_t} R^a_{t+1} + (1 - \frac{A_t}{W_t}) R^h_{t+1} \tag{1}$$

where R^a_{t+1} and R^h_{t+1} are the gross returns on financial assets and human capital, respectively.

The representative agent is endowed with preferences over his consumption stream,

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[6] Aggregate savings (net borrowing or lending) is assumed to be zero.

[7] As Lettau and Ludvigson (2001) note, there are multiple ways to model the connection between labor income and returns to human capital. Campbell (1996) and Jagannathan and Wang (1996) model labor income as the dividend paid by human wealth, while Lettau and Ludvigson (2001) model labor income as the dividend and the capital gains from human wealth. I do not believe this distinction is important for my purposes.

$U(c)$. Consumption growth, Δc_{t+1}, is specified exogenously, assumed to be the outcome of optimizing behavior on the behalf of the representative agent.[8] With these two components, the equilibrium stochastic discount factor (M_{t+1}), consumption-wealth ratio ($\frac{C_t}{W_t}$), and the return on aggregate wealth (R^W_{t+1}) become computable objects. These are the model primitives upon which asset pricing models should be assessed, as they determine the pricing of all assets in the economy.

The equity premium puzzle concerns the high average returns on equities relative to risk free bonds (Mehra & Prescott, 1985). The stock market does not pay out aggregate consumption, so assessing the asset pricing model's implications for the equity premium requires a different stream of cash flows representing the payoff of a claim to aggregate equity – dividends.

2.1 A New Cash Flow Model

Market clearing requires that $C_t = L_t + D_t$. With a model for Δc_{t+1} already in hand, the only models that can exist for labor income or dividends which continue to satisfy the constraint and produce economically meaningful representations of both series are ones which model the share of those variables in consumption. Clearly, because the shares must always sum to one, only one of the shares can be modeled explicitly. I propose to explicitly model the consumption share of labor income and leave the dividend share as the residual piece.

Let $S_t = \frac{L_t}{C_t}$ represent the share of consumption financed by labor income. By the aggregate resource constraint, $1 - S_t$ is the share of consumption financed by dividends. Log

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[8] Lowercase letters will denote variables under the natural log transformation, eg. $c_t = \ln C_t$. Log growth rates are denoted with Δ, eg. $\Delta c_{t+1} = c_{t+1} - c_t$.

labor income and dividend growth rates, $\Delta\ell_{t+1}$ and Δd_{t+1} respectively, are given by

$$\Delta\ell_{t+1} = \ln\frac{C_{t+1}S_{t+1}}{C_tS_t} = \Delta c_{t+1} + \Delta s_{t+1}, \tag{2}$$

$$\Delta d_{t+1} = \ln\frac{C_{t+1}(1-S_{t+1})}{C_t(1-S_t)} = \Delta c_{t+1} + \Delta dc_{t+1} \tag{3}$$

where Δs_{t+1} is the change in log labor share and Δdc_{t+1} is the change in log dividend share.[9] Equations (2) and (3) are simply accounting identities which are constructed to respect the market clearing condition.

I believe my approach is an acceptable one. First, labor income is the largest component of consumption. To the extent that we care about properly matching moments of macroeconomic quantities, labor income would appear to be a first order concern based on magnitude alone. Second, obtaining dividends from market clearing is consistent with theory in which dividends are the residual cash flow after all other financial commitments, such as labor payments, have been met. Third, I will show that proceeding in this manner generates heteroskedasticity and predictability in dividend growth rates whenever the share of labor income varies over time in a persistent fashion, properties that Ang and Liu (2007) list as critical for any serious model of dividend growth to display. Finally, the empirical properties of consumption growth and labor income growth are quite similar, suggesting that Δs_{t+1} is well-behaved or that the labor income share of consumption is stable. This stability suggests that a simple, parsimonious model for the labor share may provide a good fit to the data. My results suggest that is indeed the case. In contrast, the empirical behavior of consumption and dividend growth rates differs dramatically, hinting at a rather complex model for Δdc_{t+1} to account for the difference.

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[9] $\Delta dc_{t+1} = \ln(1-S_{t+1}) - \ln(1-S_t)$.

The types of labor market imperfections discussed in the Introduction centered around labor income having a sluggish response to economic shocks. If aggregate labor income does not fully and immediately adjust in response to economic shocks, or if it does so less than consumption growth, then the ratio of labor income to consumption will be time-varying, persistent, and countercyclical. Any model of the labor share of consumption should exhibit these behaviors to also be consistent with labor market frictions.

I assume that the log of the labor income share of consumption follows an autoregressive process of the form

$$s_{t+1} = \bar{s}(1 - \beta_s) + \beta_s s_t + \mathcal{U}^s_{t+1} \tag{4}$$

where $\mathcal{U}^s_{t+1}$ is the innovation to the share.[10] The parameter $\bar{s}$ represents the unconditional mean of the log labor share, while the parameter β_s controls the speed of mean reversion in the share. To link this cash flow model back to the model for the pricing kernel I place some additional structure on the innovation, specifying

$$\mathcal{U}^s_{t+1} = \beta_c \mathcal{U}^c_{t+1} + \sigma_\eta \eta_{t+1} \tag{5}$$

where $\mathcal{U}^c_{t+1} = \Delta c_{t+1} - \mathbb{E}_t[\Delta c_{t+1}]$ is unexpected consumption growth and η_{t+1} is an independent standard Normal innovation. The parameter β_c controls the direction and magnitude of the cyclicality of the share. When β_c is negative, the share becomes countercyclical – it rises when consumption growth unexpectedly falls.

Because the labor share is modeled as a stationary series, labor income and dividends are cointegrated with consumption. Thus, all three series grow at the same rate on average, never drifting apart. In the long run, all three series are equally risky, but dividends become

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[10] I have also explored using this model for the level of the labor share, which does not alter my results.

more exposed to transitory risks when the labor share of consumption is countercyclical.

As a concrete example, consider the case when consumption growth is IID Lognormal as in the Campbell and Cochrane (1999) model: $\Delta c_{t+1} = \mu + \sigma\varepsilon^c_{t+1}$. In that case, Equation (4) is isomorphic to

$$s_{t+1} = \bar{s}(1-\beta_s) + \beta_s s_t + \tilde{\sigma}_\eta \tilde{\eta}_{t+1}, \tag{6}$$

where $\tilde{\eta}_{t+1} \sim N(0,1)$, $\tilde{\sigma}_\eta = \sqrt{\beta_c^2\sigma^2 + \sigma_\eta^2}$, and $\text{Corr}(\varepsilon^c_{t+1}, \tilde{\eta}_{t+1}) = \beta_c\sigma/\tilde{\sigma}_\eta$. This is simply a standard AR(1) process with Gaussian innovations correlated with consumption growth innovations whenever β_c is nonzero. Despite the simplicity of the model, I show in Section 3 that it is quite capable of generating the observed properties of the shares and growth rates of labor income and, by implication, dividends.

Even though the process for the (log) labor income share of consumption is relatively simple, the process for its residual complement, the dividend share, is not.[11] Luckily, we can qualitatively describe a number of its properties without too much effort. The first is that dc_{t+1} must be mean reverting whenever s_{t+1} is. The flip side to the labor share being above its long run mean and expected to decline is the dividend share being below its long run mean and expected to grow. This embeds some predictability into Δdc_{t+1} and, by extension, Δd_{t+1}. This is the insight delivered by Santos and Veronesi (2006).

Second, a leverage effect takes place. The resource constraint implies that changes in these two shares must net to zero (in levels). Due to the relative size of these components, a given change in the labor share translates to a much larger change in the dividend share. Therefore, the volatility of Δdc_{t+1} is much higher than that of Δs_{t+1}. One way to see this is to examine a first order approximation to the definition of the log change in the dividend

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[11] I derive relevant properties of the labor share and log changes in the labor share in Appendix A.

share,

$$\Delta dc_{t+1} \approx -\frac{\mathrm{e}^{s_t}}{1-\mathrm{e}^{s_t}} \Delta s_{t+1}. \tag{7}$$

The term $-\frac{\mathrm{e}^{s_t}}{1-\mathrm{e}^{s_t}}$ represents the elasticity of changes in the dividend share to changes in the labor share. It is negative, large in magnitude, and time-varying because it depends on the current level of the labor share, ranging from about -4 when the labor income share of consumption is near its lowest observed value in the data to beyond -30 when the labor income share is near its highest observed value.[12] Marfè (2017) calls this the cyclicality effect of income insurance. The time variation in this elasticity imparts heteroskedasticity into dividend growth rates.

