Durability of Output and Expected Stock Returns[*]

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Abstract

The demand for durable goods is more cyclical than that for nondurable goods. Consequently, the cash flow and stock returns of durable-good producers are exposed to higher systematic risk. Using the NIPA input-output tables, we construct portfolios of durable-good, nondurable-good, and service producers. In the cross-section, a strategy that is long on durables and short on services earns a sizable risk premium. In the time series, a strategy that is long on durables and short on the market portfolio earns a countercyclical risk premium. We develop a general equilibrium model that explains these empirical findings.

JEL classification: G12; L68

Keywords: Asset pricing; Cash flow; Durable goods; Factor-mimicking portfolio

First draft: December 16, 2005

This draft: November 15, 2006

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[*] For comments and discussions, we thank Robert Stambaugh, Selale Tuzel, and seminar participants at the Federal Reserve Board, Goldman Sachs, UBC, University of Chicago, University of Utah, Wharton, and the Econometric Society North American Winter Meeting 2006.

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1 Introduction

The cross-section of stock returns has been a subject of considerable research in financial economics. A key finding in this literature is that variation in accounting and financial variables across stocks generates puzzlingly large variation in average returns.[1] In contrast, variation in measured systematic risk across stocks generates surprisingly little variation in average returns. For instance, classic studies of the capital asset pricing model (CAPM) have found no variation in average returns across portfolios of stocks sorted by the market beta (Black, Jensen, and Scholes 1972, Fama and MacBeth 1973, Fama and French 1992).

In this paper, we identify an important source of systematic risk that is priced in the cross-section of stock returns. Our approach builds on the core intuition of the consumption-based CAPM, which dictates that assets with higher exposure to aggregate-demand risk command higher risk premia. Because some components of aggregate demand are more cyclical than others, those firms producing the more cyclical components must command higher risk premia. Specifically, we argue theoretically and verify empirically that firms that produce durable goods are exposed to higher systematic risk than those that produce nondurable goods and services. An appealing aspect of our approach is that we classify firms based on an easily observable and economically meaningful source of systematic risk, rather than characteristics that have tenuous relationship with systematic risk. While durability may not be the only aspect of a firm's output that determines its exposure to aggregate-demand risk, our empirical success gives hope for identifying other sources of systematic risk that lead to variation in expected returns.

To identify the durability of each firm's output, we first develop a novel industry classification using the Benchmark Input-Output Accounts. This industry classification essentially identifies each Standard Industrial Classification (SIC) industry by its primary contribution

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[1] A partial list of accounting and financial variables that are known to be related to average stock returns are market equity (Banz 1981), earnings yield (Basu 1983), book-to-market equity (Rosenberg, Reid, and Lanstein 1985, Fama and French 1992), leverage (Bhandari 1988), and past returns (Jegadeesh and Titman 1993).

to final demand. We then sort firms into portfolios representing the three broad categories of personal consumption expenditures (PCE): durable goods, nondurable goods, and services. Because these portfolios have cash flows that are economically tied to aggregate consumption, they can be interpreted as consumption-risk mimicking portfolios in the sense of Breeden, Gibbons, and Litzenberger (1989).

We use these PCE portfolios to document a number of new empirical facts. In the cross-section, both the average and the standard deviation of returns rise with the durability of output. Over the period 1927–2004, a strategy that is long on durables and short on services earned an average annual rate of return of almost 4.5%. In the time series, a strategy that is long on durables and short on the market portfolio has countercyclical expected returns that are strongly predicted by the ratio of durable expenditure to its stock. Moreover, the conditional covariance of the strategy's returns with durable consumption growth is also countercyclical, which suggests that this variation in expected returns is compensation for consumption risk.

In order to evaluate our empirical findings, we develop a general equilibrium model that extends the two-good endowment model of Dunn and Singleton (1986), Eichenbaum and Hansen (1990), and Piazzesi, Schneider, and Tuzel (2006). We set up a simple two-sector production economy to endogenize the production of durable and nondurable consumption goods. When calibrated to match aggregate consumption data, the model delivers almost all of our key empirical findings. The basic mechanism of our model, which works in the absence of any asymmetries in preferences or technology, is quite intuitive.

The demand for durable goods is more cyclical and volatile than that for nondurable goods because a proportional change in the service flow (i.e., the stock) requires a much larger proportional change in its expenditure (i.e., the investment). Therefore, the cash flow of durable-good producers is exposed to higher systematic risk, and their unconditional expected returns are higher than those of nondurable-good producers. In addition, the magnitude of the proportional change in expenditure must be relatively large when the existing stock of durables is high relative to current demand. Therefore, the cash flow of durable-good producers is exposed to higher systematic risk when the stock of durables is high relative to its expenditure, and their conditional expected returns are more time-varying than those of nondurable-good producers.

Our work is part of a recent effort to link expected returns to fundamental aspects of firm heterogeneity. One branch of the literature shows that size and book-to-market effects arise naturally from optimal production and investment decisions.[2] A limitation of these earlier studies is that the underlying determinants of stock returns are often difficult to measure, and perhaps more significantly, they reflect fundamental differences between firms that are not true primitives of the economic environment.[3] Partly in response, Gourio (2005) and Tuzel (2005) focus on more readily identifiable sources of firm heterogeneity, such as differences in their production technology or the composition of their physical assets. This paper is in the same spirit, but we focus on heterogeneity in the characteristics of the output, rather than the inputs or technology.

The remainder of the paper is organized as follows. In Section 2, we motivate the basic idea by documenting empirical properties of portfolios sorted by the durability of output. In Section 3, we set up a simple two-sector economy that incorporates the notion of firm heterogeneity based on the durability of output. In Section 4, we calibrate the model to match aggregate quantities and examine its asset-pricing implications. In Section 5, we document cross-sectional and time-series evidence for an empirical relationship between risk and return. Section 6 concludes. A separate appendix (Gomes, Kogan, and Yogo 2006) documents details on the construction of the industry classification as well as the formation of portfolios based on durability risk.

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[2] See, for example, Berk, Green, and Naik (1999), Kogan (2001, 2004), Gomes, Kogan, and Zhang (2003), Carlson, Fisher, and Giammarino (2004), Gala (2006), and Zhang (2006).

[3] Key ingredients in these models include heterogeneity in fixed costs of operation, the degree of irreversibility in capital, and the volatility of cash flow.

2 Portfolios Sorted by the Durability of Output

2.1 Construction of Portfolios

The National Income and Product Accounts (NIPA) divides PCE into the following three categories, ordered in decreasing degree of durability.

- *Durable goods* are "commodities that can be stored or inventoried and have an average service life of at least three years." This category consists of furniture and household equipment; motor vehicles and parts; and other durable goods.
- *Nondurable goods* are "commodities that can be stored or inventoried and have an average service life of at most three years." This category consists of clothing and shoes; food; fuel oil and coal; gasoline and oil; and other nondurable goods.
- *Services* are "commodities that cannot be stored and that are consumed at the place and time of purchase." This category consists of household operation; housing[4]; medical care; net foreign travel; personal business; personal care; private education and research; recreation; religious and welfare activities; and transportation.

Our empirical analysis requires a link from industries, identified at the four-digit SIC code, to the various components of PCE. Because such a link is not readily available, we create one from scratch using NIPA's Benchmark Input-Output Accounts (Bureau of Economic Analysis 1994). The input-output accounts identify how much output each industry contributes to the four broad categories of final demand: PCE, gross private investment, government expenditures, and net exports of goods and services. Within PCE, the input-output accounts also identify how much output each industry contributes to the three categories of durability. Based on this data, we assign each industry to the category of final demand to

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[4] According to the input-output accounts, SIC 7000 (hotels and other lodging places) is the only industry that has direct output to housing services. Expenditure on owner-occupied housing is accounted as part of residential fixed investment, rather than PCE. In the publicly available files, the input-output accounts do not have a breakdown of fixed investment into residential and nonresidential. Therefore, owner-occupied housing will remain outside the scope of our analysis of durable goods.

which it has the highest value added: PCE on durable goods, PCE on nondurable goods, PCE on services, investment, government expenditures, and net exports. This industry classification as well as further details on its construction are contained in Gomes, Kogan, and Yogo (2006).

The universe of stocks is ordinary common equity traded in NYSE, AMEX, or Nasdaq, which are recorded in the Center for Research in Securities Prices (CRSP) Monthly Stock Database. We use our industry classification to sort the universe of stocks into five industry portfolios: services, nondurables, durables, investment, and other industries. Other industries include the wholesale, retail, and financial sectors as well as industries whose primary output is to government or net exports. In June of each year, we sort stocks into portfolios by their SIC code, and then track their value-weighted returns from July through June of the subsequent year.

By construction, the three PCE portfolios have cash flows that are directly tied to consumption expenditure. We therefore interpret them as consumption-risk mimicking portfolios. The notion of synthesizing assets that mimic macroeconomic risk is hardly new (see Shiller (1993)). However, our methodology differs from the conventional procedure that starts with a universe of assets, and then estimates portfolio weights that create maximal correlation with the economic variable of interest (e.g., Breeden, Gibbons, and Litzenberger (1989) and Lamont (2001)). Our procedure does not require estimation, and more importantly, the cash flows are economically (rather than just statistically) linked to consumption risk.

2.2 Portfolio Properties

Table 1 reports some basic properties of the five industry portfolios. We focus our attention on the first three portfolios, which represent PCE. To get a sense of the size of the portfolios, we report the average number of firms and the average share of total market equity that each portfolio represents. Across the full sample period, services represent 15%, nondurables represent 35%, and durables represent 16% of total market equity. On average, the service portfolio has the highest, and the nondurable portfolio has the lowest dividend yield.

For the sample period 1951–2004, we report log book-to-market equity and log liabilities-to-market equity, based on balance-sheet data from Compustat. On average, the service portfolio has the highest, and the nondurable portfolio has the lowest book-to-market equity. Similarly, the service portfolio has the highest, and the nondurable portfolio has the lowest liabilities-to-market equity. These patterns suggest that durability is not a property that is directly related to the book-to-market and leverage effects in expected stock returns.

2.3 Link to Aggregate Consumption

If our procedure successfully identifies durable-good producers, the total sales of firms in the durable portfolio should be empirically related to the aggregate expenditure on durable goods. In Figure 1, we use data from Compustat to plot the annual growth rate of sales for the service, the nondurable, and the durable portfolio. The dashed line in all three panels, shown for the purposes of comparison, is the growth rate of real durable expenditure from NIPA. As shown in Panel C, the correlation between sales of the durable portfolio and durable expenditure is almost perfect, except in the last ten years.[5] This evidence suggests that our industry classification based on the input-output tables successfully identifies durable-good producers.

Table 2 reports the same evidence in a more systematic way. Panel A reports descriptive statistics for the annual growth rate of sales for the PCE portfolios. In addition, the table reports the correlation of sales growth with the growth rate of real service consumption, nondurable consumption, and durable expenditure. (See Appendix A for further details on the consumption data.) The durable portfolio has sales that are more volatile than those of the service and the nondurable portfolio with a standard deviation of 8%. The sales of the durable portfolio have correlation of 0.81 with durable expenditure, confirming the visual

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[5] We suspect that foreign firms, producing motor vehicles and appliances in the U.S., have become an important part of durable expenditure in the recent period.

impression in Figure 1. The sales of both the service and the nondurable portfolio have relatively low correlation with nondurable and service consumption. An explanation for this low correlation is that a large part of nondurable and service consumption is produced by private firms, nonprofit firms, and households that are not part of the CRSP database.

There is a potential accounting problem in aggregating sales across firms. Conceptually, aggregate consumption in NIPA is the sum of value added across firms, which is sales minus the cost of intermediate inputs. Therefore, the sum of sales across firms can lead to double accounting of the cost of intermediate inputs. We therefore compute the operating income for each firm, defined as sales minus the cost of goods sold. Unfortunately, the cost of goods sold in Compustat includes wages and salaries in addition to the cost of intermediate inputs. However, this adjustment would eliminate double accounting and potentially give us a better correspondence between sales of firms in Compustat and aggregate consumption in NIPA.

Panel B reports descriptive statistics for the annual growth rate of operating income for the PCE portfolios. The standard deviation of operating-income growth for the durable portfolio is 13%, compared to 6% for the service and the nondurable portfolio. These differences mirror the large differences in the volatility of real aggregate quantities. In the full sample, the standard deviation of nondurable and service consumption growth is 2%, compared to 13% for durable expenditure growth (see Table 7). In comparison to sales, the operating income of service and nondurable firms have much higher correlation with nondurable and service consumption. The correlation between the operating income of the service portfolio and service consumption is 0.25, and the correlation between the operating income of the nondurable portfolio and nondurable consumption is 0.31. The correlation between the operating income of the durable portfolio and durable expenditure is 0.79.

