Durability of Output and Expected Stock Returns[*]

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October 29, 2008

Abstract

The demand for durable goods is more cyclical than that for nondurable goods and services. Consequently, the cash flow and stock returns of durable-good producers are exposed to higher systematic risk. Using the benchmark input-output accounts of the National Income and Product Accounts, we construct portfolios of durable-good, nondurable-good, and service producers. In the cross-section, an investment strategy that is long on the durable portfolio and short on the service portfolio earns a risk premium exceeding four percent annually. In the time series, an investment strategy that is long on the durable portfolio and short on the market portfolio earns a countercyclical risk premium. We develop a general equilibrium asset-pricing model, based on a two-sector production economy, to explain these empirical findings.

JEL classification: D57; E21; G12

Keywords: Cash flow; Durable goods; Factor-mimicking portfolio; Input-output accounts; Stock returns

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[*] For comments and discussions, we thank James Choi, Lars Hansen, John Heaton, Monika Piazzesi (editor), Valery Polkovnichenko, Robert Stambaugh, Selale Tuzel, Stijn Van Nieuwerburgh, Lu Zhang, and three anonymous referees. We also thank seminar participants at the Federal Reserve Board, Goldman Sachs Asset Management, New York University, PanAgora Asset Management, Stanford University, University of British Columbia, University of California Berkeley, University of Chicago, University of Pennsylvania, University of Tokyo, University of Utah, University of Washington, the 2006 North American Winter Meeting of the Econometric Society, the 2006 NYU Stern Five-Star Conference on Research in Finance, the 2007 Utah Winter Finance Conference, the 2007 Annual Meeting of the Society for Economic Dynamics, the 2007 NBER Summer Institute Capital Markets and the Economy Workshop, the 2008 Annual Meeting of the American Finance Association, and the 2008 NBER Summer Institute Asset Pricing Workshop.

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I. 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).

This paper shows that durability of a firm's output is a characteristic that is related to systematic risk and is consequently 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 consumption risk command higher risk premia. Because some components of aggregate consumption are more cyclical than others, firms producing the more cyclical components must command higher risk premia. In particular, 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 characteristic related to systematic risk, rather than accounting and financial variables that have tenuous relation with risk. While durability may not be the only aspect of a firm's output that determines its exposure to systematic risk, our empirical success provides hope for identifying other proxies for systematic risk that are tied to variation in expected stock returns.

To identify the durability of each firm's output, we first develop a novel industry classification using the benchmark input-output accounts. This classification essentially identifies each Standard Industrial Classification (SIC) industry by its primary contribution to final demand. We then sort firms into portfolios representing the three broad categories of personal consumption expenditures: 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). Because the benchmark input-output accounts allow us to sort firms precisely along a dimension of economic interest, our portfolios are more appropriate for studying cash flow and stock returns than those based on more common (and somewhat

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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).

arbitrary) industry classifications.

We use the industry portfolios to document four new facts in the cross-section of cash flow and stock returns.

1. The durable portfolio, relative to the service or the nondurable portfolio, has cash flow that is more volatile and more correlated with aggregate consumption.
2. The returns on the durable portfolio are higher on average and more volatile. Over the 1927–2007 sample period, an investment strategy that is long on the durable portfolio and short on the service portfolio earned an average annual return exceeding four percent.
3. The cash flow of the durable portfolio is conditionally more volatile whenever the durable expenditure-stock ratio (i.e., the ratio of aggregate durable expenditure to its stock) is low, which generally coincides with recessions.
4. The returns on the durable portfolio are more predictable. An investment strategy that is long on the durable portfolio and short on the market portfolio has countercyclical expected returns that are reliably predicted by the durable expenditure-stock ratio.