This leverage effect is asymmetric. Figure 1 shows the true nonlinear elasticity between share changes, ie. not the one from the first order approximation in Eq. 7. Not only is the elasticity, which is always negative, increasing in magnitude with the current level of the labor share (s_t), but it is also increasing in the realized change in the labor share (Δs_{t+1}). The implication is that positive changes to the log labor share lead to additional amplification and negative changes to the log labor share lead to reduced amplification. Because the labor share is countercyclical, positive changes are associated with consumption declines on average. As a result, the volatility of dividend growth and its correlation with consumption growth should both be larger in these states of the world, something I verify empirically.

A bonus feature of this approach is that it also implies dynamics for labor income growth, given in Eq. (2). The dynamics of labor income growth are completely specified by the combination of the models for consumption growth and the share of labor income in consumption. The resulting stochastic process for labor income growth is generally tractable and I provide its properties in Appendix A. While labor income growth also inherits some

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[12] If a loglinear approximation was used instead, this elasticity would be constant, with s_t replaced by $\bar{s}$.

predictability from movements in the labor share, the leverage effect that is so important for dividend growth is absent for labor income growth. Importantly, as is clear from the formulas in Appendix A, moments of labor income growth are crucially informative about the parameters governing the labor share process. This provides confidence that the cash flow model can be adequately assessed based on observable moments alone, it does not require the addition of unobservable state variables.

2.2 Contrast to Existing Approaches

Before performing a quantitative assessment of my cash flow model, it is useful to contrast it with existing approaches. There are two other approaches that are standard. The first, and most common, is to directly model dividend growth, Δd_{t+1}. The second is to explicitly model the dividend share of consumption, dc_{t+1}, which is the piece that I obtain as a residual from market clearing. Modeling cash flows following either of these existing approaches is an arbitrary decision, of course. The set of alternatives is infinite, and theory provides little guidance. However, these approaches are popular for a reason. Primarily, they are parsimonious, often preserve tractability, and they allow models to match many stylized facts along both macroeconomic and asset pricing dimensions. In many leading asset pricing models, asset prices can be computed almost analytically using the exponential-affine pricing results from Duffie et al. (2000), which might not be possible had cash flows been modeled in a different fashion.

Abel (1990) was among the first to specify a dividend producing asset, separate from that of the consumption producing asset, in an endowment economy. Dividends are modeled as a levered version of the consumption claim, $D_t = C_t^{\lambda}$, implying that $\Delta d_{t+1} = \lambda \Delta c_{t+1}$. Abel (1990) motivates this approach by appealing to financial leverage. Wachter (2013) is a recent example of a successful consumption-based asset pricing model that follows this approach, using a value of $\lambda = 2.6$.

Cecchetti et al. (1993) point out that modeling dividends in the style of Abel (1990) implies a few counterfactual statistical properties. First, it implies consumption and dividend growth rates are perfectly correlated, whereas they are not perfectly correlated in the data. Second, it implies that both the mean and the volatility of dividend growth rates become levered versions of their consumption counterparts, whereas the historical mean of both series is roughly the same. They relax the Abel (1990) relationship by specifying consumption and dividend growth rates to follow the same style of stochastic process, regime switching in their case, but allow the parameters to freely differ in each process in order to best match the data. A short survey of the literature suggests that this is the most common approach used by recent consumption-based asset pricing papers, such as Campbell and Cochrane (1999) and Bansal and Yaron (2004) and extensions.

The approach of directly modeling dividend growth also has its drawbacks. The first is that it almost surely implies that consumption and dividends are not cointegrated.[13] When consumption and dividends are not cointegrated, the two series can drift apart. Thus, the share of consumption financed by dividends can become arbitrarily large or small. This implies that the stock market will either consume the aggregate economy or cease to exist, which of course has undesirable mirror image effects on the stock of human capital. To quote Lettau and Ludvigson (2014):

> Despite these statistical concerns, there are good economic reasons to believe that there is a common long-run relationship between c_t, a_t, and y_t: cointegration is implied by an aggregate budget constraint identity (Campbell and Mankiw

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[13] In Appendix B I provide some formality to this claim.

> 1989; Lettau and Ludvigson 2001). Just as no reasonable economic model would imply that the log price-dividend ratio is nonstationary (where stationarity follows from a Taylor approximation to the equation defining the log stock return), no reasonable model would imply that c, a, and y are not cointegrated, or equivalently that the system is characterized by three independent random walks.

The failure of this approach to deliver cointegration among macro aggregates is not a new fact, but is one that deserves to be restated.[14]

A number of papers model the ratio of dividends to consumption rather than directly modeling dividend growth.[15] When this ratio is stationary, consumption and dividends become cointegrated. One advantage of this approach is that by judiciously choosing the stochastic process for the dividend share, analytical tractability can still be preserved.

A second shortcoming, which applies to both approaches, is that the observed behavior of consumption and dividend growth rates differs markedly. This suggests that modeling the two series with the same stochastic process, or by specifying a parsimonious model for the dividend share, is unlikely sufficient to simultaneously match the stylized facts about the series' univariate and joint behaviors. Indeed, many existing models encounter this tension, but place greater priority on matching the consumption growth moments when the constraint becomes binding.

These shortcomings matter as more than just an exercise in matching endowment moments, they have potentially important asset pricing implications. Prior literature has indeed shown that asset pricing conclusions appear sensitive to how cash flows are modeled. Van Binsbergen et al. (2012) document that the term structure of equity risk premia is downward sloping in

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[14] Campbell and Cochrane (1999) discuss lack of cointegration in their model, but suggest it is unimportant to their results.

[15] Examples include Longstaff and Piazzesi (2004), Bekaert et al. (2009), and Marfè (2016).

the data, but upward sloping in leading asset pricing models, and Belo et al. (2015) show that correcting the term structure of cash flow volatility corrects the term structure of risk premia in the habit and long run risk models. Hansen et al. (2008) show that their results change dramatically depending on whether cash flows are assumed to be cointegrated with consumption. Bekaert et al. (2010) find that when they explore alternative models that dispense with stationarity in the consumption-dividend ratio the models no longer converge to a meaningful solution.

The common theme in these approaches is to ignore the aggregate resource constraint, $C_t = L_t + D_t$, and leave labor income in the background of the model. My paper uses that market clearing condition as its point of departure. Furthermore, I'm going to ask my model for cash flows, combined with a model for consumption growth, to simultaneously match a broad array of stylized facts about consumption growth, dividend growth, and labor income growth.

3 Results

I first document several empirical properties of cash flow growth rates their joint behavior with consumption growth. Next, I show that many leading consumption-based asset pricing models have difficulty matching these facts simultaneously, which stems directly from the discussion in Section 2.2. I implement the approach outlined in Section 2.1 to show that the approach is widely applicable and generally leads to an improvement along several dimensions. Finally, I examine the asset pricing implications of my proposed cash flow process in the context of external habit model of Campbell and Cochrane (1999) and the long run risks model of Bansal and Yaron (2004).

3.1 Data

As any mapping from model variable to empirical counterpart is imperfect and never without assumptions, I do not impose that the resource constraint holds in the data. Additionally, the distinction between payments to capital and labor can at times unclear, such as for those who are self-employed. To combat these issues, I examine a number of different empirical proxies for aggregate labor income and dividends. I consider the standard consumption growth series, defined as real nondurables and services consumption, with growth rates computed as in Beeler and Campbell (2012).

My source for labor income data is the Bureau of Economic Analysis. For my preferred measure, I consider a construction corresponding to after-tax labor income (ATLI) set forth by Lettau and Ludvigson (2001) and also used by Santos and Veronesi (2006). This definition is intended to precisely capture all payments for labor that households receive in aggregate on an after-tax basis. One potential drawback of this measure is that it includes government transfer payments, which are countercyclical and can be sizable, and contaminate any effects of private sector labor frictions. Therefore, I also examine the ATLI measure without government transfers. Finally, I also consider the compensation of employees (COE) variable, which includes only wages, salaries, and supplemental payments.

The resource constraint is an economy wide constraint, not one that exists only for publicly traded firms. Because of this, my preferred series is aggregate equity payout computed from the Flow of Funds as net dividends paid plus net share repurchases by the nonfinancial corporate sector, the same series used by Larrain and Yogo (2008) and Belo et al. (2015).[16]

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[16] I make 3 modifications to the Flow of Funds data to undo some accounting oddities that arise due to tax and securities law changes that surround the 1982 SEC Rule 10b-18, 2004 Homeland Reinvestment Act, and 2017 Tax Cuts and Jobs Act. The modification, while sensible, is not strictly necessary, and all results continue to hold without it. The appendix contains additional detail.