The fundamental economic mechanism in this paper is that durable-good producers have demand that is more cyclical than that of nondurable-good producers. Table 2 provides strong empirical support for this mechanism, consistent with previous findings by Petersen and Strongin (1996). In the Census of Manufacturing for the period 1958–1986, they find that durable manufacturers are three times more cyclical than nondurable manufacturers, as measured by the elasticity of output (i.e., value added) to gross national product. Moreover, they find that this difference in cyclicality is driven by demand, rather than factors that affect supply (e.g., factor intensities, industry concentration, and unionization).

2.4 Stock Returns

Table 3 reports descriptive statistics for excess returns (over the three-month T-bill) on the five industry portfolios. In the full sample period 1927–2004, both the average and the standard deviation of returns rise in the durability of output. Excess returns on the service portfolio has mean of 5.99% and a standard deviation of 18.70%. Excess returns on the durable portfolio has mean of 10.40% and a standard deviation of 29.27%. In ten-year subsamples, durables generally have higher average returns than both services and nondurables. Interestingly, the largest spread in average returns occurred in the period 1927–1934, during the Great Depression. The spread between durables and nondurables is almost 8%, and the spread between nondurables and services is over 6%.

2.5 Predictability of Returns

Panel A of Table 4 examines evidence for the predictability of excess returns on the PCE portfolios. Our main predictor variable is durable expenditure as a fraction of its stock, which captures the strength of demand for durable goods over the business cycle. As shown in Panel A of Figure 2, the durable expenditure-stock ratio is strongly procyclical, peaking during expansions as identified by the National Bureau of Economic Research (NBER). We report results for the full sample 1930–2004 and the postwar sample 1951–2004. The postwar sample is commonly used in empirical work due to apparent non-stationarity in durable expenditure during and immediately after the war (e.g., Ogaki and Reinhart (1998) and Yogo (2006)). We focus our discussion on the postwar sample because the results are qualitatively similar for the full sample.

In an univariate regression, the durable expenditure-stock ratio predicts excess returns on the service portfolio with coefficient -0.75, the nondurable portfolio with coefficient -0.14, and the durable portfolio with coefficient -1.11. The negative coefficient across the portfolios implies that the durable expenditure-stock ratio predicts the common countercyclical component of expected returns. This finding is similar to a previous finding that the ratio of investment to the capital stock predicts aggregate stock returns (Cochrane 1991). Of more interest than the common sign is the relative magnitude of the coefficient across the portfolios. The coefficient is the most negative for the durable portfolio, implying that it has the largest amount of countercyclical variation in expected returns.

In order to assess the strength of the evidence for return predictability, Table 4 also examines a bivariate regression that includes each portfolio's own dividend yield. The coefficient for the durable expenditure-stock ratio is hardly changed from the univariate regression. The dividend yield predicts excess returns with a positive coefficient as expected, but adds little predictive power over the durable expenditure-stock ratio in terms of the R^2.

In Panel B, we examine whether there is cyclical variation in the volatility of returns. Rather than a structural estimation of risk and return, which we implement in Section 5, we report here a simple reduced-form regression of absolute excess returns onto the lagged predictor variables. In an univariate regression, the durable expenditure-stock ratio predicts absolute excess returns on the service portfolio with coefficient 0.12, the nondurable portfolio with coefficient 0.16, and the durable portfolio with coefficient -0.18. While these coefficients are not statistically significant in the postwar sample, the empirical pattern suggests that the volatility of returns on the durable portfolio is more countercyclical than that of the service or the nondurable portfolio.

2.6 Predictability of Cash-Flow Volatility

Panel B of Table 4 shows that differences in conditional risk are difficult to isolate based on returns data alone. This may be because returns are driven by both news about aggregate discount rates and news about industry-specific cash flows. In Table 5, we therefore examine evidence for the predictability of cash-flow volatility for the PCE portfolios. The basic idea is that because the returns on these portfolios are predictable, their conditional risk should also be predictable. We use the same predictor variables as those used for predicting returns in Table 4.

As reported in Panel A, the durable expenditure-stock ratio predicts absolute sales growth for the service portfolio with coefficient 0.14, the nondurable portfolio with coefficient 0.25, and the durable portfolio with coefficient -0.20. This empirical pattern suggests that the volatility of cash-flow growth on the durable portfolio is more countercyclical than that of the service or the nondurable portfolio. The evidence is robust to including the dividend yield as an additional regressor, and to using operating income instead of sales as the measure of cash flow.

In Panel C, we examine evidence for the predictability of the volatility of five-year dividend growth. We motivate five-year dividend growth as a way to empirically implement the cash-flow news component of a standard return decomposition (Campbell 1991). The durable expenditure-stock ratio predicts absolute dividend growth for the service portfolio with coefficient 0.15, the nondurable portfolio with coefficient -1.17, and the durable portfolio with coefficient -1.46. This evidence suggests that the cash flow of the durable portfolio is exposed to higher systematic risk than that of the service or the nondurable portfolio during recessions, when durable expenditure is low relative to its stock.

3 General Equilibrium Model

The last section established two key facts about the cash flow and returns of durable-good producers in comparison to those of nondurable-good producers. First, the cash flow of durable-good producers is more volatile and more correlated with aggregate consumption. This unconditional cash-flow risk appears to explain the fact that durable-good producers have higher average returns than nondurable-good producers. Second, the cash flow of durable-good producers is more volatile when the durable expenditure-stock ratio is low. This conditional cash-flow risk appears to explain the fact that durable-good producers have expected returns that are more time-varying than nondurable-good producers.

In this section, we build a simple general equilibrium model as an organizing framework for our empirical findings. Specifically, we start with the frictionless representative-household model of Yogo (2006) and endogenize the production of nondurable and durable consumption goods. Our analysis focuses on durability as an economic mechanism for generating differences in equilibrium output and cash-flow risk between firms.

3.1 Representative Household

There is an infinitely lived representative household in an economy with a complete set of financial markets. In each period t, the household purchases C_t units of a nondurable consumption good and E_t units of a durable consumption good. The nondurable good is taken to be the numeraire, so that P_t denotes the price of the durable good in units of the nondurable good. The nondurable good is entirely consumed in the period of purchase, whereas the durable good provides service flows for more than one period. The household's stock of the durable good D_t is related to its expenditure by the law of motion

$$D_t = (1 - \delta)D_{t-1} + E_t, \tag{1}$$

where $\delta \in (0, 1]$ is the depreciation rate.

The household's utility flow in each period is given by the Cobb-Douglas function

$$u(C, D) = C^{1-\alpha}D^{\alpha}, \tag{2}$$

where $\alpha \in (0, 1)$ is the utility weight on the durable good.[6] As is well known, Cobb-

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[6] We use homothetic preferences to ensure that the difference in the volatility of expenditures is a conse-

Douglas utility implies a unit elasticity of substitution between the two goods. Implicit in this specification is the assumption that the service flow from the durable good is a constant proportion of its stock. We therefore use the words "stock" and "consumption" interchangeably in reference to the durable good.

The household maximizes the discounted value of future utility flows, defined through the Epstein-Zin (1991) recursive function

$$U_t = \{(1-\beta)u(C_t, D_t)^{1-1/\sigma} + \beta(\mathbf{E}_t[U_{t+1}^{1-\gamma}])^{1/\kappa}\}^{1/(1-1/\sigma)}. \tag{3}$$

The parameter $\beta \in (0,1)$ is the household's subjective discount factor. The parameter $\sigma \geq 0$ is its elasticity of intertemporal substitution (EIS), $\gamma > 0$ is its relative risk aversion, and $\kappa = (1-\gamma)/(1-1/\sigma)$.

3.2 Technology

Let X_t be the aggregate productivity at time t, which evolves as a geometric random walk with drift. Specifically, we assume that

$$\begin{aligned} \frac{X_{t+1}}{X_t} &= \exp\{\mu + z_{t+1} + \epsilon_{t+1}\}, & (4) \\ z_{t+1} &= \phi z_t + \nu_{t+1}, & (5) \end{aligned}$$

where $\epsilon_t \sim \mathbf{N}(0, \sigma_\epsilon^2)$ and $\nu_t \sim \mathbf{N}(0, \sigma_\nu^2)$ are independently and identically distributed shocks. The variable z_t captures the persistent (i.e., business-cycle) component of aggregate productivity, which evolves as a first-order autoregression.

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quence of durability alone, rather than income elasticity. See Bils and Klenow (1998) and Pakoš (2004) for a model with non-homothetic preferences.

3.3 Firms and Production

In each period t, the household inelastically supplies one unit of productive labor at the wage rate Y_t. The unit of labor is allocated competitively between two infinitely lived firms, a nondurable-good producer and a durable-good producer. The variable $L_t \in [0, 1]$ denotes the share of labor allocated to the nondurable firm in period t. The nondurable firm has the production function

$$C_t = X_t L_t^{\theta}, \tag{6}$$

where $\theta \in (0, 1)$ is the labor elasticity of output.

The relative price of durable goods has steadily fallen, and the production of durable goods relative to that of nondurable goods and services has steadily risen in the postwar period (see Yogo (2006, Figure 1)). These facts suggest that the productivity of the durable sector has grown faster than that of the nondurable sector. We therefore model the production function of the durable firm as

$$E_t = X_t^{\lambda}(1 - L_t)^{\theta}, \tag{7}$$

where $\lambda \geq 1$ is the relative productivity of the durable firm.

The firms have fixed costs of operation each period, which we model as constant units of unproductive labor hired at the wage rate θX_t. The fixed cost of operation creates operating leverage and drives a wedge between the consumption expenditure of the household and the profit of the firm. Because the two firms operate at different scales, except in the special case $\alpha = 0.5$, the fixed cost must be carefully chosen to scale in firm size. Let $\overline{L} \in [0, 1)$ be the total amount of unproductive labor in the economy. The units of unproductive labor hired by the nondurable and the durable firm are given by

$$\overline{L}_C = (1-\alpha)\overline{L}, \tag{8}$$

$$\overline{L}_E = \alpha\overline{L}. \tag{9}$$

Proposition 1 below states the precise sense in which these fixed costs scale in firm size.

The nondurable firm chooses the amount of productive labor each period to maximize profits

$$\Pi_{Ct} = C_t - Y_t L_t - \theta X_t \overline{L}_C. \tag{10}$$

Similarly, the profits of the durable firm are given by

$$\Pi_{Et} = P_t E_t - Y_t(1 - L_t) - \theta X_t \overline{L}_E. \tag{11}$$

In each period, the firms distribute their profits back to the household. Define the household's total labor income as

$$\Pi_{Yt} = Y_t + \theta X_t \overline{L}. \tag{12}$$

The sum of the profits imply the aggregate budget constraint

$$C_t + P_t E_t = \Pi_{Ct} + \Pi_{Et} + \Pi_{Yt}. \tag{13}$$

3.4 Competitive Equilibrium

We solve for optimal allocations through the central planner's problem. We first substitute out labor in equations (6) and (7) to write the production-possibilities frontier as

$$C(E_t, X_t) = X_t \left[1 - \left(\frac{E_t}{X_t^{\lambda}}\right)^{1/\theta}\right]^{\theta}. \tag{14}$$

The Bellman equation for the problem is

$$\begin{aligned} J_t = J(D_{t-1}, X_t) &= \max_{E_t} \{(1-\beta)u(C(E_t, X_t), D_t)^{1-1/\sigma} \\ &\quad + \beta(\mathbf{E}_t[J(D_t, X_{t+1})^{1-\gamma}])^{1/\kappa}\}^{1/(1-1/\sigma)}. \end{aligned} \tag{15}$$

Equations (1) and (4) define the law of motion for the state variables. The policy variable is the optimal level of durable expenditure. We solve for the policy function through numerical methods as described in Appendix B.

3.4.1 Equilibrium Condition for the Household

Let R_{Wt} be the gross rate of return on aggregate wealth in period t, which is defined more precisely below. Define the household's intertemporal marginal rate of substitution (IMRS) as

$$M_{t+1} = \left[\beta \left(\frac{C_{t+1}}{C_t}\right)^{-1/\sigma} \left(\frac{(D_{t+1}/C_{t+1})^{\alpha}}{(D_t/C_t)^{\alpha}}\right)^{1-1/\sigma} R_{W,t+1}^{1-1/\kappa}\right]^{\kappa}. \tag{16}$$

The household's first-order conditions imply that

$$\frac{\alpha}{1-\alpha}\left(\frac{D_t}{C_t}\right)^{-1} = P_t - (1-\delta)\mathbf{E}_t[M_{t+1}P_{t+1}] = Q_t. \tag{17}$$

Intuitively, the marginal rate of substitution between the durable and the nondurable good must equal the user cost of the service flow for the durable good, denoted by Q_t. The user cost is equal to the purchase price today minus the present discounted value of the depreciated stock tomorrow.