The first finding is not surprising in light of the well known fact that the aggregate expenditure on durable goods is more cyclical than that on nondurable goods and services. Therefore, it is merely a statement of the fact that our industry classification based on the benchmark input-output accounts reliably sorts firms based on the characteristic of their output. Although the second finding may seem like a natural implication of the first, it is surprising because empirical research in asset pricing has so far failed to produce direct evidence on a relation between (cash-flow) risk and return in the cross-section of stocks. The third and fourth findings are less obvious implications of durability that we discovered only after developing a model that guided our search.

We develop a general equilibrium asset-pricing model to demonstrate that the durability of output is a source of consumption risk that is priced in both the cross-section and the time series of expected stock returns. We start with a representative household that has utility over a nondurable and a durable consumption good (Dunn and Singleton 1986, Eichenbaum and Hansen 1990, Yogo 2006, Piazzesi, Schneider and Tuzel 2007). We then endogenize both household consumption and firm cash flows through a dynamic production economy with two types of firms, a nondurable-good and a durable-good producer. We assess the model in two ways. First, we calibrate the general equilibrium model to match macro data and show that both the magnitude of the risk premium and its variation over time are appropriate for the amount of measured systematic risk. Second, we estimate the household's Euler equations, which hold regardless of specific assumptions about the nature of production. We find that the household's intertemporal marginal rate of substitution prices our industry portfolios in the sense that the J-test fails to reject the model.

The basic mechanism of our model is fairly intuitive. A proportional change in the service flow (i.e., the stock) of durable goods requires a much larger proportional change in the expenditure on durable goods. This magnification effect is analogous to that present in the relation between capital stock and investment. As a result, the demand for durable goods is more cyclical and volatile than that for nondurable goods and services, which implies that the cash flow and stock returns of durable-good producers have higher risk. Because the model generates an empirically realistic magnitude of cyclical variation in durable expenditure and cash flow, it also matches the relatively high stock returns for durable-good producers. Moreover, the model shows that the magnification effect must be relatively large when the existing stock of durable goods is high relative to current demand. As a result, the difference in conditional risk between the cash flows of durable-good and nondurable-good producers is relatively high when the existing stock of durable goods is high relative to current demand. This mechanism leads to a testable implication that the durable expenditure-stock ratio predicts cross-sectional differences in the conditional moments of cash flow and stock returns, which is the basis for the third and fourth findings above.

Our work is part of a recent effort to link expected stock returns to fundamental aspects of firm heterogeneity. One branch of the literature shows that the 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. Key ingredients in these models include heterogeneity in fixed costs of operation, the degree of irreversibility in capital, and the volatility of cash flow. 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 proceeds as follows. Section II explains our industry classification based on the benchmark input-output accounts and documents the construction of our industry portfolios. We then lay out the empirical foundations of the paper by documenting

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

key empirical properties of portfolios sorted by the durability of output. In section III, we set up a general equilibrium asset-pricing model, based on a two-sector production economy, that incorporates the notion of firm heterogeneity based on the durability of output. In section IV, we calibrate the general equilibrium model to match macro data and examine its quantitative implications for asset prices. In section V, we estimate Euler equations using cross-sectional and time-series moments of consumption and industry portfolio returns to test for an empirical relation between risk and return. Section VI concludes.

II. Portfolios Sorted by the Durability of Output

Most empirical studies in asset pricing are based on portfolios constructed along fairly arbitrary dimensions. On the one hand, portfolios sorted by characteristics directly related to stock prices or returns generate large variation in average returns, but little meaningful variation in risk (Lewellen, Nagel and Shanken 2006). On the other hand, industry portfolios based on somewhat subjective industry classifications generate little variation in average returns, but puzzling variation in risk (Fama and French 1997).

In this paper, we propose an alternative set of portfolios that is related to macroeconomic risk, carefully building a connection between consumption expenditures and firm cash flows. As a result, we believe that our new portfolios provide a much more appropriate benchmark for evaluating the performance of existing asset pricing models. The notion of synthesizing assets that mimic macroeconomic risk is hardly new (e.g., 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 et al. (1989) and Lamont (2001)). Our approach does not require estimation, and more importantly, the cash flows are economically (rather than just statistically) linked to consumption risk.