This is in contrast to the existing literature which primarily focuses on the dividends eminating from public firms, typically those covered by the CRSP database, which differs in three ways. First, public firms are a subset of the entire nonfinancial corporate sector. Second, these measures are computed on a per-share basis, whereas my preferred series is an aggregate dollar amount. Third, these measures are gross payout measures and do include issuances. To examine the importance of these differences, I compute two CRSP payout series following the methodology in Bansal et al. (2005), the first having both cash dividends and share repurchases with the second covering only cash dividends. Some authors, such as Longstaff and Piazzesi (2004), suggest that corporate earnings might be a less noisy proxy for economic dividends if actual dividends are subject to agency problems. Therefore, I also include a series representing aggregate after-tax corporate profits. Finally, I include net operating surplus as it is an earnings measure used by Belo et al. (2015) to represent aggregate EBITDA.

All series are quarterly and for the postwar sample (1947-2019), with the exception of the Flow of Funds net payout series beginning in 1952. Unless otherwise specified, the data is time-aggregated from quarterly to annual frequency in an overlapping fashion in the manner described by Beeler and Campbell (2012). Appendix C contains more complete detail on the sample.

3.2 Properties of Macroeconomic Fundamentals in the Data

Table 1 contains univariate summary statistics for each series. The moments of the different labor income measures are quite similar to each other. The labor income proxies exhibit the familiar properties of postwar consumption – low volatility, some degree of positive persistence, and near-zero higher moments. Furthermore, they are each highly correlated with consumption growth.

Figure 2 shows the variance ratios for labor income growth and for growth in the labor income share of consumption. The term structure of volatility of labor income growth is at least mildly upward sloping no matter which variable definition we examine and whether we are considering annual or quarterly frequencies. On the other hand, the term structure of volatility of labor income share growth is generally flat or downward sloping. This is consistent with the labor income share being a strongly persistent autoregressive process with positive autocorrelation, as in Equation (4).

When short-run macroeconomic risk is pushed away from labor income, near-term labor income growth should be less correlated with consumption growth than over longer horizons, ie. the term structure of correlations is upward sloping. Figure 3 shows that this is indeed the case. I view these bivariate term structures as an additional lens with which we can inspect the plausibility of the mechanism.

In contrast, there is considerable variation in all of the moments across the proxies for aggregate dividends. Volatilities range from under 6% per year to over 26%. Skewness ranges from heavily negative to moderately positive. Autocorrelation coeficients range from essentially 0 to moderately positive. Thus, it might seem hopeless to think that we can make general conclusions about the properties of dividend growth in the face of these dissimilarities. However, this is not the case. Figure 4 shows that the variance ratios for dividend growth and dividend share growth almost always display a decreasing pattern with horizon, sometimes following a small positive bump at the beginning. Notably, even though the univariate statistics of each series differed considerably, each series displays a similar pattern for the timing of risk. This pattern stands in sharp contrast to the upward sloping term structures of volatility for labor income growth. The similarity between the left and right panels of Figure 4 is consistent with most of the variation in dividend growth between driven by changes in the dividend share. The downward sloping nature of these curves is indicative of short horizon risk being much more pronounced than long horizon risk, and is consistent with dividends absorbing the portion of short run macroeconomic risk that is not absorbed by labor income.

Figure 5 shows the term structure of correlations for dividend growth and consumption growth. It ranges from flat to steeply downward sloping. Qualitatively, this continues to be consistent with the proposed cash flow model. Because dividends absorb more than their fair share of transitory macroeconomic shocks, the correlation of short run growth rates becomes inflated. As we move to longer horizons, the fraction of variation of dividend growth due to these shocks becomes less relative to the mean reversion in the dividend share itself, which is unrelated to consumption growth.

An additional economic moment to examine the channel concerns the joint tail behavior of these consumption, dividend, and labor income series. As discussed in the development of the cash flow model, the leverage effect is asymmetric – it makes bad times even worse for dividend growth. Schreindorfer (2020) documents a similar empirical pattern directly between consumption and dividend growth rates. He finds that when consumption growth is low the correlation between consumption and dividend growth rates is higher. I first replicate his exercise using my sample. Next, I conduct the same exercise using labor income growth. The I find that its correlation with consumption growth is symmetric between good and bad times, as expected.

As more direct empirical evidence for the mechanism, I tweak the previous exercise to condition on periods when the labor share increased or decreased, rather than consumption growth being above or below its median value. The results are shown in Table 2. The correlation between consumption and dividend growth in periods when Δs_{t+1} is positive is higher than when Δs_{t+1} is negative. Again, as expected, the correlation between consumption and labor income growth in these periods is symmetric. Additionally, the volatility of dividend growth in the bad periods is 1.5 times higher than in good periods, whereas the volatility of labor income growth is basically the same in good or bad times.

Finally, the market clearing condition implies that the changes in the two shares must net to zero. Equivalently, they must be negatively related. At the annual frequency, the correlation between changes in the two shares, defined using my preferred labor income and dividend series, is -0.32.

Taken as a whole, these results suggest that labor market frictions indeed play a large role in shaping the observed properties of dividend growth. Next, I will embed my cash flow model into the habit and long run risk models and examine the modified models alongside their original specifications while repeating the analysis here.

3.3 Properties of Macroeconomic Fundamentals in Models

The habit model of Campbell and Cochrane (1999) and the long run risks model of Bansal and Yaron (2004) deliver important insights about the driving forces behind risk premia. They do so with very different mechanisms and with very different assumptions about the behavior of consumption growth. In the habit model, consumption growth is IID Lognormal. In the long run risks model, consumption growth exhibits extremely persistent swings in its conditional mean and variance. Both models counterfactually assume that dividend growth behaves quite similarly to consumption growth.

To generate model simulated data, I simulate 100,000 small samples of 864 months from the model. The parameters for the labor share are chosen to match the moments of labor income growth.[17] Otherwise, the parameter values are those from the original model

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[17] For now, these parameters are hand calibrated. The values are $\bar{s} = \ln(0.9)$, $\beta_s = 0.965$, $\beta_c = -0.3$, and

specifications. I compute the statistic of interest in each small sample and take the average across samples.

Figure 6 compares the variance ratios for dividend growth in the modified and unmodified models to the data, as well as displaying the variance ratios for labor income growth. As is clear, the cash flow model produces upward sloping variance ratios for labor income growth in both settings, which is consistent with the data. In the original model specifications, the term structure of volatility of dividend growth was mildly or strongly upward sloping. This is not consistent with any of the definitions of dividends that I've explored in this paper during the postwar sample. When my cash flow process is embedded into the existing models, the resulting variance ratios exhibit an impressive fit to the data. This is despite not being estimated to minimize this distance. Notably, the patterns match well even though both models have very different assumptions about the nature of consumption risk. This is suggestive evidence that the combination of the equilibrium market clearing condition and the existence of labor market frictions is a dominant force in determining the dynamics of dividends.

Turning to the bivariate measures, Figure 7 shows the term structure of correlations between consumption and dividend growth (or labor income growth) in the model specifications and the data. Both models do well to match the high level and small positive slop of the correlation term structure between labor income and consumption growth. In the original habit model, consumption and dividend growth have the same correlation measured across any horizon. In the modified habit model, the correlation term structure becomes slightly downward sloping, which is due to the increased comovement brought on by additional exposure to transitory consumption shocks. In the original long run risk model, the correlation

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$\sigma_\eta = 0.0037$.

term structure is upward sloping. This occurs because as we examine longer and longer horizon growth rates, the share of variation due to the common component (the conditional mean and volatility processes) continues to grow. The modified long run risks model displays first a downward sloping pattern of correlation, consistent with the story, but quickly turns upward due to the strong amount of comovement induced by the long run risk components. Recall that Figure 5 displayed a range of outcomes from flat to steeply downward sloping for the correlation between consumption and dividend growth rates, suggesting that the behavior of the modified models is broadly consistent along this dimension as well.

Finally, Table 2 shows the conditional correlations in the models. The cash flow model does generate some degree of asymmetry in the relationship between consumption and dividend growth, as seen in the data, even though all innovations in both of these asset pricing models are symmetrically distributed Gaussian shocks.

It is clear that modeling cash flows such that the market clearing condition holds and capturing the essence of labor market frictions in these endowment economies is crucial to getting the dynamics of cash flows correct. In the next section I will examine the implications of changing cash flow specifications for asset prices.

3.4 Asset Prices

Having explored the implications for fundamentals, I now ask in what way my approach alters the asset pricing predictions in these models. I solve the habit and long run risks models numerically on a discretized state space for the state variables.[18] The model simulation procedure follows that of the previous section.

Note that because the preferences and consumption growth process from the original

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[18] I am still in the process of completing the solution for the long run risks model.

model specifications remains unchanged, the pricing kernel does as well. Therefore, the behavior of interest rates in the models is the same in the existing and modified specifications.