3.4.2 Equilibrium Conditions for the Firms

The firms' first-order conditions imply that the competitive wage is equal to the marginal product of labor,

$$Y_t = \theta X_t^{1/\theta} C_t^{1-1/\theta} = \theta P_t X_t^{\lambda/\theta} E_t^{1-1/\theta}. \tag{18}$$

In equilibrium, productive labor earns a higher wage than unproductive labor because $Y_t \geq \theta X_t$. Rearranging this equation, the supply of the durable good, relative to that of the nondurable good, is

$$P_t = X_t^{(1-\lambda)/\theta} \left(\frac{E_t}{C_t}\right)^{1/\theta - 1}. \tag{19}$$

In equilibrium, the firm profits are given by

$$\begin{aligned} \Pi_{Ct} &= (1-\theta)C_t - \theta X_t \overline{L}_C, & (20) \\ \Pi_{Et} &= (1-\theta)P_t E_t - \theta X_t \overline{L}_E. & (21) \end{aligned}$$

Each firm's profit is proportional to consumption expenditure, up to the fixed cost of operation. The profit of the durable firm, relative to that of the nondurable firm, is

$$\frac{\Pi_{Et}}{\Pi_{Ct}} = \frac{(1-\theta)P_t E_t - \theta X_t \overline{L}_E}{(1-\theta)C_t - \theta X_t \overline{L}_C}. \tag{22}$$

The key economic mechanism in the model is captured by equations (17) and (22). On the one hand, equation (17) shows that the household smoothes the ratio the *stock* of durables to nondurable consumption. On the other hand, equation (22) shows that the profit of the durable firm, relative to that of the nondurable firm, is proportional to the ratio of the *expenditure* on durables to nondurable consumption. Consequently, the profits of the durable firm are more volatile than that of the nondurable firm because a proportional change in the durable stock requires a much larger proportional change in its expenditure.

3.5 Equilibrium Asset Prices

Let V_{Ct} be the value of a claim to the profits of the nondurable firm, or the present discounted value of the stream $\{\Pi_{C,t+s}\}_{s=1}^{\infty}$. The one-period return on the claim is

$$R_{C,t+1} = \frac{V_{C,t+1} + \Pi_{C,t+1}}{V_{Ct}}. \tag{23}$$

In analogous notation, the one-period return on a claim to the profits of the durable firm is

$$R_{E,t+1} = \frac{V_{E,t+1} + \Pi_{E,t+1}}{V_{Et}}. \tag{24}$$

Let V_{Mt} be the value of a claim to total consumption expenditure, or the present discounted value of the stream $\{C_{t+s} + P_{t+s}E_{t+s}\}_{s=1}^{\infty}$. The one-period return on the claim is

$$R_{M,t+1} = \frac{V_{M,t+1} + C_{t+1} + P_{t+1}E_{t+1}}{V_{Mt}}. \tag{25}$$

As shown by Yogo (2006, Appendix B), the one-period return on the "wealth portfolio" that enters the IMRS (16) is given by

$$R_{W,t+1} = \left(1 - \frac{Q_t D_t}{V_{Mt} + P_t D_t}\right)^{-1} \left(\frac{V_{M,t+1} + P_{t+1}D_{t+1} + C_{t+1}}{V_{Mt} + P_t D_t}\right). \tag{26}$$

If the durable good fully depreciates each period (i.e., $\delta = 1$), the durable stock does not enter the wealth portfolio. In this special case, the wealth portfolio collapses to the claim on total consumption expenditure (i.e., $R_{Wt} = R_{Mt}$).

The absence of arbitrage implies that the one-period return on any asset i satisfies

$$\mathbf{E}_t[M_{t+1} R_{i,t+1}] = 1, \tag{27}$$

where the IMRS is given by equation (16). In particular, the one-period riskfree interest rate satisfies

$$R_{f,t+1} = \frac{1}{\mathbf{E}_t[M_{t+1}]}. \tag{28}$$

We use the solution to the planner's problem and numerical methods to compute asset prices as described in Appendix B.

3.6 Discussion of the Model

Our model is designed to focus on durability as the sole economic mechanism that drives differences in profits and expected returns. For emphasis, we state this point formally as a proposition.

Proposition 1. *In the special case $\delta = 1$, the profit of the durable firm is a constant proportion of that of the nondurable firm. Consequently, the two firms have identical rates of return (i.e., $R_{Ct} = R_{Et}$).*

Proof. When $\delta = 1$, the household's first-order condition (17) simplifies to

$$\frac{\alpha}{1-\alpha}\left(\frac{E_t}{C_t}\right)^{-1} = P_t.$$

Substituting this expression in equation (22),

$$\frac{\Pi_{Et}}{\Pi_{Ct}} = \frac{\alpha}{1-\alpha}.$$

□

The proposition immediately implies that, in the general case $\delta < 1$, any differences in the firms' rates of return arise from durability alone. The result might initially be surprising because the productivity of the durable firm is more cyclical than that of the nondurable firm when $\lambda > 1$. The reason is that the profit of the durable firm also depends on the relative price of durables, which is endogenously determined through optimal resource allocation. In our view, the fact that durability is the only source of asymmetry between the firms is a strength of the production approach. In an endowment model, firms are different because of exogenous assumptions about their cash flows. Of course, the endowment model has the advantage of being well suited for realistic calibration to aggregate quantities and asset prices. We refer to Piazzesi, Schneider, and Tuzel (2006) and Yogo (2006) for an analysis of the endowment model.

4 Asset-Pricing Implications of the Model

4.1 Choice of Parameters

Panel A of Table 7 reports the four macroeconomic quantities that we target in the calibration. These quantities are

- the log growth rate of real nondurable consumption, or $\log(C_t/C_{t-1})$;
- the log growth rate of real durable expenditure, or $\log(E_t/E_{t-1})$;
- the ratio of durable expenditure to its stock, or E_t/D_t;
- the ratio of durable expenditure to nondurable consumption, or P_tE_t/C_t.

By matching the first two moments and the autocorrelation for these quantities, we ensure realistic implications for aggregate consumption and the relative price. For the purposes of calibration, "nondurable consumption" in the model is matched to nondurable and service consumption in the data. Similarly, the "nondurable firm" in the model is matched to the combination of the nondurable and the service portfolio in the data. We report the empirical moments for two sample periods, 1930–2004 and 1951–2004. Both nondurable consumption and durable expenditure are somewhat more volatile in the longer sample, but otherwise, the empirical moments are quite similar across the samples. We calibrate to the longer sample because it is an easier target from the perspective of explaining asset prices.

Table 6 reports the parameters in our benchmark calibration. We set the depreciation rate to 22%, which matches the value reported by the Bureau of Economic Analysis (BEA) for consumer durables. We set the growth rate of technology to 2% in order to match the growth rate of real nondurable consumption. We set the relative productivity of the durable sector to $\lambda = 1.8$ in order to match the growth rate of real durable expenditure. We set labor elasticity, which is approximately the labor share of aggregate output in the model, to $\theta = 0.7$ and perform sensitivity analysis around that value.

As with most general equilibrium models, especially those with production, our model implies the equity premium and volatility puzzles. Because a resolution of the classic asset-pricing puzzles is not a goal of this paper, we acknowledge the quantitative failures and focus on the qualitative successes. To help improve the asset-pricing implications of the model, we model productivity growth as having a persistent component with an autoregressive parameter $\phi = 0.78$, following Bansal and Yaron (2004). We choose the standard deviation of the shocks so that $\log(X_{t+1}/X_t)$ has the moments

$$\begin{aligned} \text{SD} &= \left(\sigma_\epsilon^2 + \frac{\sigma_\nu^2}{1-\phi^2}\right)^{1/2} = 3\%, \\ \text{Autocorrel} &= \frac{\phi}{1+\sigma_\epsilon^2(1-\phi^2)/\sigma_\nu^2} = 0.4. \end{aligned}$$

To generate a nontrivial equity premium, we choose a fairly high risk aversion of $\gamma = 10$. At the same time, we choose a fairly high EIS of $\sigma = 2$, which helps keep both the mean and the volatility of the riskfree rate low. An EIS greater than one also implies that the substitution effect dominates the income effect, so that asset prices rise in response to a positive productivity shock. This helps magnify both the equity premium and the volatility of asset returns. Finally, the intratemporal first-order condition (17) requires that $\alpha = 0.12$ to pin down the level of durable expenditure relative to nondurable consumption.

4.2 Calibration to Aggregate Consumption

Panel A of Table 7 shows that our choice of parameters leads to an outstanding match of the targeted quantities. We match the mean, the standard deviation, and the autocorrelation of nondurable consumption growth. We do the same for durable expenditure, except that the standard deviation is somewhat lower than the empirical counterpart. The standard deviation of durable expenditure growth is 14% in the full sample and 8% in the model. A higher value of labor elasticity can raise the spread in volatility between nondurable consumption and durable expenditure, by making it easier to transfer resources between the nondurable and durable sectors. However, this channel cannot fully account for the relatively high volatility of durable expenditure.

Figure 3 shows the optimal policy for the planner's problem under the benchmark parameters. We plot policy functions for a state with high productivity growth when $\epsilon_t = \sigma_\epsilon$, and a state with low productivity growth when $\epsilon_t = -\sigma_\epsilon$. Panel A shows that, holding the existing stock of durables constant, labor allocated to the production of durables rises in the productivity shock. In response to a positive productivity shock, the expenditure on durables rises (in Panel B) and the relative price of durables falls (in Panel C). These policy functions verify the simple intuition that the expenditures on durables are more volatile and cyclical than that on nondurables.

Panel A also shows that, holding the productivity growth constant, labor allocated to the production of durables falls in the existing stock of durables. Intuitively, the household has little need for additional durables when the existing stock, and hence the service flow, is already high. Both the expenditure on durables (in Panel B) and the user cost of durables (in Panel D) are more volatile when the stock of durables is relatively high. If we rearrange the accumulation equation (1) and compute the conditional variance of both sides,

$$\frac{D_{t-1}}{E_{t-1}} = \frac{\sigma_{t-1}(E_t/E_{t-1})}{\sigma_{t-1}(D_t/D_{t-1})}.$$

This relationship between the stock of durables and the conditional volatility of durable expenditure is a natural consequence of durability. A negative productivity shock causes the desired future service flow from durables to fall, which is accomplished through a reduction in the expenditures on new durables. When the existing stock is relatively high, such a reduction must be more pronounced.

4.3 Calibration to Profits

In our discussion of parameters above, we have deliberately omitted the fixed cost of labor. This is because the parameter has no bearing on the planner's problem, and consequently, any of the quantities reported in Panel A of Table 7. We now set this parameter to $\overline{L} = 0.3$ in order to calibrate the model to the volatility of profits. Our empirical proxy for profits is operating income, which is sales minus the cost of goods sold. Data on sales and the cost of goods sold, which includes wages and salaries, are from Compustat and are available only for the postwar sample. In both the model and the data, the market portfolio is the combination of the nondurable and the durable firm.

Panel B of Table 7 reports the mean and the standard deviation of profit growth. Our simple model of operating leverage introduces a realistic wedge between the volatility of consumption expenditure and profits. For the nondurable firm, the standard deviation of profit growth is 3% in the model and 5% in the data. For the durable firm, the standard deviation of profit growth is 14% in the model and 13% in the data.

4.4 Implied Asset Returns

Equity is a leveraged claim on the firm's profits. In order to compare firm returns in the model to stock returns in the data, we must first introduce financial leverage. Consider a portfolio that is long V_{it} dollars in firm i and short bV_{it} dollars in the riskfree asset. The one-period return on the leveraged strategy is

$$\widetilde{R}_{it} = \frac{1}{1-b} R_{it} - \frac{b}{1-b} R_{ft}.$$

In the model, we compute stock returns in this way using an empirically realistic leverage ratio. We compute the leverage ratio for all Compustat firms as the ratio of the book value of liabilities to the market value of assets (i.e., the sum of book liabilities and market equity). While the leverage ratio varies over time, it is on average 52% in the postwar sample. We therefore set $b = 52\%$ in the calibration.