A. Industry Classification Based on the Benchmark Input-Output Accounts

The National Income and Product Accounts (NIPA) divides personal consumption expenditures 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; 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 by the four-digit SIC code, to the various components of personal consumption expenditures. Because such a link is not readily available, we create our own using the 1987 benchmark input-output accounts (Bureau of Economic Analysis 1994).[3] The benchmark input-output accounts identify how much output each industry contributes to the four broad categories of final demand: personal consumption expenditures, gross private investment, government expenditures, and net exports of goods and services. Within personal consumption expenditures, the benchmark 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 which it has the highest value added: personal consumption expenditures on durable goods, personal consumption expenditures on nondurable goods, personal consumption expenditures on services, investment, government expenditures, and net exports.

NIPA classifies expenditure on owner-occupied housing as part of private residential fixed investment, rather than personal consumption expenditures. In the publicly available files, the benchmark input-output accounts do not have a breakdown of private fixed investment into residential and nonresidential. Therefore, we are forced to classify industries whose primary output is owner-occupied housing as part of investment, rather than personal consumption expenditures on durable goods. SIC 7000 (hotels and other lodging places) is the only industry that has direct output to housing services in the benchmark input-output accounts. We therefore keep housing services as part of personal consumption expenditures on services.

Appendix A contains further details on the construction of the industry classification. The industry classification is available in spreadsheet format at Motohiro Yogo’s webpage.

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[3] We use the 1987 benchmark input-output accounts because the industry identifiers in the CRSP database are based on the 1987 SIC codes. However, we have examined the benchmark input-output accounts from other available years (1958, 1963, 1967, 1977, 1992, and 1997) to verify that the industry classification is stable over time.

B. Construction of the Industry Portfolios

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. In June of each year t, we sort the universe of stocks into five industry portfolios based on their SIC code: services, nondurable goods, durable goods, investment, and other industries. Other industries include the wholesale, retail, and financial sectors as well as industries whose primary output is to government expenditures or net exports. We use the SIC code from Compustat if available (starting in 1983), and the SIC code from CRSP otherwise. We first search for a match at the four-, then at the three-, and finally at the two-digit SIC. Once the portfolios are formed, we track their value-weighted returns from July of year t through June of year $t + 1$. We compute annual portfolio returns by compounding monthly returns.

We compute dividends for each stock based on the difference of holding period returns with and without dividends. Since 1971, we augment dividends with equity repurchases from Compustat's statement of cash flows (Boudoukh, Michaely, Richardson and Roberts 2007). We assume that the repurchases occur at the end of each fiscal year. Monthly dividends for each portfolio are simply the sum of dividends across all stocks in the portfolio. We compute annual dividends in December of each year by accumulating monthly dividends, assuming that intermediate (January through November) dividends are reinvested in the portfolio until the end of the calendar year. We compute dividend growth and the dividend yield for each portfolio based on a "buy and hold" investment strategy starting in 1927.

Since 1951, we compute other characteristics for each portfolio using the subset of firms for which the relevant data are available from Compustat. Book-to-market equity is book equity at the end of fiscal year t divided by the market equity in December of year t. We construct book equity data as a merge of Compustat and historical data from Moody's Manuals, downloaded from Kenneth French's webpage. We follow the procedure described in Davis, Fama and French (2000) for the computation of book equity. Market leverage is liabilities at the end of fiscal year t divided by the sum of liabilities and market equity in December of year t. Operating income is sales minus the cost of goods sold. We compute the annual growth rate of sales and operating income in each year t based on the subset of firms that are in the portfolio in years $t - 1$ and t.

C. Characteristics of the Industry Portfolios

Table 1 reports some basic characteristics of the five industry portfolios. We focus our attention on the first three portfolios, which represent personal consumption expenditures.