For the habit model, the headline asset pricing numbers of the mean and volatility of annual stock returns are not too different from their original values, 6.5% and 12% respectively. This is encouraging because the cash flow model was developed, not with returns in mind, but to correct the properties of cash flows in these models. Therefore, the fact that bringing the models more in line with the data when it comes to the behavior of major macroeconomic quantities does not destroy the asset pricing implications of the models is reassuring.

A more stringent test is to examine the term structure of risk premia in the modified models. As documented by Van Binsbergen et al. (2012), this is steeply upward sloping in the original models and downward sloping in the data. Figure 8 showcases the term structure of dividend strip expected returns in the habit model combined with my proposed model for cash flows – it is slightly downward sloping. Figure 9 shows the term structure of dividend strip return volatility, which is also downward sloping. This suggests that the effects of labor market frictions are first order for studying risk premia as well, echoing Marfè (2017).

4 Conclusion

Equilibrium models contain market clearing conditions that must hold in equilibrium. I propose a model for cash flows that respects the equilibrium market clearing condition that states aggregate consumption is the sum of capital and labor income. The cash flow model can be embedded into existing discrete time endowment economies to capture the effects that labor market frictions have on labor income and dividends. The approach is tractable, delivers cointegration between macroeconomic quantities, and allows models to simultaneously match the stylized facts about the univariate and joint behavior of consumption, dividend, and labor income growth rates.

Instead of modeling dividends directly, I model the log labor income-consumption ratio with a simple autoregressive process. I use this model and the market clearing condition to back out, or imply, dividend growth rates period-by-period. These implied dividend growth rates exhibit predictability and heteroskedasticity, as in the data.

When embedded into the habit and long run risks models, the cash flow model generates downward sloping term structures of dividend volatility and upward sloping term structures of labor income volatility, as in the data. Beyond the properties of cash flows, the method also has positive implications for asset prices, bringing the term structure of dividend strip expected returns and volatility closer to the data, and continuing to deliver a high and volatile equity risk premium.

A Labor Share and Labor Income Growth Properties

Begin with the following decomposition of log consumption growth,

$$\Delta c_{t+1} = \mu_c + \mathbb{E}_t[\Delta c_{t+1} - \mu_c] + \mathcal{U}^c_{t+1} \tag{8}$$

where unexpected consumption growth $\mathcal{U}^c_{t+1}$ has zero expectation and is unpredictable using past information. Then $\mathrm{Var}_t(\Delta c_{t+1}) = \mathrm{Var}_t(\mathcal{U}^c_{t+1})$, $\mathrm{Var}(\Delta c_{t+1}) = \mathrm{Var}(\mathbb{E}_t[\Delta c_{t+1} - \mu_c]) + \mathrm{Var}(\mathcal{U}^c_{t+1})$.

The log labor share is given by

$$s_{t+1} = \bar{s}(1 - \beta_s) + \beta_s s_t + \beta_c \mathcal{U}^c_{t+1} + \sigma_\eta \eta_{t+1} \tag{9}$$

where η_{t+1} is an independent standard Normal innovation. The conditional mean and variance of the labor share are $\mathbb{E}_t[s_{t+1}] = \bar{s}(1 - \beta_s) + \beta_s s_t$ and $\mathrm{Var}_t(s_{t+1}) = \sigma^2_\eta + \beta^2_c \mathrm{Var}_t(\mathcal{U}^c_{t+1})$, while the unconditional variance is $\mathrm{Var}(s_{t+1}) = \left(\sigma^2_\eta + \beta^2_c \mathrm{Var}(\mathcal{U}^c_{t+1})\right)/(1 - \beta^2_s)$.

The conditional covariance between the log labor share and consumption growth is $\mathrm{Cov}_t(s_{t+1}, \Delta c_{t+1}) = \beta_c \mathrm{Var}_t(\mathcal{U}^c_{t+1})$. To compute the unconditional covariance, it is first necessary to compute $\mathrm{Cov}(s_t, \mathbb{E}_t[\Delta c_{t+1} - \mu_c])$. By recursive substitution, we find

$$\mathrm{Cov}(s_t, \mathbb{E}_t[\Delta c_{t+1} - \mu_c]) = \beta_c \sum_{k=0}^{\infty} \beta^k_s \mathrm{Cov}(\mathcal{U}^c_{t-k}, \mathbb{E}_t[\Delta c_{t+1} - \mu_c]), \tag{10}$$

which is capturing the relationship between past realized consumption growth innovations and current expected consumption growth. This would represent a correlation between the innovations to Δc_{t+1} and x_{t+1} in the long run risks model, for example. The unconditional covariance of the log labor share and consumption growth is then

$$\mathrm{Cov}(s_{t+1}, \Delta c_{t+1}) = \beta_c \mathrm{Var}(\mathcal{U}^c_{t+1}) + \beta_c \sum_{k=0}^{\infty} \beta_s^{k+1} \mathrm{Cov}(\mathcal{U}^c_{t-k}, \mathbb{E}_t[\Delta c_{t+1} - \mu_c]). \tag{11}$$

The conditional covariance is negative when β_c is negative, while the unconditional covariance is negative as long as $\sum_{k=0}^{\infty} \beta_s^{k+1} \mathrm{Cov}(\mathcal{U}^c_{t-k}, \mathbb{E}_t[\Delta c_{t+1} - \mu_c]) > -\mathrm{Var}(\mathcal{U}^c_{t+1})$. Changes in the log labor share exhibit many of the same (or similar) properties because

$$\Delta s_{t+1} = (\beta_s - 1)s_t + \beta_c \mathcal{U}^c_{t+1} + \sigma_\eta \eta_{t+1}. \tag{12}$$

Labor income growth is, after substituting Eqs. (8) and (12) into (2) and some simplification, given by

$$\Delta \ell_{t+1} = \mu_c + \mathbb{E}_t[\Delta c_{t+1} - \mu_c] + (\beta_s - 1)s_t + (1 + \beta_c)\mathcal{U}^c_{t+1} + \sigma_\eta \eta_{t+1}. \tag{13}$$

It is quick to verify that the first two conditional moments are $\mathbb{E}_t[\Delta \ell_{t+1}] = \mu_c + \mathbb{E}_t[\Delta c_{t+1} - \mu_c] + (\beta_s - 1)s_t$ and $\mathrm{Var}_t(\Delta \ell_{t+1}) = \sigma_\eta^2 + (1 + \beta_c)^2 \mathrm{Var}_t(\mathcal{U}^c_{t+1})$. The conditional covariance with consumption growth is $\mathrm{Cov}_t(\Delta \ell_{t+1}, \Delta c_{t+1}) = (1 + \beta_c)\mathrm{Var}_t(\mathcal{U}^c_{t+1})$.

The unconditional expectation of labor income grown is the same as that of consumption growth. The unconditional variance is

$$\begin{aligned} \mathrm{Var}(\Delta \ell_{t+1}) = \mathrm{Var}(\mathbb{E}_t[\Delta c_{t+1} - \mu_c]) + (\beta_s - 1)^2 \mathrm{Var}(s_t) + \sigma_\eta^2 + (1 + \beta_c)^2 \mathrm{Var}(\mathcal{U}^c_{t+1}) \\ + 2(\beta_s - 1)\mathrm{Cov}(s_t, \mathbb{E}_t[\Delta c_{t+1} - \mu_c]) \end{aligned} \tag{14}$$

and the unconditional covariance with consumption growth is

$$\text{Cov}(\Delta\ell_{t+1}, \Delta c_{t+1}) = \text{Var}(\mathbb{E}_t[\Delta c_{t+1} - \mu_c]) + (1+\beta_c)\text{Var}(\mathcal{U}^c_{t+1}) + (\beta_s - 1)\text{Cov}(s_t, \mathbb{E}_t[\Delta c_{t+1} - \mu_c]). \tag{15}$$

In many cases, the formulas above simplify considerably. Many models do not include time-variation in expected consumption growth. For those that do, the term $\text{Cov}(s_t, \mathbb{E}_t[\Delta c_{t+1} - \mu_c])$ shown in Eq. (10) will be zero in most models, as they do not generally incorporate such correlation.

B Dividend Shares in Existing Models

The following proposition shows that a broad class of models in which dividend growth is explicitly characterized, covering much of the existing literature, log changes in the dividend share are simultaneously implicitly characterized in a similar manner.

Proposition 1. *Decompose both Δc_{t+1} and Δd_{t+1} into their unconditionally expected, time-varying conditionally expected, and unexpected parts: $\mu_x + E_t[\Delta x_{t+1} - \mu_x] + \mathcal{U}^x_{t+1}$. If*

1. $E_t[\Delta d_{t+1} - \mu_d] \propto E_t[\Delta c_{t+1} - \mu_c]$
2. *and $\mathcal{U}^d_{t+1}$ and $\mathcal{U}^c_{t+1}$ come from a class of stable distributions, such that their sum remains within the same class,*

then the process for log changes in the dividend share, $\Delta dc_{t+1} = \Delta d_{t+1} - \Delta c_{t+1}$, is a reparameterized version of the same stochastic process used for consumption or dividend growth.