In Panel C of Table 7, we report the first two moments of asset returns implied by the model. The nondurable firm has excess returns (over the riskfree rate) with mean of 6.77% and a standard deviation of 10.11%. The durable firm has excess returns with mean of 8.87% and a standard deviation of 13.28%. The spread in average returns between the two firms is more than 2%, which is comparable to the empirical counterpart. However, the spread in the volatility of returns is somewhat lower than the empirical counterpart because our model is not designed to resolve the equity volatility puzzle. The riskfree rate is 0.96% on average with low volatility, consistent with empirical evidence. Overall, the model supports the key empirical facts, that the durable portfolio has returns that are higher on average and more volatile.

4.5 Predictability of Returns

We use the calibrated model to simulate 10,000 samples, each consisting of 50 annual observations. In each sample, we run a regression of excess returns onto the lagged durable expenditure-stock ratio. Panel A of Table 8 reports the mean and the standard deviation of the t-statistic from the regression across the simulated samples. The goal of this exercise is to see whether the model replicates the evidence for predictability in actual data, reported in Panel A of Table 4. The regression coefficient is negative for both firms, and the t-statistic for the durable firm is larger than that for the nondurable firm. This pattern is consistent with empirical evidence, especially accounting for the moderate sampling variance.

In Panel B, we use the simulated data to run a regression of absolute excess returns onto the lagged durable expenditure-stock ratio. The regression coefficient is negative for both firms, and the t-statistic for the durable firm is larger than that for the nondurable firm. These results are consistent with the evidence presented in Panel B of Table 4.

In Panel C, we use the simulated data to run a regression of absolute profit growth onto the lagged durable expenditure-stock ratio. The regression coefficient is positive for the nondurable firm and negative for the durable firm. These results are consistent with the evidence presented in Table 5.

To understand these simulation results, it is helpful to distinguish two sources of predictability. The first is the common source that is responsible for the predictability of the market portfolio. The IMRS (16) depends on the stock of durables as a ratio of nondurable consumption, which is proportional to the user cost of durables through the household's intratemporal first-order condition (17). As shown in Panel D of Figure 3, the user cost of durables is more volatile when the stock of durables is relatively high. This implies that the IMRS is more volatile when the stock of durables is relatively high.

The second is the independent source that is responsible for the predictability of the durable firm above and beyond that of the nondurable firm. Figure 4 shows the profits and the value (i.e., the present discounted value of profits) of both firms as a function of the existing stock of durables. The profits of the durable firm (in Panel B) is more sensitive to aggregate productivity shocks when the stock of durables is high, in contrast to the profits of the nondurable firm (in Panel A). In other words, the conditional volatility of the profits of the durable firm rises in the existing stock of durables. As compensation for higher conditional cash-flow risk, the durable firm earns a higher expected return when the stock of durables is relatively high.

5 Relationship between Risk and Return

This section extends the analysis in Section 2 by further investigating the empirical properties of portfolios sorted by the durability of output. Specifically, we use a model of risk and return, implied by the Euler equation (27), to show that the durability of output is a priced risk factor in both the cross-section and the time series of expected returns. As is well known, the Euler equation holds even in an economy where production is different from the stylized model in Section 3. In that sense, the analysis in this section is more general than the calibration in the last section.

We use quarterly (rather than annual) data for the period 1951:1–2004:4 to obtain more precise estimates of the covariance between asset returns and consumption growth. Throughout this section, R_{it} denotes the excess return on an asset i in period t. "Nondurable consumption" refers to real nondurable and service consumption, and its log growth rate is denoted by Δc_t. "Durable consumption" refers to the real stock of consumer durables, and its log growth rate is denoted by Δd_t. (See Appendix A for further details on the consumption data.) The log return on the wealth portfolio is denoted by $r_{Wt} = \log(R_{Wt})$. Because this return in not directly observable, we use the real return on the CRSP value-weighted portfolio as an empirical proxy, following Epstein and Zin (1991) and Yogo (2006).

5.1 Cross-Sectional Variation in Expected Returns

5.1.1 Empirical Framework

An approximation to the unconditional version of the Euler equation (27) implies a linear factor model,

$$\mathbf{E}[R_{it}] = b_1 \mathrm{Cov}(\Delta c_t, R_{it}) + b_2 \mathrm{Cov}(\Delta d_t, R_{it}) + b_3 \mathrm{Cov}(r_{Wt}, R_{it}). \tag{29}$$

(See Yogo (2006, Appendix C) for the derivation.) This equation says that variation in expected returns across assets must reflect variation in the quantity of risk across assets, measured by the covariance of returns with consumption growth.

Yogo (2006) shows that the durable consumption model (29) prices standard cross-sectional test assets, including the 25 Fama-French (1992) portfolios and portfolios sorted by book-to-market within industry. In this section, we test the model on a set of portfolios that more directly captures risk associated with the durability of output. Central to our portfolio formation is a zero-investment strategy that is long on the durable portfolio and short on the service portfolio, which we view as a durable minus service (DMS) factor-mimicking portfolio. We form 15 portfolios by sorting the universe of stocks into five industries and three levels of pre-formation DMS beta. Insofar as durability is a priced risk factor, we expect to see a spread in post-formation betas and returns that is related to pre-formation DMS beta. Gomes, Kogan, and Yogo (2006) contains further details on the construction of the portfolios, and Appendix C contains details on estimation of the linear factor model.

5.1.2 Empirical Findings

Panel A of Table 9 reports annualized excess returns (over the three-month T-bill) on the 15 portfolios sorted by industry and DMS beta. Within the service, investment, and other industries, average returns are positively related to pre-formation DMS beta. Within the service industry, stocks with the lowest exposure to the DMS factor have average excess returns of 4.85%, while stocks with the highest exposure to the DMS factor have average excess returns of 9.99%. Within the investment industry, stocks with the lowest exposure to the DMS factor have average excess returns of 5.15%, while stocks with the highest exposure to the DMS factor have average excess returns of 7.58%. Within the two remaining industries, average returns are nearly flat in pre-formation DMS beta. For the nondurable industry, the lack of spread in returns can be attributed to the relatively small variation in post-formation DMS beta. For the durable industry, the lack of spread in returns can be attributed to the negative relationship between post-formation market and DMS beta.

In the first column of Table 10, we examine whether the Fama-French (1993) three-factor model explains cross-sectional returns on the 15 portfolios. The risk price for the market factor is 3.08 and significantly different from zero, while the risk price for the high minus low (HML) book-to-market factor is 1.03 and not significantly different from zero. These estimates imply that the risk on these portfolios are more related to market risk, rather than to HML risk. The R^2 is only 4%, implying that the Fama-French model generates large alphas on these portfolios as reported in Panel B of Table 9.

In the second column of Table 10, we examine whether the durable consumption model (29) explains cross-sectional returns on the 15 portfolios. The risk price for nondurable consumption growth is 35, while the risk price for durable consumption growth is 85. Of the three risk factors, only durable consumption growth has a risk price that is significantly different from zero, implying that this factor alone explains most of the variation in cross-sectional returns. The R^2 of the model is 83%, which is much higher than the R^2 of the Fama-French model. However, the J-test (i.e., the test of overidentifying restrictions) has a p-value of 10%, which is a consequence of the model's inability to explain returns on the investment portfolio as discussed below.

In order to better understand the relationship between risk and return, Panel C of Table 9 reports the betas and alphas for the durable consumption model. Within the service and investment industries, durable consumption beta is positively related to pre-formation DMS beta. Within the service industry, stocks with the lowest exposure to the DMS factor have a durable consumption beta of -0.18, while stocks with the highest exposure to the DMS factor have a durable consumption beta of 0.16. Within the investment industry, stocks with the lowest exposure to the DMS factor have a durable consumption beta of -0.21, while stocks with the highest exposure to the DMS factor have a durable consumption beta of 0.50.

The alphas are large and negative for all three portfolios in the investment industry, that is, these portfolios have average returns that are too low relative to their measured risk. As shown in Panel B, this is also the case if risk is measured by the Fama-French model. This failure can be partly rationalized by the fact that firms that produce investment goods, which presumably act as inputs for firms that produce consumption goods, are outside the scope of our general equilibrium model. A potentially interesting extension of our model is to incorporate a third type of firm that produces investment goods (see Papanikolaou (2006)).

5.2 Time Variation in Expected Returns

5.2.1 Empirical Framework

An approximation to the Euler equation (27) implies a conditional factor model,

$$\mathbf{E}_{t-1}[R_{it}] = b_1 \mathrm{Cov}_{t-1}(\Delta c_t, R_{it}) + b_2 \mathrm{Cov}_{t-1}(\Delta d_t, R_{it}) + b_3 \mathrm{Cov}_{t-1}(r_{Wt}, R_{it}). \tag{30}$$

This equation says that variation in expected returns over time must reflect variation in the quantity of risk over time, measured by the conditional covariance of returns with consumption growth.

Following the approach in Campbell (1987) and Harvey (1989), we model the conditional moments in equation (30) as linear functions of a vector of instruments x_{t-1} observed at

$t-1$. For a set of assets indexed by i, we estimate the linear regression model

$$\begin{aligned} R_{it} &= \Pi_i' x_{t-1} + \epsilon_{it}, && (31) \\ \epsilon_{it}\Delta c_t &= \Upsilon_{i1}' x_{t-1} + \eta_{i1t}, && (32) \\ \epsilon_{it}\Delta d_t &= \Upsilon_{i2}' x_{t-1} + \eta_{i2t}, && (33) \\ \epsilon_{it} r_{Wt} &= \Upsilon_{i3}' x_{t-1} + \eta_{i3t}. && (34) \end{aligned}$$

The conditional factor model (30) implies cross-equation restrictions of the form

$$\Pi_i = b_1\Upsilon_{i1} + b_2\Upsilon_{i2} + b_3\Upsilon_{i3}. \tag{35}$$

Our estimation is based on four excess returns and three instruments. The excess returns are the market portfolio over the three-month T-bill and each of the PCE (service, nondurable, and durable) portfolios *over the market portfolio.* The instruments are the durable expenditure-stock ratio, the dividend yield for the market portfolio, and a constant. In the estimation, we impose the risk prices $b_1 = 35$, $b_2 = 85$, and $b_3 = 0.55$, which are the estimated risk prices from Table 10. This procedure ensures that the asset-pricing implications for the time series are consistent with those for the cross-section. Appendix C contains further details on estimation of the conditional factor model.

5.2.2 Empirical Findings

Panel A of Table 11 reports estimates of the regression model (31) for the conditional mean of excess returns. The estimates imply that the durable expenditure-stock ratio is the key instrument that explains time variation in expected returns. The estimated coefficient is -0.13 for excess returns on the market portfolio. Because the expenditure-stock ratio is procyclical, the negative coefficient implies that the equity premium is countercyclical.

The estimated coefficient is 0.02 for excess returns on the service portfolio over the market portfolio. The positive coefficient implies that the expected return on the service portfolio is *less cyclical* than that on the market portfolio. In contrast, the estimated coefficient is -0.06 for excess returns on the durable portfolio over the market portfolio. The negative coefficient implies that the expected return on the durable portfolio is *more cyclical* than that on the market portfolio. Between these two extremes is the expected return on the nondurable portfolio, which is slightly more cyclical than the market portfolio.

In Panels B and C, we investigate whether the cyclical variation in expected returns is matched by cyclical variation in risk, measured by the conditional covariance of returns with consumption growth. In particular, Panel C reports estimates of the regression model (33) for the conditional covariance of excess returns with durable consumption growth. The durable expenditure-stock ratio predicts the product of the innovations to market return and durable consumption growth with coefficient -0.12. Because the expenditure-stock ratio is procyclical, the negative coefficient implies that the conditional covariance of the market return with durable consumption growth is countercyclical.

The estimated coefficient is 0.01 for excess returns on the service portfolio over the market portfolio. The positive coefficient implies that the conditional covariance for the service portfolio is *less cyclical* than that for the market portfolio. In contrast, the estimated coefficient is -0.06 for excess returns on the durable portfolio over the market portfolio. The negative coefficient implies the conditional covariance for the durable portfolio is *more cyclical* than that for the market portfolio.

Panel B of Figure 2 is a visual representation of the results in Table 11. The figure shows a time-series plot of the equity premium (i.e., expected excess market returns), implied by the estimates in Table 11. The heavy line represents the total equity premium (i.e., $\mathbf{E}_{t-1}[R_{it}]$), and the light line represents the part due to durable consumption (i.e., $b_2\mathrm{Cov}_{t-1}(\Delta d_t, R_{it})$). The difference is the premium due to nondurable consumption and market return. The plot reveals two interesting facts. First, the equity premium is strongly countercyclical, that is, highest at business-cycle troughs and lowest at peaks. Second, the two lines move closely together, which implies that most of the time variation in the equity premium is driven by time variation in durable consumption risk.