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. In the 1927–2007 sample period, services represent 15 percent, nondurable goods represent 35 percent, and durable goods represent 16 percent of total market equity. On average, the service portfolio has the highest, and the nondurable portfolio has the lowest dividend yield. The service portfolio has the highest, and the durable portfolio has the lowest book-to-market equity.

In the 1951–2007 sample period, 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 market leverage. These patterns show that durability of output is not a characteristic that is directly related to common accounting and financial variables like book-to-market equity and market leverage.

D. 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 plot the annual growth rate of sales for four portfolios representing firms that produce services, nondurable goods, durable goods, and investment goods. The dashed line in all four panels, shown for the purposes of comparison, is the growth rate of real durable expenditure from NIPA. As panel C demonstrates, the correlation between the sales of durable firms and durable expenditure is almost perfect. This evidence suggests that our industry classification based on the benchmark input-output accounts 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 industry portfolios. In addition, the table reports the correlation between sales growth and the growth rate of real service consumption, real nondurable consumption, and real durable expenditure. (See Appendix B for a detailed description of the consumption data.) Durable firms have sales that are more volatile than those of service or nondurable firms with a standard deviation of 8 percent. The sales of durable firms have correlation of 0.74 with durable expenditure, confirming the visual impression in figure 1. The sales of both service and nondurable firms 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 the aggregation of sales across firms. Conceptually, aggregate consumption in NIPA is the sum of value added across all 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 of 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 the output of Compustat firms and aggregate consumption.

Panel B reports descriptive statistics for the annual growth rate of operating income for the industry portfolios. The standard deviation of operating-income growth for service and nondurable firms is 6 percent, compared to 13 percent for durable firms. These differences mirror the large differences in the volatility of real aggregate quantities. In the 1951–2007 sample period, the standard deviation of nondurable and service consumption growth is 1 percent, compared to 8 percent for durable expenditure growth (see table 9). In comparison to sales, the operating income of service and nondurable firms has much higher correlation with nondurable and service consumption. The correlation between the operating income of service firms and service consumption is 0.20, and the correlation between the operating income of nondurable firms and nondurable consumption is 0.29. The correlation between the operating income of durable firms and durable expenditure is 0.75.

The fundamental economic mechanism in this paper is that durable-good producers have demand that is more cyclical than that of nondurable-good producers. Tables 2 and 3 provide 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-good manufacturers are three times more cyclical than nondurable-good 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).

Table 3 shows that our findings for sales and operating income extend to dividends. The dividends of durable firms are more volatile and more correlated with aggregate consumption. In the next section, we examine whether these differences in the empirical properties of cash flows lead to differences in their stock returns.

E. Stock Returns

Table 4 reports descriptive statistics for excess stock returns, over the three-month T-bill, on the five industry portfolios. In the 1927–2007 sample period, both the average and the standard deviation of returns rise in the durability of output. Excess stock returns on the service portfolio has mean of 6.11 percent and a standard deviation of 18.46 percent. Excess stock returns on the nondurable portfolio has mean of 8.81 percent and a standard deviation of 18.51 percent. Excess stock returns on the durable portfolio has mean of 10.30 percent and a standard deviation of 28.38 percent. The difference in average stock returns between the durable and service portfolios, reported in the last column, is 4.19 percent with a standard error of 2.08 percent.

In ten-year sub-samples, the durable portfolio generally has higher average stock returns than both the service and the nondurable portfolio. Interestingly, the largest spread in average stock returns occurred in the 1927–1936 period, during the Great Depression. The spread between the durable portfolio and the nondurable portfolio is almost 11 percent, and the spread between the durable portfolio and the service portfolio is almost 14 percent. In the next section, we provide more formal evidence for time-varying expected stock returns that is related to the business cycle.