Proof. See that $\Delta dc_{t+1} = \mu_d - \mu_c + \mathbb{E}_t[\Delta d_{t+1} - \mu_d] - \mathbb{E}_t[\Delta c_{t+1} - \mu_c] + \mathcal{U}^d_{t+1} - U^c_{t+1}$. Clearly, $\mu_{dc} = \mu_d - \mu_c$. If the first condition is met, then $E_t[\Delta dc_{t+1} - \mu_{dc}] = \lambda\mathbb{E}_t[\Delta c_{t+1} - \mu_c]$. If the second condition is met, then $\mathcal{U}_{t+1}^{d} - U_{t+1}^{c}$ can be reinterpreted as a new composite random variable whose distribution is a reparameterized instance of that of $\mathcal{U}_{t+1}^{d}$ or $\mathcal{U}_{t+1}^{c}$. $\square$

An example of a model in which the conditions do not hold can be found in Backus et al. (2018) where expected consumption and dividend growth follow ARMA(2,1) processes, parameterized such that the first condition fails.

C Data Construction

This appendix provides the necessary details to construct the data used in the analysis of this paper.

C.1 Consumption

The series used for aggregate consumption is the sum of real per-capita nondurables and services consumption from BEA NIPA Table 7.1. Consumption growth is computed as log changes in this series, as in Beeler and Campbell (2012).

C.2 Labor Income

Aggregate labor income is computed following Lettau and Ludvigson (2001), using BEA NIPA Table 2.1. The definition is

$$\begin{aligned}\text{After-tax labor income} =& \text{Wages and salaries} + \text{Transfer payments} + \\ &+ \text{Employer contributions for employee pensions and insurance} \\ &- \text{Employee contributions for social insurance} \\ &- \text{Taxes.}\end{aligned}$$

For robustness, I also consider the Compensation of Employees series from line 2 of BEA NIPA Table 2.1. The variables are converted to real per-capita series using the implicit PCE deflator and population series from the BEA. Labor income shares of consumption are computed by taking the ratio of the nominal labor income series to the nominal consumption series. Alternatively, changes in the labor share can be constructed by taking $\Delta s_{t+1} = \Delta \ell_{t+1} - \Delta c_{t+1}$.

C.3 Dividends

Aggregate equity payout is computed from the Flow of Funds as the difference between net dividends paid and changes in corporate equity. Both series are taken from Table F.103 for Nonfinancial Corporate Business (lines 3 and 43, respectively).

I make 3 modifications to the Flow of Funds data to undo some oddities that arise due to tax and securities law changes that surround the 1982 SEC Rule 10b-18, 2004 Homeland Reinvestment Act, and 2017 Tax Cuts and Jobs Act. The modification, while sensible, is not strictly necessary, and all results continue to hold without it. The latter two are simply due to a large amount of foreign profits being repatriated back to US companies. These repatriations are counted as special dividends being *paid* by the foreign subsidiary and *received* by the US parent company. In the Flow of Funds, this counts against the aggregate amount of dividends paid by the US corporate sector. However, this is just a transfer of cash within the corporation, not an economic dividend. I interpolate between the periods before and after the bulk of these payments take place. For the first modification, the SEC changed its guidance regarding stock market manipulation surrounding firms transacting in their own securities. Before this, firms did not engage in share buybacks for fear of being prosecuted. Following this guidance, there was a tremendous amount of repurchase activity. I backfill some of this activity to the periods leading up to the regulatory change, which is an assumption about the additional payout that would have occurred if firms were legally allowed to buyback shares. Without the modifications, there are frequently growth rates in excess of 100% or -100% due to these events.

For robustness I also consider a number of other series used in the literature. Payout from publicly traded firms is constructed following Bansal et al. (2005). I construct the series both with and without repurchases. Some papers have argued that corporate earnings might represent a better empirical proxy for dividends than the actual dividend series (Longstaff & Piazzesi, 2004). Therefore, I also consider After-tax nonfinancial corporate profits (also from Flow of Funds F.103) and Net Operating Surplus, which is the empirical proxy for aggregate EBIT used in Belo et al. (2015) and constructed from BEA NIPA Table 1.14.

The variables are converted to real per-capita series using the implicit PCE deflator and population series from the BEA.

C.4 Returns

My proxy for the return on the aggregate equity claim is return on the CRSP value-weighted index of all common stocks. Risk-free rates follow the method in Beeler and Campbell (2012). Real returns are created by adjusting the nominal returns by the growth in the seasonally adjusted CPI series.

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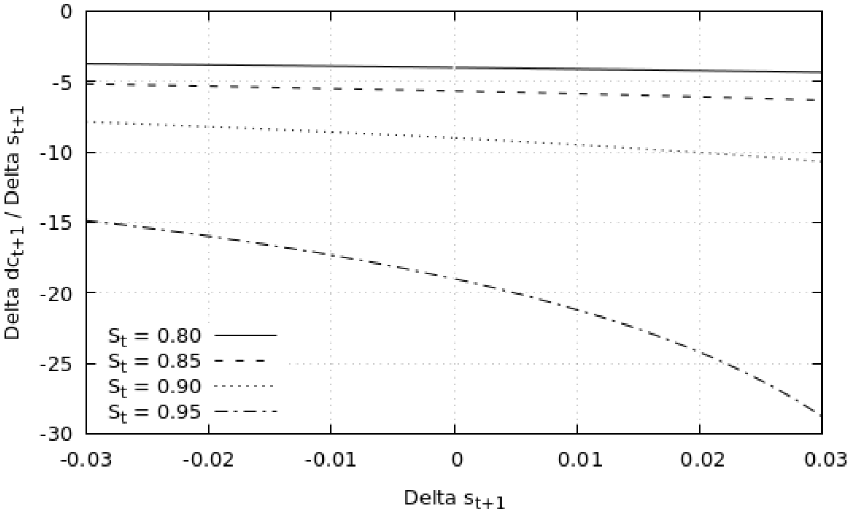

Figure 1: Leverage effect. The ratio of the log dividend share growth rate (Δdc_{t+1}) to the log labor share growth rate (Δs_{t+1}) conditional on a value for Δs_{t+1} (x-axis), given four different values for S_t.