Figure 5 shows the premium on the service, the nondurable, and the durable portfolios over the market portfolio. A portfolio strategy that is long on the service portfolio and short on the market portfolio has procyclical expected returns. For example, expected returns are low during the 1960:2–1961:3 and 1980:1–1982:4 recessions. In contrast, a portfolio strategy that is long on the durable portfolio and short on the market portfolio has countercyclical expected returns. For example, expected returns are high during the same two recessions.

In summary, Table 11 uncovers a new empirical fact that the premium on the service portfolio is less cyclical, and the premium on the durable portfolio is more cyclical than that on the market portfolio. The countercyclical variation in expected returns is matched by countercyclical variation in the quantity of risk, as captured by the conditional covariance of returns with durable consumption growth. Durable stocks deliver unexpectedly low returns during recessions when durable consumption growth is low. Therefore, investors demand a higher premium for holding durable stocks during recessions, above and beyond the usual compensation for stock market risk.

6 Conclusion

The literature on the cross-section of stock returns has documented a number empirical relationships between characteristics and expected returns. Although these studies provide useful descriptions of stock market data, they provide a limited insight into the underlying economic determinants of stock returns. Consequently, proposed explanations for these empirical findings represent a broad spectrum of ideologies, which include compensation for yet undiscovered economic risk factors (Fama and French 1993), investor mistakes (De Bondt and Thaler 1985, Lakonishok, Shleifer, and Vishny 1994), and data snooping (Lo and MacKinlay 1990). A more fruitful approach to the study of stock returns is to find direct empirical relationships between sources of systematic risk and expected returns. For instance, Pástor and Stambaugh (2003) find evidence that aggregate liquidity risk is priced in the cross-section of stock returns.

Ultimately, prices should not be viewed as characteristics by which to rationalize differences in expected returns. Instead, prices and expected returns should jointly be explained by more fundamental aspects of firm heterogeneity, such as the demand for their output. In this paper, we have shown that durability is an important aspect of demand that is priced in the cross-section of stock returns. Firms that produce durable goods have higher average returns, and their expected returns vary more over the business cycle. We suspect that there are other, and perhaps more important, aspects of demand that explain differences in expected returns.

Appendix A Consumption Data

We work with two samples of consumption data: a longer annual sample for the period 1930–2004 and a shorter quarterly sample for the period 1951:1–2004:4. We construct our data using the following tables from the BEA.

- NIPA Table 2.3.4: Price Indexes for Personal Consumption Expenditures by Major Type of Product.
- NIPA Table 2.3.5: Personal Consumption Expenditures by Major Type of Product.
- NIPA Table 7.1: Selected Per Capita Product and Income Series in Current and Chained Dollars.
- Fixed Assets Table 8.1: Current-Cost Net Stock of Consumer Durable Goods.

Nondurable consumption is the properly chain-weighted sum of real PCE on nondurable goods and services. The data for the stock of durable goods are available only at annual frequency (measured at each year end). We therefore construct a quarterly series that is consistent with the accumulation equation (1), using quarterly data for real PCE on durable goods. The depreciation rate for durable goods, implied by the construction, is about 6% per quarter. In computing growth rates, we divide all quantities by the population. In matching consumption growth to returns at the quarterly frequency, we use the "beginning-of-period" timing convention as in Campbell (2003).

To deflate asset returns and cash-flow growth, we use the consumer price index (CPI) for all urban consumers from the Bureau of Labor Analysis. The CPI is the only consistent time series for consumer prices going back to 1926, which is the beginning of the CRSP database. The CPI is based on a basket of goods and services from eight major groups of expenditures: food and beverages; housing; apparel; transportation; medical care; recreation; education and communication; and other nondurable goods and services. Because the CPI measures the price of nondurable goods and services, our deflating methodology is consistent with our modeling convention that the nondurable good is the numeraire in the economy.

Appendix B Numerical Solution of the Model

B.1 Central Planner's Problem

We first rescale all variables by the appropriate power of aggregate productivity to make the planner's problem stationary. We define the rescaled value function $\widehat{J}_t = J_t/X_t^{1+\alpha(\lambda-1)}$. We also define the rescaled variables $\widehat{C}_t = C_t/X_t$, $\widehat{E}_t = E_t/X_t^{\lambda}$, $\widehat{D}_t = D_t/X_t^{\lambda}$, and $\widehat{P}_t = P_t/X_t^{1-\lambda}$. Let $\Delta X_{t+1} = X_{t+1}/X_t$. By homotheticity, we can solve an equivalent problem defined by the Bellman equation

$$\begin{aligned} \widehat{J}_t = \widehat{J}(\widehat{D}_{t-1}, \Delta X_t) &= \max_{\widehat{E}_t}\{(1-\beta)u(\widehat{C}(\widehat{E}_t), \widehat{D}_t)^{1-1/\sigma} \\ &\quad +\beta(\mathbf{E}_t[\Delta X_{t+1}^{(1-\gamma)(1+\alpha(\lambda-1))}\widehat{J}(\widehat{D}_t, \Delta X_{t+1})^{1-\gamma}])^{1/\kappa}\}^{1/(1-1/\sigma)}, \quad \text{(B1)} \\ \widehat{C}(\widehat{E}_t) &= (1-\widehat{E}_t^{1/\theta})^{\theta}. \quad \text{(B2)} \end{aligned}$$

The law of motion for the state variables are given by

$$\widehat{D}_t = (1-\delta)\frac{\widehat{D}_{t-1}}{\Delta X_t^{\lambda}} + \widehat{E}_t \quad \text{(B3)}$$

and equation (4).

We discretize the state space and solve the dynamic program through policy iteration. We start with an initial guess that the user cost is $Q_t = \delta P_t$. Then the intratemporal first-order condition (17) implies that

$$\frac{\alpha}{1-\alpha}\left(\frac{\widehat{D}_t}{\widehat{C}_t}\right)^{-1} = \delta\widehat{P}_t. \quad \text{(B4)}$$

Our initial guess of the policy function, $\widehat{E}_t = E(\widehat{D}_{t-1}, \Delta X_t)$, is the solution to the system of three nonlinear equations (19), (B2), and (B4). We then use the following recursion to solve the problem.

1. Compute the value function $\widehat{J}_i$ corresponding to the current policy function $\widehat{E}_i$.
2. Update the policy function $\widehat{E}_{i+1}$ using $\widehat{J}_i$ and the intratemporal first-order condition (17).
3. If $\|\widehat{E}_{i+1} - \widehat{E}_i\|$ is less than the convergence criteria, stop. Otherwise, return to step 1.

B.2 Asset Prices

As shown by Yogo (2006, Appendix B), the value of the claim to consumption expenditure is related to the value function (15) through the equation

$$V_{Mt} = \frac{C_t^{1/\sigma}(D_t/C_t)^{\alpha(1/\sigma-1)} J_t^{1-1/\sigma}}{(1-\beta)(1-\alpha)} - C_t - P_t D_t. \tag{B5}$$

We use the solution to the planner's problem to compute the return on the wealth portfolio (26) and the IMRS (16). We then solve for the (rescaled) value of the two firms by iterating on the Euler equations

$$\begin{aligned} \widehat{V}_{Ct} = \widehat{V}_C(\widehat{D}_{t-1}, \Delta X_t) &= \mathbf{E}_t[M_{t+1}\Delta X_{t+1}(\widehat{V}_C(\widehat{D}_t, \Delta X_{t+1}) + \widehat{\Pi}_{C,t+1})], & \text{(B6)} \\ \widehat{V}_{Et} = \widehat{V}_E(\widehat{D}_{t-1}, \Delta X_t) &= \mathbf{E}_t[M_{t+1}\Delta X_{t+1}(\widehat{V}_E(\widehat{D}_t, \Delta X_{t+1}) + \widehat{\Pi}_{E,t+1})]. & \text{(B7)} \end{aligned}$$

We compute the riskfree rate through equation (28). We simulate the model for 500,000 years to compute the moments reported in Table 7.

Appendix C Estimating the Relationship between Risk and Return

We use the following notation throughout this appendix. The vector $R_t = (R_{1t}, \ldots, R_{Nt})'$ denotes the time t observation on N excess returns with mean μ_R and covariance matrix Σ_R. The vector $f_t = (f_{1t}, \ldots, f_{Ft})'$ denotes the time t observation on F factors with mean μ_f and covariance matrix Σ_f. The vector x_t denotes the time t observation on I instruments. For any parameter vector θ, the symbol $\widehat{\theta}$ denotes a corresponding consistent estimator.

C.1 Cross-Sectional Estimation

We estimate the linear factor model by two-step generalized method of moments (GMM) (see Cochrane (2001, Chapter 13.2) and Yogo (2006, Appendix C)). The parameters of the model are the vector of risk prices b and factor means μ_f. Stack the parameters in a vector as $\theta = (b', \mu_f')'$, and also stack the data in a vector as $z_t = (R_t', f_t')'$. Define the moment function

$$e(z_t, \theta) = \begin{bmatrix} e_N(z_t, \theta) \\ e_F(z_t, \theta) \end{bmatrix} = \begin{bmatrix} R_t - R_t(f_t - \mu_f)'b \\ f_t - \mu_f \end{bmatrix}. \tag{C1}$$

The linear factor model (29) implies the moment restriction $\mathbf{E}[e(z_t, \theta_0)] = 0$ at the true parameter $\theta = \theta_0$.

In the first stage, we use the weighting matrix

$$W = \begin{bmatrix} \det(\widehat{\Sigma}_R)^{-1/N} I_N & 0 \\ 0 & \widehat{\Sigma}_f^{-1} \end{bmatrix}, \tag{C2}$$

which puts an equal weight on each of the N asset-pricing moment restrictions. As a measure of first-stage fit, we compute the statistic

$$R^2 = 1 - \frac{\| \sum_t e_N(z_t, \widehat{\theta})\|^2}{\| \sum_t (R_t - \widehat{\mu}_R)\|^2}. \tag{C3}$$

We compute heteroskedasticity- and autocorrelation-consistent (HAC) standard errors through the VARHAC procedure with automatic lag length selection by the Akaike information criteria (see Den Haan and Levin (1997)).

C.2 Time-Series Estimation

We estimate the conditional factor model by two-step GMM (see Yogo (2006, Appendix D)). The linear regression model (31)–(34), in more compact notation, is

$$\begin{aligned} R_{it} = &\quad \Pi_i' x_{t-1} + \epsilon_{it} \quad (i = 1, \ldots, N), & \text{(C4)} \\ \epsilon_{it} f_{jt} = &\quad \Upsilon_{ij}' x_{t-1} + \eta_{ijt} \quad (i = 1, \ldots, N; j = 1, \ldots, F). & \text{(C5)} \end{aligned}$$

The parameters of the model are the vector of risk prices b and the conditional covariance matrices

$$\begin{aligned} \Upsilon_j = &\quad [\Upsilon_{1j} \cdots \Upsilon_{Nj}] \quad (I \times N), & \text{(C6)} \\ \Upsilon = &\quad [\Upsilon_1 \cdots \Upsilon_F] \quad (I \times NF). & \text{(C7)} \end{aligned}$$

Stack the parameters in a vector as $\theta = (b', \mathrm{vec}(\Upsilon)')'$, and also stack the data in a vector as $z_t = (R_t', f_t', x_{t-1}')'$. Define the moment function

$$e(z_t, \theta) = \begin{bmatrix} R_t - (\sum_{j=1}^F b_j \Upsilon_j)' x_{t-1} \\ \mathrm{vec}([R_t - (\sum_{j=1}^F b_j \Upsilon_j)' x_{t-1}] f_t') - \Upsilon' x_{t-1} \end{bmatrix} \otimes x_{t-1}. \tag{C8}$$

The conditional factor model (30) implies the moment restriction $\mathbf{E}[e(z_t, \theta_0)] = 0$ at the true parameter $\theta = \theta_0$.

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Table 1: Properties of the PCE Portfolios

We sort NYSE, AMEX, and Nasdaq stocks into five industry portfolios based on their SIC codes. The industries are defined by their primary contribution to final demand according to the NIPA input-output tables. We compute portfolio properties in December of each year and report the time-series average over the indicated sample period. The reported properties are the number of firms in each portfolio, the share of total market equity that each portfolio represents, log dividend yield, log book-to-market equity, and log liabilities-to-market equity.

Property	Services	Nondurables	Durables	Investment	Other
Panel A: Sample Period 1927–2004					
Number of Firms	415	401	189	638	1175
Share of Market Equity (%)	14.6	35.3	15.9	16.7	17.5
Dividend Yield	-2.97	-3.12	-3.04	-3.29	-3.24
Panel B: Sample Period 1951–2004					
Number of Firms	547	493	233	844	1616
Share of Market Equity (%)	10.2	39.2	15.6	17.2	17.8
Dividend Yield	-3.01	-3.18	-3.09	-3.42	-3.34
Book-to-Market Equity	-0.24	-0.71	-0.52	-0.63	-0.58
Liabilities-to-Market Equity	0.07	-0.82	-0.13	-0.62	0.63

Table 2: Sales and Operating Income for the PCE Portfolios

The table reports descriptive statistics for the log annual growth rate of sales and operating income for the PCE portfolios. Operating income is sales minus the cost of goods sold. Correlation is with the log growth rate of real service consumption, nondurable consumption, and durable expenditure. Data on sales and the cost of goods sold are from Compustat and are deflated by the CPI. The sample period is 1951–2004.

Statistic	Services	Nondurables	Durables
Panel A: Sales			
Mean (%)	5.62	4.54	3.15
Standard Deviation (%)	5.94	5.43	8.16
Correlation with the Growth of			
Service Consumption	0.13	-0.01	0.62
Nondurable Consumption	0.19	0.04	0.49
Durable Expenditure	0.07	-0.10	0.81
Panel B: Operating Income			
Mean (%)	5.36	4.70	3.00
Standard Deviation (%)	5.99	5.55	12.77
Correlation with the Growth of			
Service Consumption	0.25	0.27	0.60
Nondurable Consumption	0.20	0.31	0.39
Durable Expenditure	0.29	0.33	0.79

Table 3: Excess Returns on the PCE Portfolios

We sort NYSE, AMEX, and Nasdaq stocks into five industry portfolios based on their SIC codes. The industries are defined by their primary contribution to final demand according to the NIPA input-output tables. The table reports the mean and the standard deviation of annual real excess returns over the three-month T-bill.

Period	Services	Nondurables	Durables	Investment	Other
Panel A: Average Excess Returns (%)					
1927–2004	5.99	8.52	10.40	8.18	8.51
1927–1934	-4.47	2.74	10.59	5.28	5.77
1935–1944	12.65	9.48	17.16	13.67	11.31
1945–1954	11.33	16.67	18.73	18.58	16.47
1955–1964	11.09	10.65	12.00	11.43	8.89
1965–1974	-6.13	-0.39	-6.00	-0.23	-2.78
1975–1984	7.68	6.31	10.99	4.77	8.04
1985–1994	8.19	11.73	9.10	1.60	8.74
1995–2004	5.47	9.76	10.67	9.77	11.07
Panel B: Standard Deviation of Excess Returns (%)					
1927–2004	18.70	18.68	29.27	28.27	22.33
1927–1934	25.33	34.09	59.31	58.08	42.69
1935–1944	24.72	18.38	33.61	28.28	23.51
1945–1954	14.77	16.79	23.15	25.13	17.48
1955–1964	15.23	15.02	21.73	25.60	17.80
1965–1974	12.51	16.86	22.82	23.47	22.10
1975–1984	11.39	14.33	24.99	19.16	15.64
1985–1994	15.62	14.99	14.96	8.87	16.56
1995–2004	22.86	17.44	25.59	28.50	20.78

Table 4: Predictability of Excess Returns

The table reports predictive regressions for real excess returns (over the three-month T-bill) and the absolute value of excess returns for the PCE portfolios. The lagged predictor variables are the log durable expenditure-stock ratio and each portfolio's own log dividend yield. Heteroskedasticity-consistent standard errors are in parentheses. Coefficients significant at the 10% level (i.e., t-statistic greater than 1.645) are in bold type.

Lagged Predictor	Sample Period 1927–2004						Sample Period 1951–2004					
	Services		Nondurables		Durables		Services		Nondurables		Durables	
Panel A: Excess Returns												
Durable Expenditure-Stock	-0.20	-0.13	-0.19	-0.11	-0.40	**-0.42**	**-0.75**	**-0.61**	-0.14	0.07	**-1.11**	**-1.09**
	(0.13)	(0.13)	(0.14)	(0.11)	(0.25)	(0.24)	(0.30)	(0.31)	(0.35)	(0.31)	(0.45)	(0.44)
Dividend Yield		**0.17**		**0.26**		**0.17**		0.09		**0.24**		0.09
		(0.06)		(0.06)		(0.10)		(0.07)		(0.06)		(0.11)
R^2	0.04	0.11	0.03	0.17	0.06	0.10	0.10	0.12	0.00	0.16	0.10	0.12
Panel B: Absolute Excess Returns												
Durable Expenditure-Stock	**-0.15**	**-0.17**	-0.13	-0.11	-0.34	**-0.36**	0.12	0.07	0.16	0.23	-0.18	-0.18
	(0.09)	(0.09)	(0.12)	(0.11)	(0.21)	(0.21)	(0.18)	(0.19)	(0.18)	(0.18)	(0.25)	(0.26)
Dividend Yield		-0.05		**0.09**		0.11		-0.03		0.07		-0.01
		(0.04)		(0.05)		(0.07)		(0.04)		(0.05)		(0.07)
R^2	0.05	0.07	0.04	0.08	0.11	0.15	0.01	0.02	0.01	0.04	0.01	0.01

Table 5: Predictability of the Volatility of Cash-Flow Growth

The table reports predictive regressions for the absolute value of real sales growth, operating-income growth, and five-year dividend growth for the PCE portfolios. The lagged predictor variables are the log durable expenditure-stock ratio and each portfolio's own log dividend yield. Heteroskedasticity-consistent standard errors are in parentheses. Coefficients significant at the 10% level (i.e., t-statistic greater than 1.645) are in bold type. The sample period is 1951–2004.

Lagged Predictor	Services		Nondurables		Durables	
Panel A: Absolute Sales Growth						
Durable Expenditure-Stock	0.14	0.01	**0.25**	**0.24**	**-0.20**	**-0.20**
	(0.09)	(0.07)	(0.09)	(0.08)	(0.09)	(0.09)
Dividend Yield		**-0.08**		-0.01		0.03
		(0.02)		(0.02)		(0.02)
R^2	0.04	0.31	0.17	0.18	0.07	0.10
Panel B: Absolute Operating-Income Growth						
Durable Expenditure-Stock	-0.11	-0.20	**0.23**	**0.22**	-0.26	-0.25
	(0.13)	(0.18)	(0.04)	(0.05)	(0.16)	(0.16)
Dividend Yield		-0.06		-0.01		0.03
		(0.04)		(0.02)		(0.03)
R^2	0.01	0.06	0.26	0.28	0.04	0.06
Panel C: Absolute 5-Year Dividend Growth						
Durable Expenditure-Stock	0.15	-0.06	**-1.17**	**-1.09**	**-1.46**	**-1.43**
	(0.23)	(0.24)	(0.31)	(0.30)	(0.51)	(0.50)
Dividend Yield		**-0.18**		**0.12**		-0.09
		(0.08)		(0.06)		(0.17)
R^2	0.00	0.14	0.27	0.32	0.13	0.14

Table 6: Parameters in the Benchmark Calibration

Parameter	Symbol	Value
Depreciation rate of durable good	δ	22%
Preferences:		
Discount factor	β	0.98
EIS	σ	2
Risk aversion	γ	10
Utility weight on durable good	α	0.12
Technology:		
Growth rate	μ	2.0%
SD of i.i.d. component	σ_ϵ	2.1%
SD of shock to persistent component	σ_ν	1.3%
Autocorrel of persistent component	ϕ	0.78
Production:		
Labor elasticity of output	θ	0.70
Relative productivity of durable sector	λ	1.80
Fixed labor cost	$\overline{L}$	0.30
Financial leverage	b	52%

Table 7: Calibration of the Model and Implied Asset Returns

Panel A reports moments for various quantities in the data and in the calibrated model. The quantities are the log growth rate of real nondurable and service consumption, the log growth rate of real durable expenditure, the ratio of durable expenditure to its stock, and the ratio of durable expenditure to nondurable consumption. Panel B reports moments for the log growth rate of real operating income (profits in the model). Panel C reports moments for excess portfolio returns over the three-month T-bill rate (over the riskfree rate in the model). Table 6 lists the parameters of the calibrated model.

Variable	Statistic	Sample Period		Model
		1930–2004	1951–2004	
Panel A: Consumption Growth				
Nondurable Consumption	Mean (%)	1.88	2.06	2.00
	SD (%)	2.26	1.13	3.00
	Autocorrel	0.43	0.30	0.46
Durable Expenditure	Mean (%)	3.38	3.68	3.60
	SD (%)	13.44	6.58	7.71
	Autocorrel	0.26	0.10	0.27
Durable Expenditure-Stock	Mean (%)	23.57	24.66	24.70
	SD (%)	3.73	1.64	2.93
	Autocorrel	0.79	0.65	0.88
Durable-Nondurable Expenditure	Mean (%)	14.02	15.17	14.56
	SD (%)	2.71	1.17	0.98
	Autocorrel	0.87	0.70	0.78
Panel B: Profit Growth				
Market Portfolio	Mean (%)		4.30	2.00
	SD (%)		5.44	3.54
Nondurable & Service Portfolio	Mean (%)		4.64	2.00
	SD (%)		5.03	2.68
Durable Portfolio	Mean (%)		3.00	2.00
	SD (%)		12.77	13.68
Panel C: Excess Returns				
Market Portfolio	Mean (%)	7.39	7.40	6.98
	SD (%)	18.65	15.85	10.43
Nondurable & Service Portfolio	Mean (%)	7.03	7.25	6.77
	SD (%)	17.51	15.21	10.11
Durable Portfolio	Mean (%)	9.81	8.83	8.87
	SD (%)	28.28	23.20	13.28
T-bill / Riskfree Asset	Mean (%)	0.90	1.66	0.96
	SD (%)	4.17	2.45	0.76

Table 8: Predictability of Excess Returns in the Model

We use the calibrated model to simulate 10,000 samples, each consisting of 50 annual observations. In Panel A, we run a regression of excess returns onto the lagged durable expenditure-stock ratio and report the mean and the standard deviation of the *t*-statistic across the simulated samples. In Panel B (Panel C), we repeat the same exercise for a regression of the absolute value of excess returns (profit growth) onto the lagged durable expenditure-stock ratio. Table 6 lists the parameters of the calibrated model.

Statistic	Portfolio		
	Market	Nondurables	Durables
Panel A: Excess Returns			
Mean	-0.61	-0.60	-0.70
SD	1.05	1.05	1.04
Panel B: Absolute Excess Returns			
Mean	-0.35	-0.33	-0.52
SD	1.08	1.08	1.06
Panel C: Absolute Profit Growth			
Mean	1.16	2.48	-1.15
SD	1.31	1.72	1.12

Table 9: Average Returns and Betas for Portfolios Sorted by Industry and DMS Beta

We form 15 portfolios by sorting NYSE, AMEX, and Nasdaq stocks into five industries and three levels of pre-formation DMS beta. We estimate DMS beta for each stock through a 60-month (minimum of 36-month) rolling regression onto the excess market return and the DMS portfolio return. Panel A reports average excess returns (over the three-month T-bill) and post-formation market and DMS beta. Panel B reports the beta and alpha for the Fama-French three-factor model. Panel C reports the beta and alpha for the durable consumption model, in which the factors are nondurable consumption growth, durable consumption growth, and the real market return. All returns and alpha are reported in annualized percentage units. The sample period is 1951:1–2004:4.