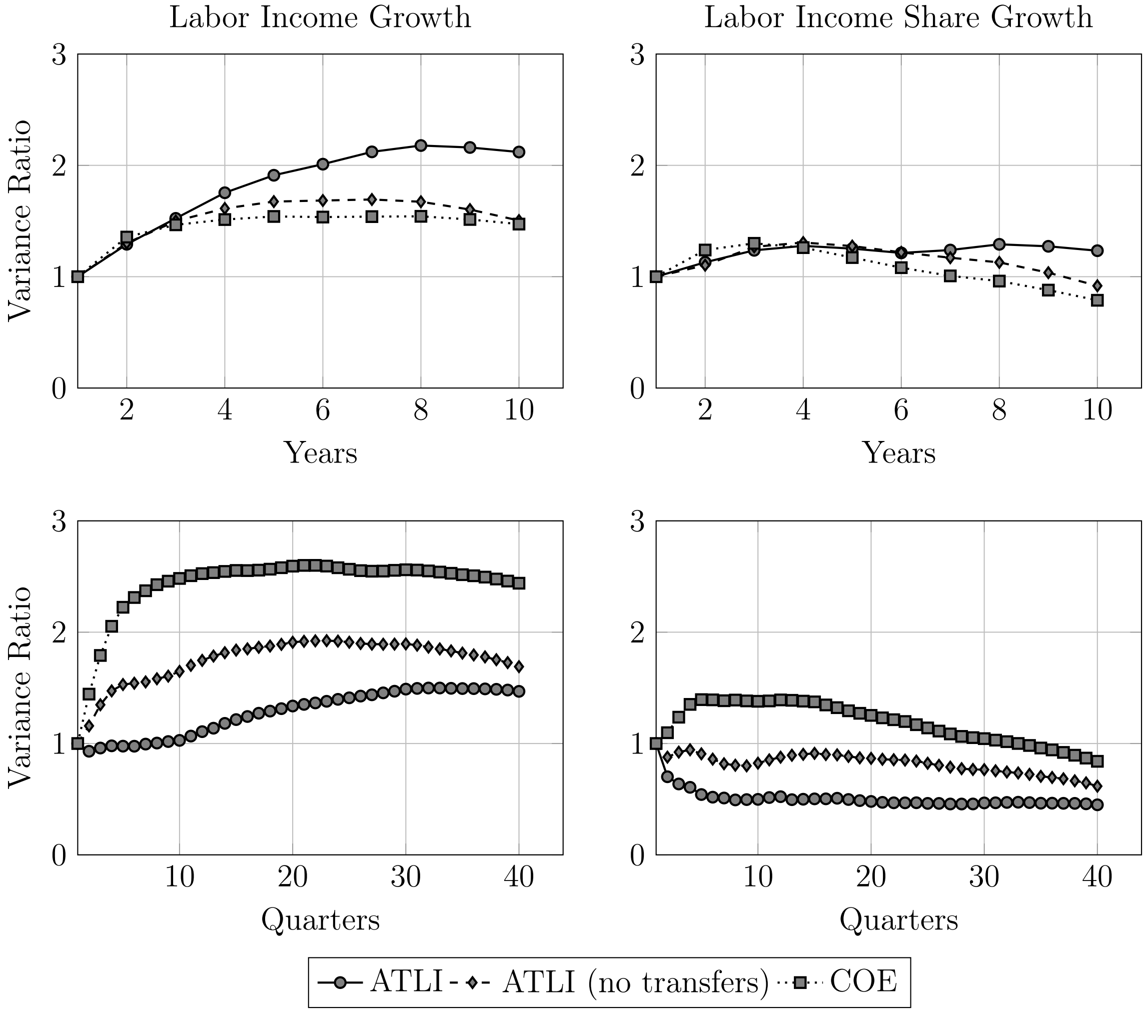

Figure 2: Variance ratios of labor income growth ($\Delta\ell$, left) and labor income share growth (Δs, right) for different empirical proxies for labor income and for annual or quarterly frequencies. ATLI is the labor income definition from Lettau and Ludvigson (2001), ATLI (no transfers) is the same but removing goverment transfer payments, and COE is Compensation of Employees. Labor income share growth is computed as $\Delta s = \Delta\ell - \Delta c$, where Δc is nondurables and services consumption growth. All data is from BEA NIPA and 1947-2019, and for the upper panels is time-aggregated to overlapping annual observations. See Appendix C for more details.

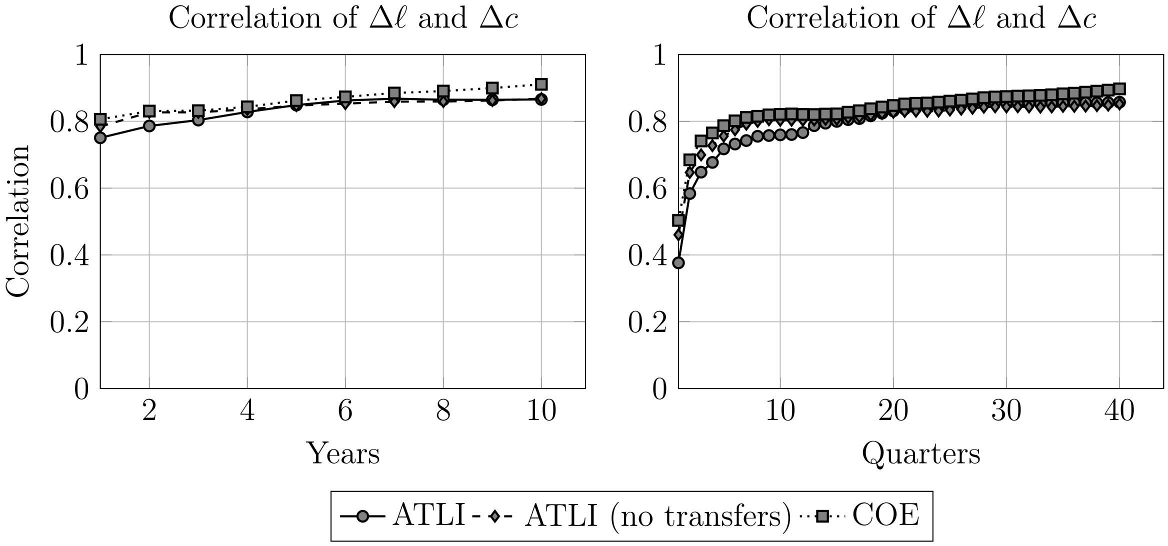

Figure 3: Term structure of correlations of labor income growth and consumption growth for different empirical proxies for labor income and for annual or quarterly frequencies. ATLI is the labor income definition from Lettau and Ludvigson (2001), ATLI (no transfers) is the same but removing goverment transfer payments, and COE is Compensation of Employees. Labor income share growth is computed as $\Delta s = \Delta\ell - \Delta c$, where Δc is nondurables and services consumption growth. All data is from BEA NIPA and 1947-2019, and for the upper panels is time-aggregated to overlapping annual observations. See Appendix C for more details.

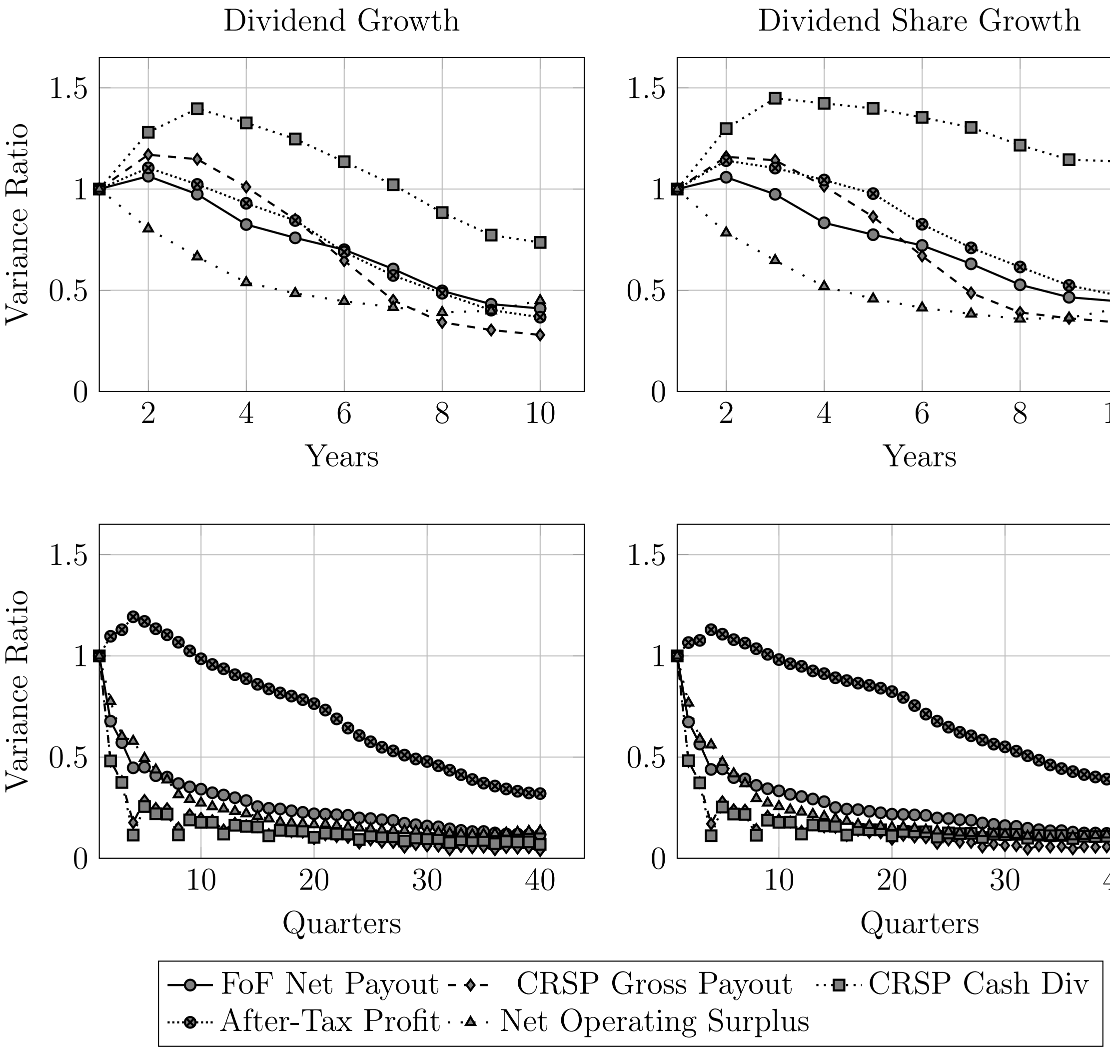

Figure 4: Variance ratios of dividend growth (Δd, left) and dividend share growth (Δdc, right) for different empirical proxies for dividends or equity payout and for annual or quarterly frequencies. FoF Net Payout is aggregate net payout, dividends plus net share repurchases, from the US corporate sector in the Flow of Funds, CRSP Gross Payout is the dividends plus share repurchases and CRSP Cash Div the cash dividend component both computed following the methodology in Bansal et al. (2005), and After-Tax Profit as used in Longstaff and Piazzesi (2004). Net Operating Surplus is used in Belo et al. (2015) as an earnings measure, and is included here for comparison. Dividend share growth is computed as $\Delta dc = \Delta d - \Delta c$, where Δc is nondurables and services consumption growth. Data is quarterly and from 1947-2019 with the exception of the first series which begins in 1952, and for the upper panels is time-aggregated to overlapping annual observations. See Appendix C for more details.