Industry	Services			Nondurables			Durables			Investment			Other		
DMS Beta	Low	Med	High	Low	Med	High	Low	Med	High	Low	Med	High	Low	Med	High
Panel A: Post-Formation Properties															
Excess Return (%)	4.85	8.12	9.99	9.10	8.62	8.83	7.61	7.30	8.13	5.15	7.13	7.58	8.46	7.61	9.45
Market Beta	0.90	1.05	1.18	0.90	0.83	1.01	1.12	1.03	0.89	1.15	1.11	1.14	1.14	1.02	1.15
DMS Beta	-0.44	-0.09	0.12	-0.18	-0.07	0.08	0.23	0.36	0.74	-0.01	0.11	0.33	-0.08	0.12	0.27
Panel B: Fama-French Model															
Market Beta	0.88	0.99	1.09	0.90	0.91	1.04	1.02	1.11	1.16	0.97	1.13	1.19	1.03	1.04	1.19
SMB Beta	-0.24	0.25	0.66	-0.27	-0.26	0.19	0.69	0.40	0.04	0.30	0.07	0.36	0.20	0.17	0.32
HML Beta	0.20	0.18	0.26	-0.16	0.07	0.22	0.08	0.33	0.18	-0.41	0.02	0.26	-0.14	0.10	0.19
Alpha (%)	-2.05	0.68	1.95	2.28	1.56	0.96	0.27	-1.08	-0.73	-1.76	-1.40	-1.41	0.88	-0.21	0.52
Panel C: Durable Consumption Model															
Nondurable Beta	0.53	0.50	1.47	-0.02	-0.01	-0.22	0.21	0.83	2.03	0.60	0.98	-0.13	-0.53	-0.35	0.13
Durable Beta	-0.18	0.32	0.16	1.07	1.22	0.99	0.21	-0.30	-0.46	-0.21	0.08	0.50	0.93	0.55	0.56
Market Beta	0.75	1.01	1.19	0.85	0.81	1.03	1.17	1.13	1.08	1.11	1.11	1.22	1.11	1.07	1.22
Alpha (%)	0.52	0.48	0.14	0.44	-0.42	-0.10	0.12	0.79	0.14	-1.14	-1.05	-0.64	-0.05	0.47	0.51

Table 10: Cross-Sectional Test on Portfolios Sorted by Industry and DMS Beta

The table reports estimated factor risk prices for the Fama-French three-factor model and the durable consumption model. The test assets are the 15 portfolios described in the notes to Table 9. Estimation is by two-step GMM. HAC standard errors are in parentheses. The mean absolute pricing error (MAE) and R^2 are based on the first-stage estimate. The p-values for the J-test are in parentheses.

Factor Price	Fama-French	Durable Model
Market	3.08	0.55
	(1.15)	(0.70)
SMB	-1.94	
	(1.57)	
HML	1.03	
	(2.19)	
Nondurables		35.05
		(23.74)
Durables		85.28
		(21.55)
MAE (%)	1.18	0.47
R^2	0.04	0.83
J-test	14.39	18.61
	(0.28)	(0.10)

Table 11: Expected Return and Conditional Covariance with Consumption Growth
Panel A reports estimates of a regression model for expected excess returns. Panel B (Panel C) reports estimates of a regression model for the conditional covariance of returns with nondurable (durable) consumption growth. Panel D reports estimates of a regression model for the conditional covariance of returns with real market returns. Estimation uses four excess returns and three lagged instruments. The excess returns are the market portfolio over the three-month T-bill and each of the PCE portfolios over the market portfolio. The instruments are log durable expenditure-stock ratio, log dividend yield for the market portfolio, and a constant. Estimation is by two-step GMM. Heteroskedasticity-consistent standard errors are in parentheses. Coefficients significant at the 10% level (i.e., *t*-statistic greater than 1.645) are in bold type.

Instrument	Market	Excess Returns over Market		
		Services	Nondurables	Durables
Panel A: Expected Excess Returns				
Durable Expenditure-Stock	**-0.13**	0.02	**-0.03**	**-0.06**
	(0.03)	(0.01)	(0.01)	(0.02)
Dividend Yield	0.01	0.00	0.00	0.00
	(0.01)	(0.00)	(0.00)	(0.00)
Panel B: Covariance with Nondurable Consumption				
Durable Expenditure-Stock	**-0.10**	0.01	0.00	**-0.04**
	(0.03)	(0.01)	(0.01)	(0.02)
Dividend Yield	0.01	0.00	-0.01	0.01
	(0.01)	(0.00)	(0.00)	(0.00)
Panel C: Covariance with Durable Consumption				
Durable Expenditure-Stock	**-0.12**	0.01	**-0.03**	**-0.06**
	(0.03)	(0.01)	(0.02)	(0.02)
Dividend Yield	0.00	**0.01**	0.00	0.00
	(0.01)	(0.00)	(0.00)	(0.01)
Panel D: Covariance with Market Return				
Durable Expenditure-Stock	0.33	0.19	-0.12	0.42
	(0.78)	(0.27)	(0.25)	(0.32)
Dividend Yield	0.15	**-0.18**	**0.21**	0.02
	(0.24)	(0.09)	(0.10)	(0.10)

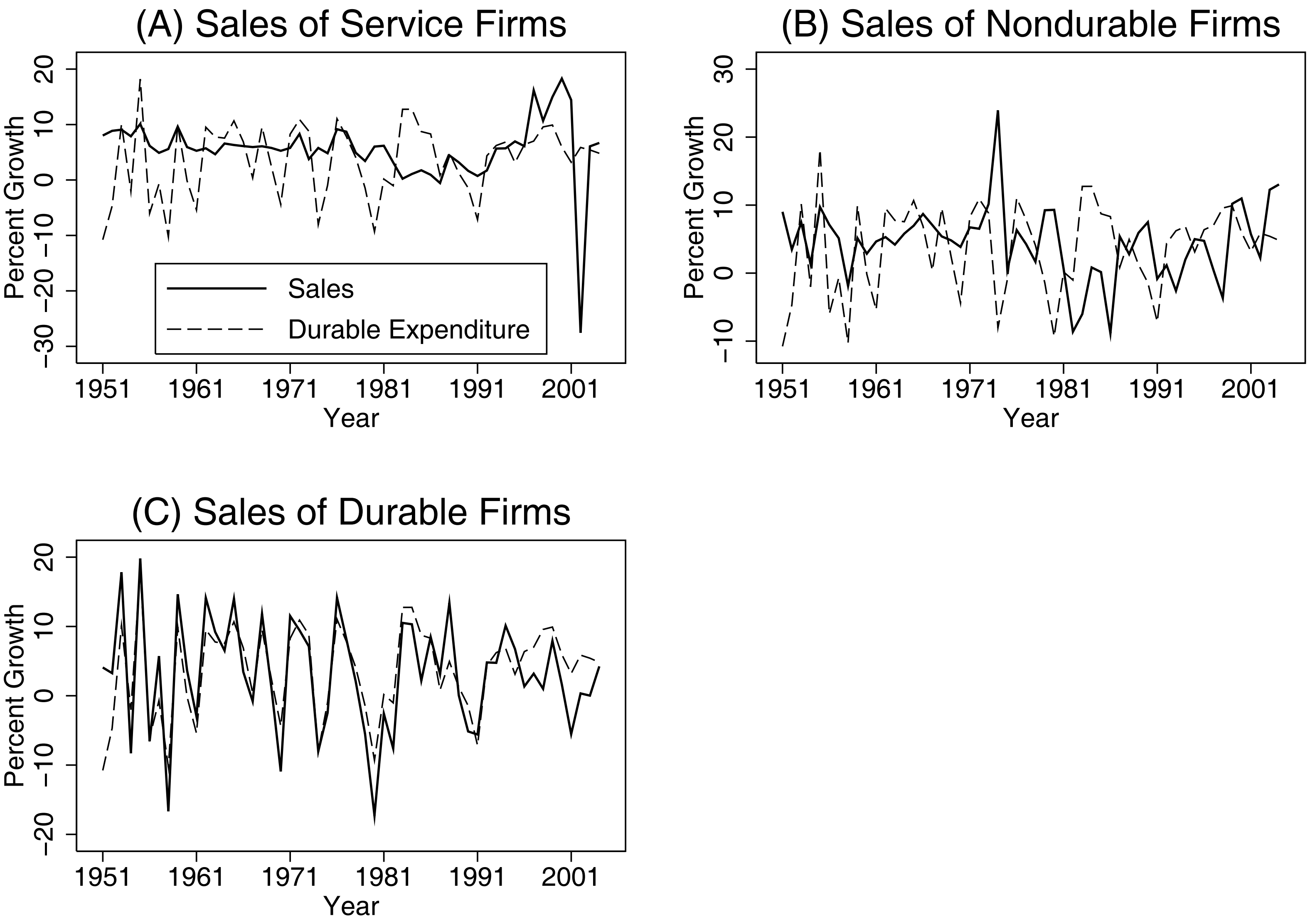

Figure 1: Sales Growth for the PCE Portfolios
The figure shows the log annual growth rate of sales for the PCE portfolios. The dashed line in each panel is the log growth rate of real durable expenditure. Data on sales are from Compustat and are deflated by the CPI. The sample period is 1951–2004.

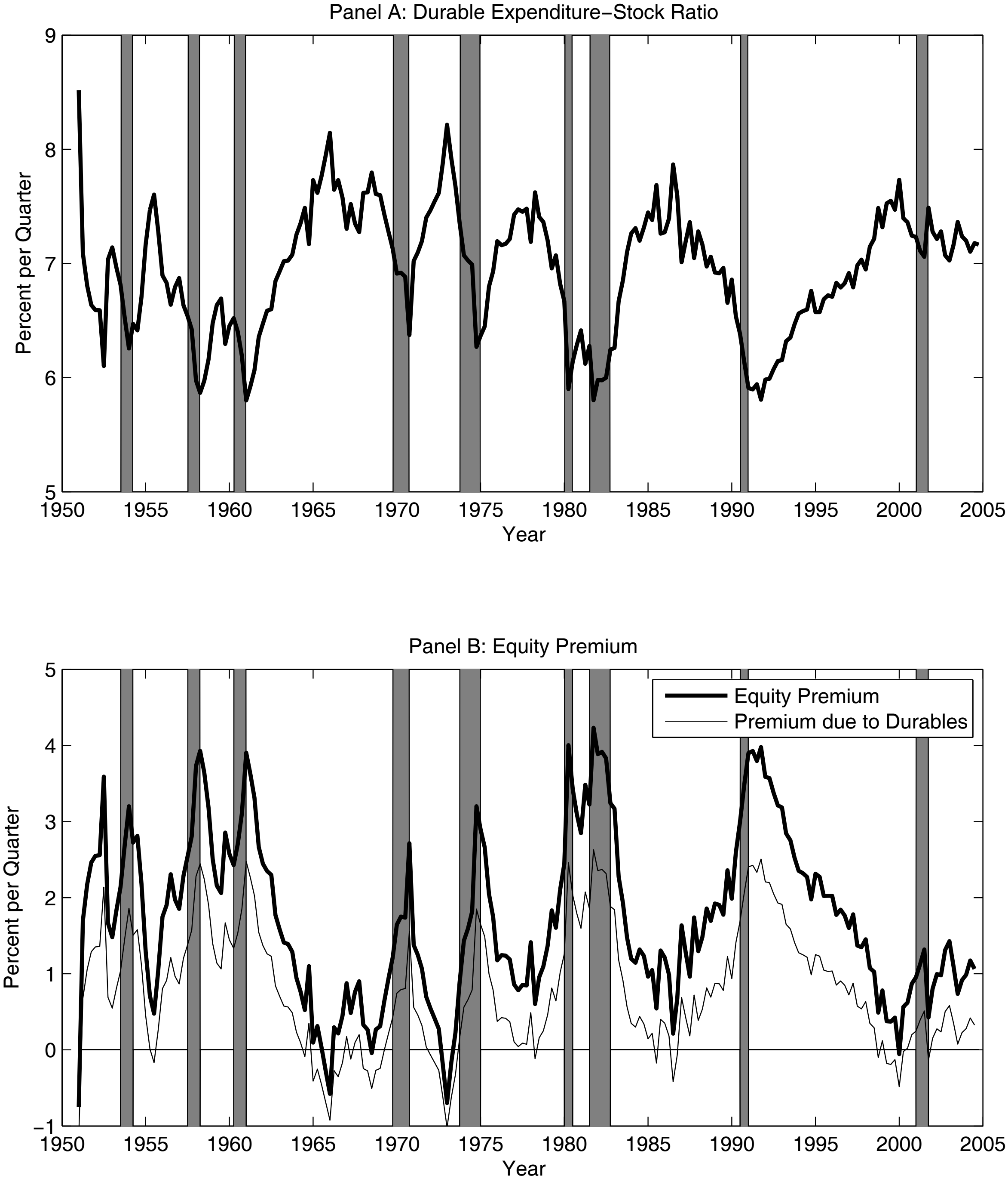

Figure 2: Time Variation in the Equity Premium

Panel A is a time-series plot of the durable expenditure-stock ratio. Panel B is a time-series plot of expected excess returns on the market portfolio over the three-month T-bill rate, implied by the regression model estimated in Table 11. The sample period is 1951:1–2004:3, and the shaded regions are NBER recessions.