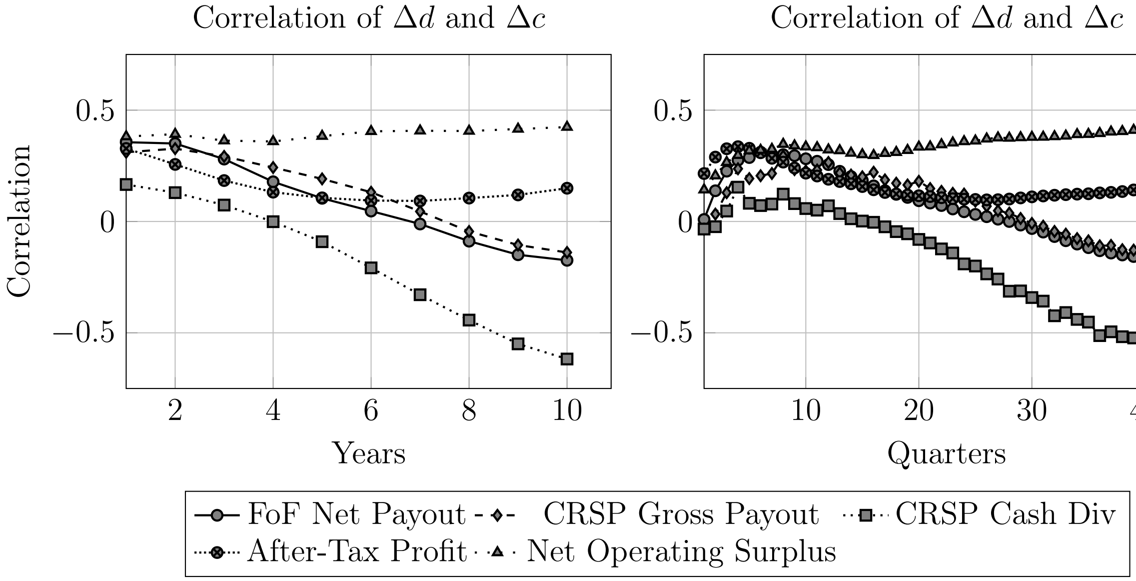

Figure 5: Term structure of correlations of dividend growth and consumption growth for different empirical proxies for dividend income and for annual or quarterly frequencies. FoF Net Payout is aggregate net payout, dividends plus net share repurchases, from the US corporate sector in the Flow of Funds, CRSP Gross Payout is the dividends plus share repurchases and CRSP Cash Div the cash dividend component both computed following the methodology in Bansal et al. (2005), and After-Tax Profit as used in Longstaff and Piazzesi (2004). Net Operating Surplus is used in Belo et al. (2015) as an earnings measure, and is included here for comparison. Dividend share growth is computed as $\Delta dc = \Delta d - \Delta c$, where Δc is nondurables and services consumption growth. Data is quarterly and from 1947-2019 with the exception of the first series which begins in 1952, and for the upper panels is time-aggregated to overlapping annual observations. See Appendix C for more details.

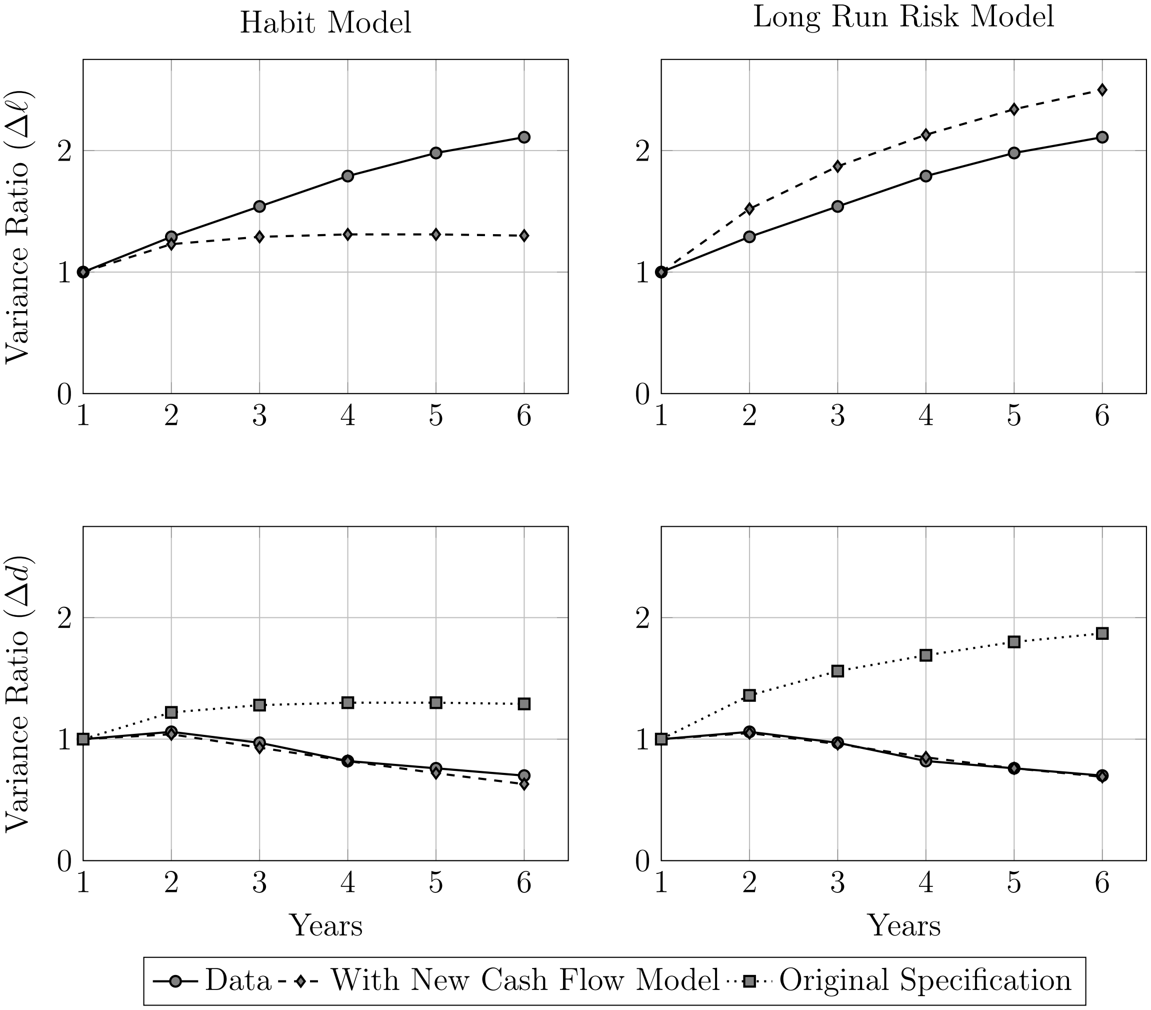

Figure 6: Variance ratios of labor income and dividend growth rates in the models and in the data. Model statistics computed from 100,000 sample samples and averaged. See Section 3 and Appendix C for data definitions.

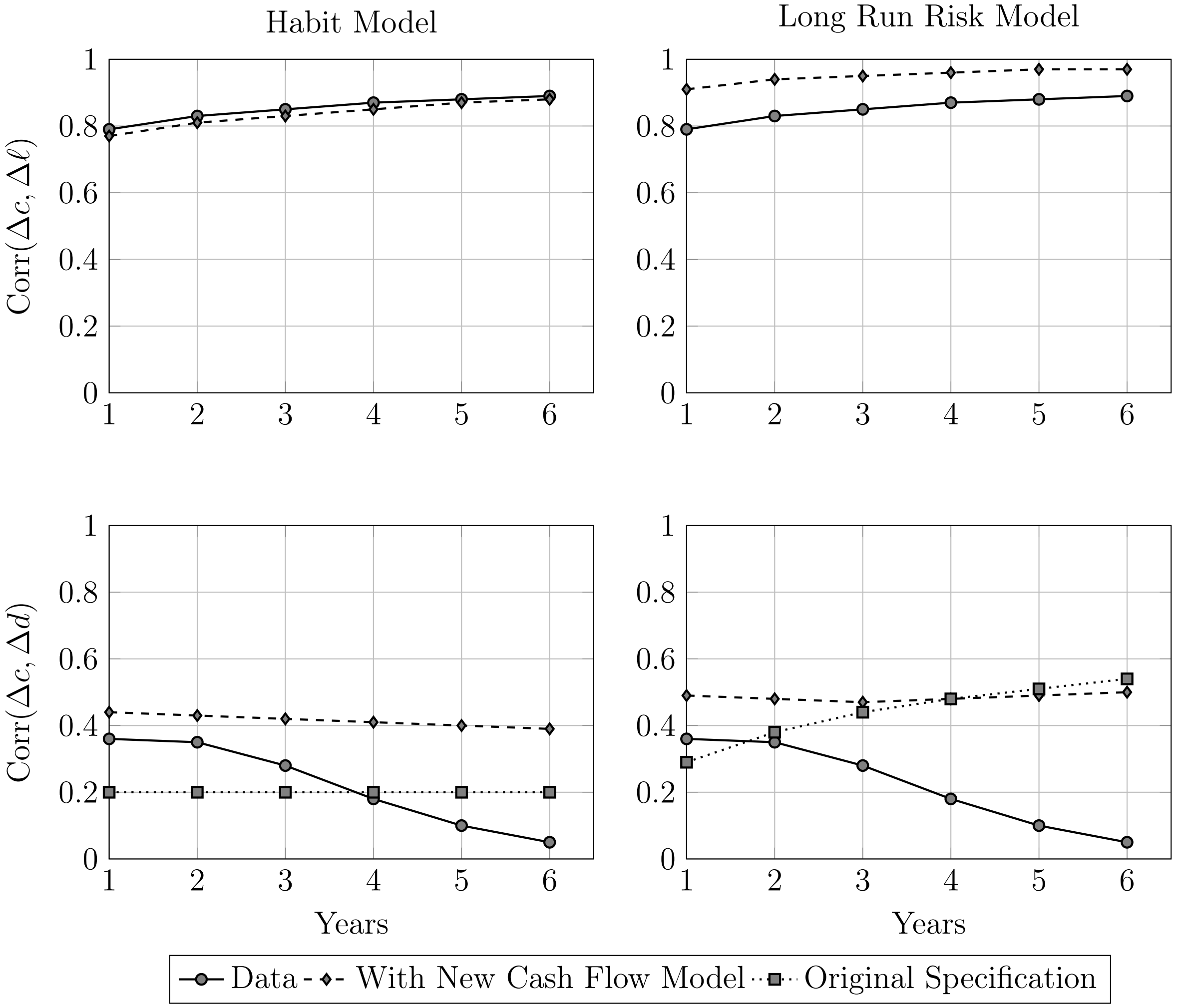

Figure 7: Term structure of correlations of labor income and dividend growth rates with consumption growth in the models and in the data. Model statistics computed from 100,000 sample samples and averaged. See Section 3 and Appendix C for data definitions.

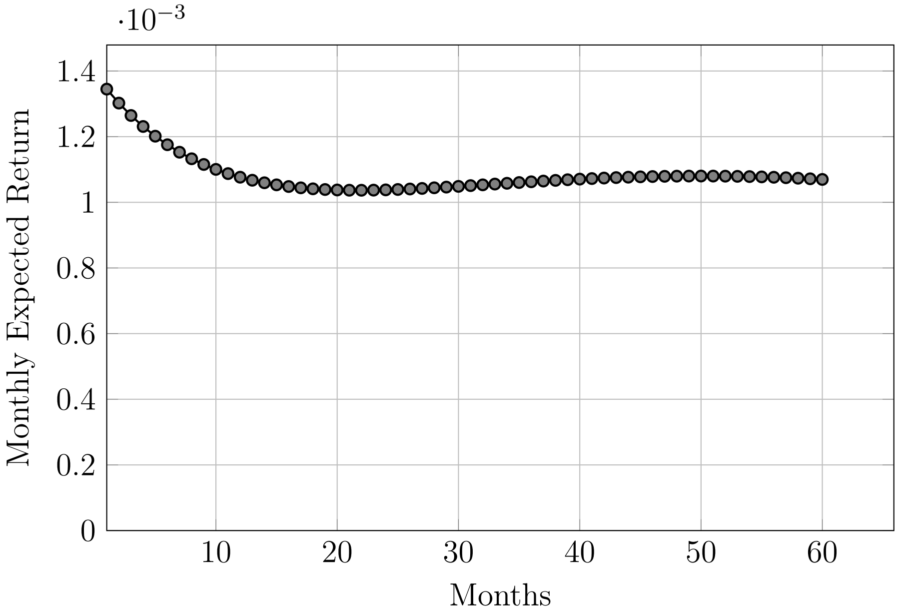

Figure 8: Habit model with new cash flow process. Term structure of dividend strip expected returns. Model statistics computed from 100,000 sample samples and averaged.

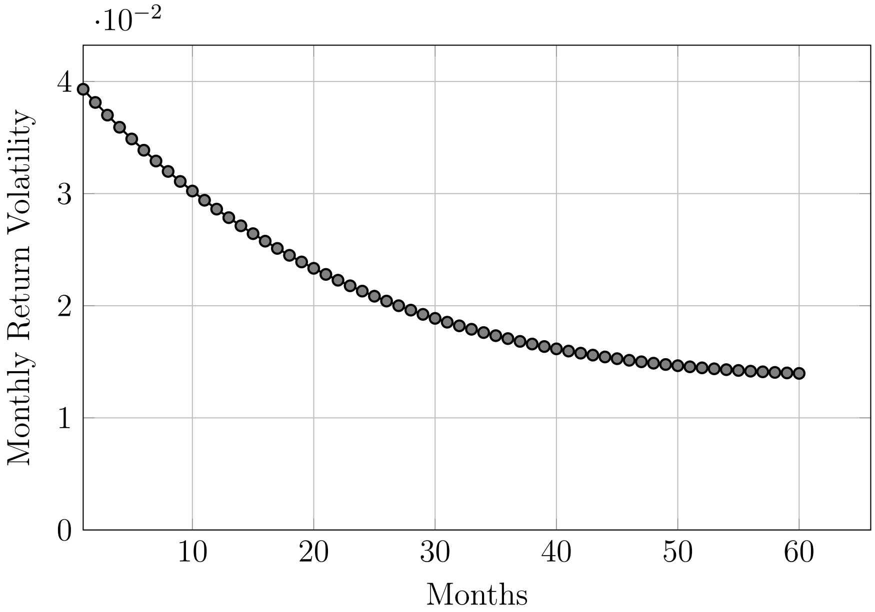

Figure 9: Habit model with new cash flow process. Term structure of dividend strip return volatility. Model statistics computed from 100,000 sample samples and averaged.

x	$\mathbb{E}[x]$	$\sigma(x)$	$\gamma(x)$	$\kappa(x)$	$\rho_1(x)$	$\mathrm{Corr}(x, \Delta c)$
Consumption(Δc)						
NDS	1.90	1.19	-0.28	-0.18	0.45	
Labor Income$(\Delta \ell)$						
ATLI	2.16	1.61	0.00	-0.13	0.26	0.75
ATLI (no transfers)	1.85	2.11	-0.13	-0.06	0.28	0.78
COE	2.04	2.43	-0.10	0.28	0.32	0.81
Dividends(Δd)						
FoF Net Payout	3.80	26.51	-0.53	0.18	0.04	0.36
CRSP Gross Payout	2.89	12.64	-1.19	4.19	0.16	0.31
CRSP Cash Div	2.80	6.88	0.45	1.55	0.26	0.17
After-Tax Profit	2.50	5.54	-0.01	-0.28	0.08	0.33
Net Operating Surplus	4.60	10.72	-0.44	5.99	-0.14	0.38

Table 1: Summary stats. Overlapping annual statistics from postwar quarterly data. γ = skewness, κ = excess kurtosis, ρ_1 = autocorrelation. See Appendix C for sample construction and empirical proxy definitions.

	Δc		Δs	
	$\Delta c < q_{50}$	$\Delta c \geq q_{50}$	$\Delta s < 0$	$\Delta s \geq 0$
Data	0.3	0.1	0.3	0.43
Habit (Orig)	0.12	0.12		
Habit (New)	0.29	0.28	0.35	0.42
LRR (Orig)	0.18	0.18		
LRR (New)	0.33	0.32	0.42	0.5

Table 2: Conditional correlations. Annual correlations between consumption and dividend growth conditional on the statement given, ie. $\mathrm{Corr}(\Delta c_{t+1}, \Delta d_{t+1} \,|x)$ where x is the column heading. q_{50} is the consumption growth sample median. Δc is nondurables and services consumption growth. Δd is aggregate equity payout growth. Sample period 1952-2019. Model statistics computed from 100,000 sample samples.