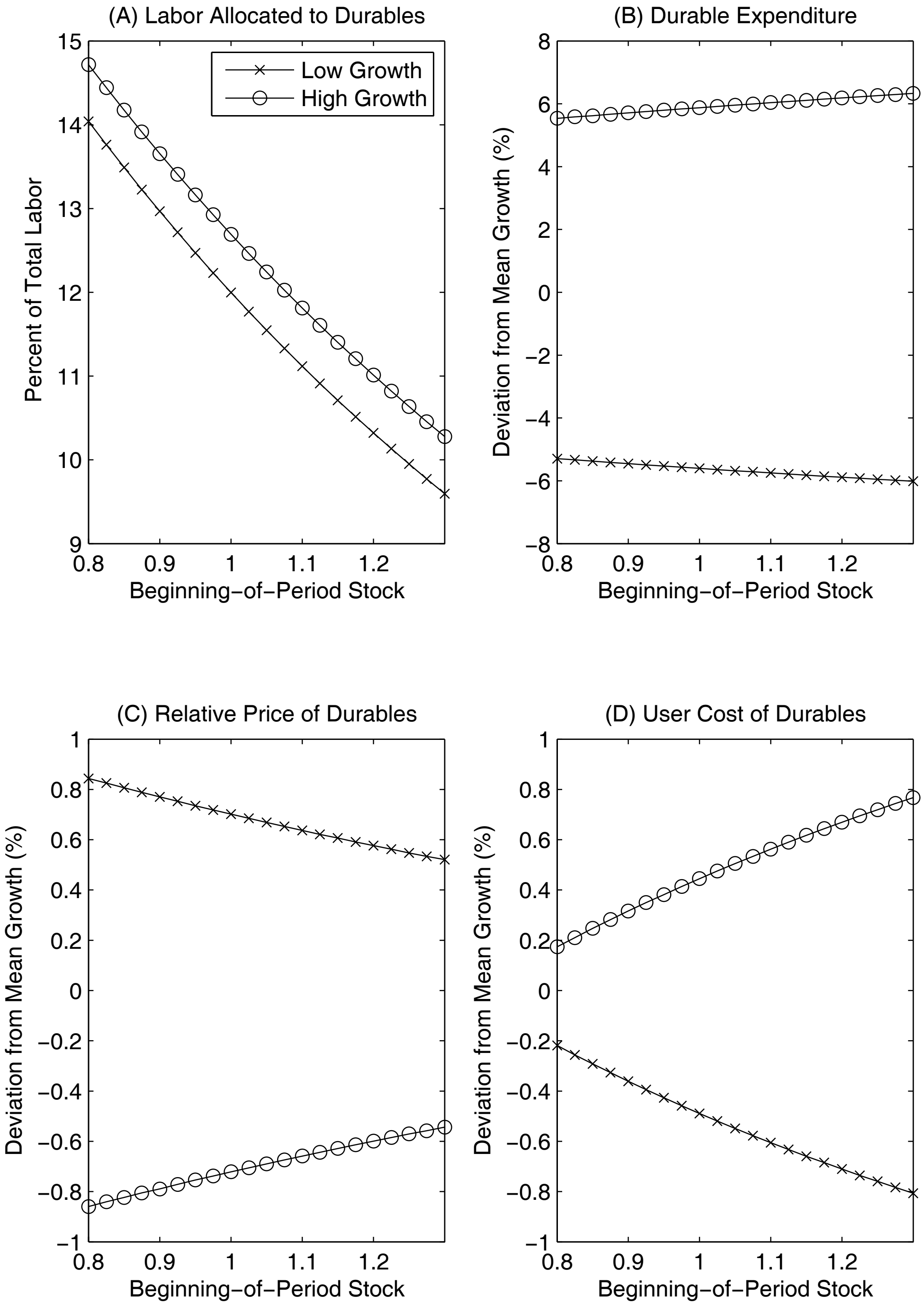

Figure 3: Optimal Production and Equilibrium Price of the Durable Good
In the notation described in the text, the figure shows (A) $1 - L_t$, (B) E_t, (C) P_t, and (D) Q_t. High (low) growth refers to the state when the i.i.d. component of productivity growth is one standard deviation above (below) the mean (i.e., $\epsilon_t = \pm\sigma_\epsilon$ and $z_t = 0$). All quantities, except for labor, are reported as percent deviation from the corresponding value in steady state (i.e., $\epsilon_t = 0$ and $z_t = 0$). The horizontal axis is the normalized stock of durables at the beginning of period (i.e., $D_{t-1}/X^{\lambda}_{t-1}$). Table 6 lists the parameters of the calibrated model.

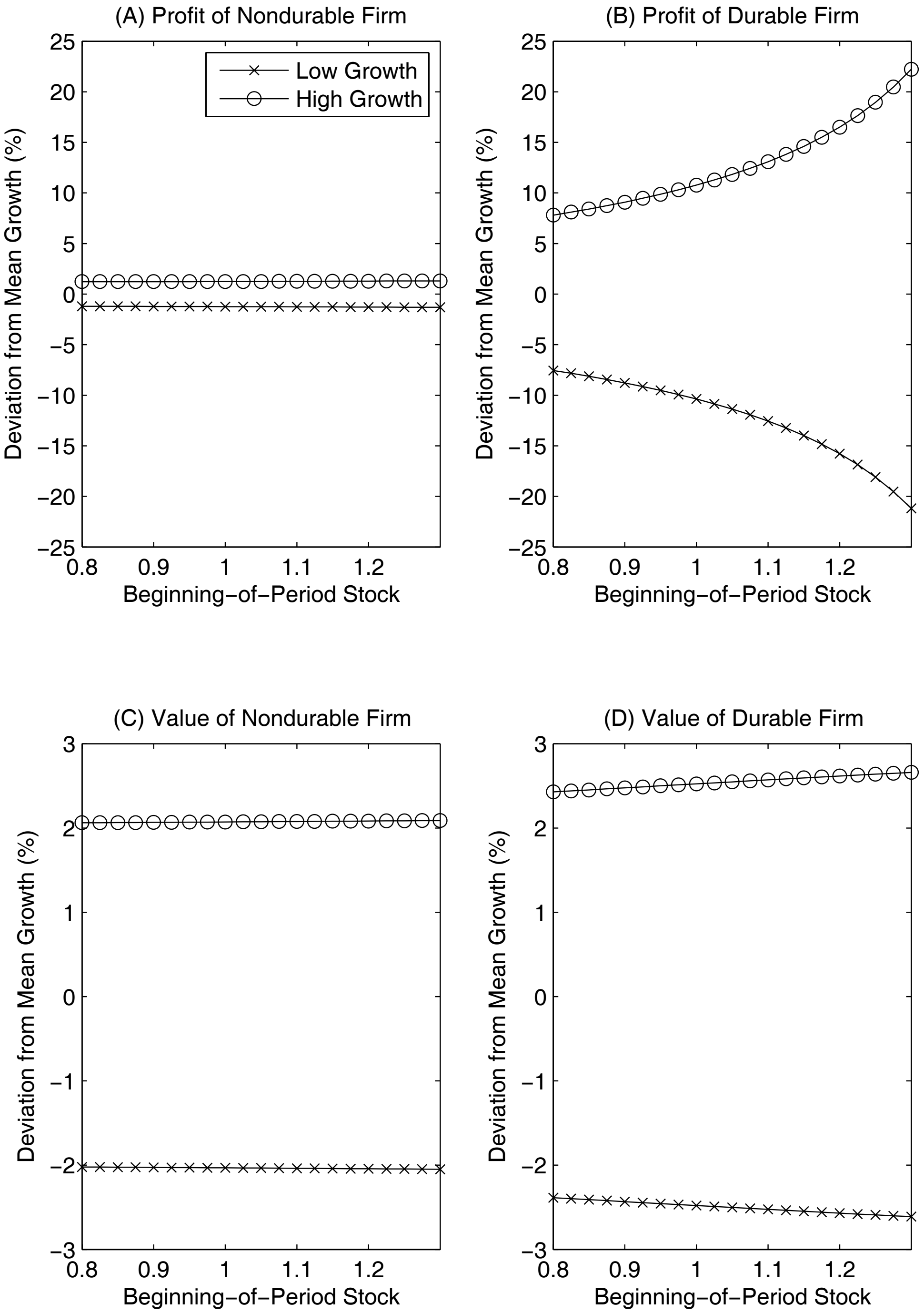

Figure 4: Profits and Equilibrium Asset Prices
In the notation described in the text, the figure shows (A) Π_{Ct}, (B) Π_{Et}, (C) V_{Ct}, and (D) V_{Et}. High (low) growth refers to the state when the i.i.d. component of productivity growth is one standard deviation above (below) the mean (i.e., $\epsilon_t = \pm\sigma_\epsilon$ and $z_t = 0$). All quantities are reported as percent deviation from the corresponding value in steady state (i.e., $\epsilon_t = 0$ and $z_t = 0$). The horizontal axis is the normalized stock of durables at the beginning of period (i.e., $D_{t-1}/X_{t-1}^{\lambda}$). Table 6 lists the parameters of the calibrated model.

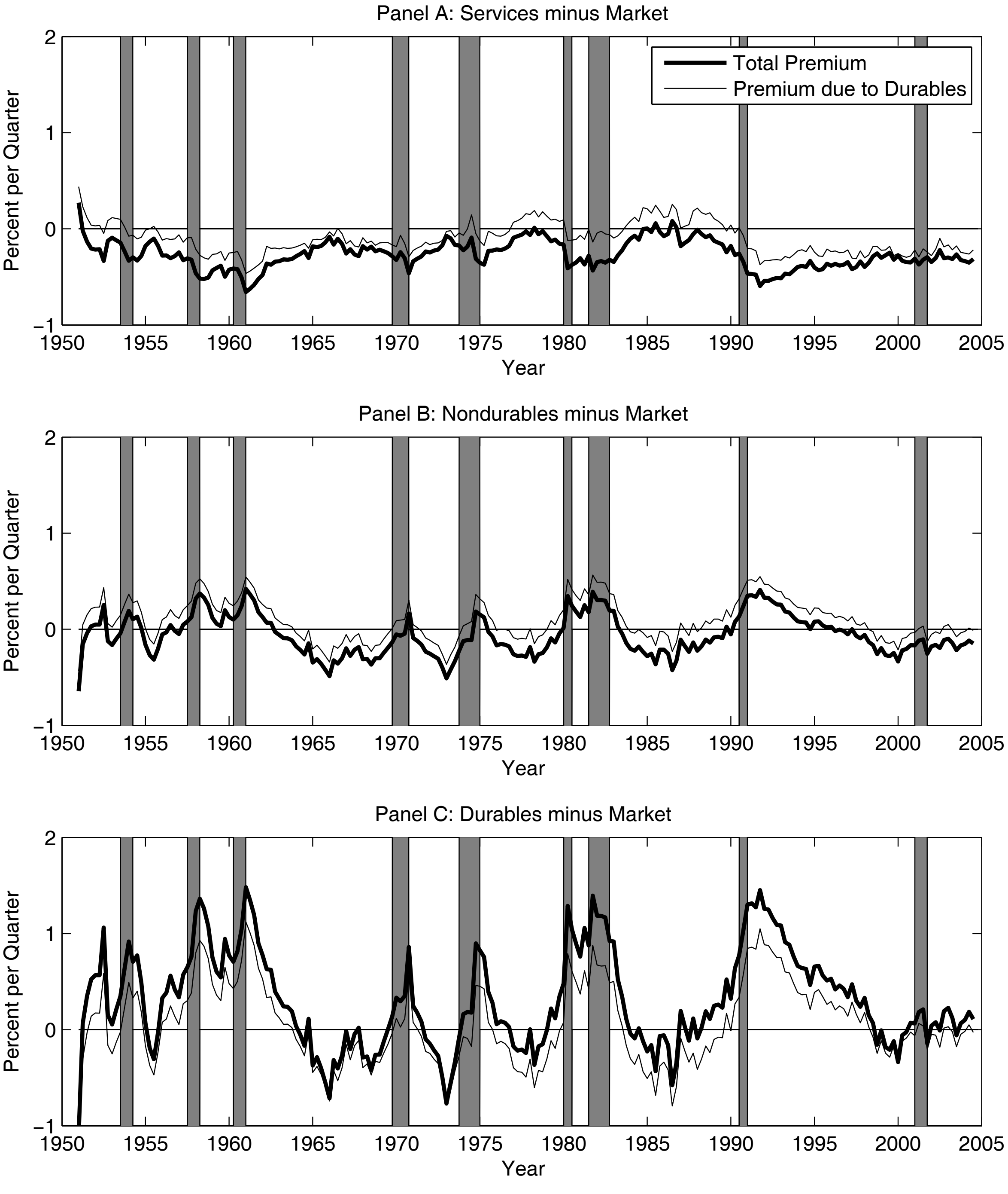

Figure 5: Time Variation in Expected Returns on the PCE Portfolios
The panels are time-series plots of expected excess returns on each of the PCE portfolios over the market return, implied by the regression model estimated in Table 11. The sample period is 1951:1–2004:3, and the shaded regions are NBER recessions.