F. Predictability of Stock Returns

Panel A of table 5 examines evidence for the predictability of excess stock returns on the industry 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 figure 2, the durable expenditure-stock ratio is strongly procyclical, peaking during expansions as dated by the National Bureau of Economic Research. We report results for both the full sample, 1927–2007, and the postwar sample, 1951–2007. 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 stock returns on the service portfolio with a coefficient of -2.71, the nondurable portfolio with a coefficient of -0.46, and the durable portfolio with a coefficient of -3.78. The negative coefficient across the portfolios implies that the durable expenditure-stock ratio predicts the common countercyclical component of expected stock 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 durable portfolio has the largest coefficient, implying that it has the largest amount of countercyclical variation in expected returns. More formally, the last column of table 5 shows that excess stock returns on the durable portfolio over the market portfolio is predictable with a statistically significant coefficient of -1.98.

In order to further assess the evidence for return predictability, table 5 also examines a bivariate regression that includes each portfolio's own dividend yield. The dividend yield predicts excess stock returns with a positive coefficient as expected, and adds predictive power over the durable expenditure-stock ratio in terms of the R^2. However, the coefficient for the durable expenditure-stock ratio is hardly changed from the univariate regression.

In a model of risk and return, the returns on the industry portfolios should be predictable only if their conditional risk is also predictable. Rather than a structural estimation of risk and return, which is the topic of section V, table 6 reports a simple regression of absolute excess stock returns onto the lagged predictor variables. In an univariate regression, the durable expenditure-stock ratio predicts absolute excess stock returns on the service portfolio with a coefficient of 0.25, the nondurable portfolio with a coefficient of 0.63, and the durable portfolio with a coefficient of -1.22. 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 on the service or the nondurable portfolio.

G. Predictability of Cash-Flow Volatility

Differences in the conditional risk of the industry portfolios are difficult to isolate solely based on stock returns. This difficulty could arise from the fact that stock returns are driven by both news about aggregate discount rates and news about industry-specific cash flow. In table 7, we therefore examine evidence for the predictability of cash-flow volatility. We use the same predictor variables as those used for predicting stock returns in table 5.

As reported in panel A, the durable expenditure-stock ratio predicts absolute sales growth for the service portfolio with a coefficient of 0.57, the nondurable portfolio with a coefficient of 0.90, and the durable portfolio with a coefficient of -0.98. This empirical pattern suggests that the volatility of cash-flow growth for the durable portfolio is more countercyclical than that for the service or the nondurable portfolio. The evidence is robust to including the portfolio's own dividend yield as an additional regressor. Panel B shows that the evidence is also robust 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 a coefficient of 1.89, the nondurable portfolio with a coefficient of -3.17, and the durable portfolio with a coefficient of -5.46. 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.

III. General Equilibrium Asset-Pricing Model

In the last section, we established two key facts about the cash flow and returns of durable-good producers in comparison to those of nondurable-good and service producers. First, the cash flow of durable-good producers is more volatile and more correlated with aggregate consumption. This unconditional cash-flow risk can be a mechanism that explains why durable-good producers have higher average stock 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 can be a mechanism that explains why durable-good producers have expected stock returns that are more time varying than those of nondurable-good producers.

In this section, we develop a general equilibrium asset-pricing model as a framework to organize our empirical findings. We start with the representative-household model of Dunn and Singleton (1986), Eichenbaum and Hansen (1990), Yogo (2006), and Piazzesi et al. (2007). We then endogenize the production of nondurable and durable consumption goods. Our analysis highlights the role of durability as an economic mechanism that generates differences in firm output and cash-flow risk, abstracting from other sources of heterogeneity. The model delivers most of our key empirical findings in a simple and parsimonious setting. It also provides the necessary theoretical structure to guide our formal econometric tests in section V.

A. 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 constant elasticity of substitution function

$$u(C, D) = [(1 - \alpha)C^{1-1/\rho} + \alpha D^{1-1/\rho}]^{1/(1-1/\rho)}. \tag{2}$$

The parameter $\alpha \in (0, 1)$ is the utility weight on the durable good, and $\rho \geq 0$ is the elasticity of substitution between the two consumption 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 and Zin (1991) and Weil (1990) 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, $\gamma > 0$ is its relative risk aversion, and $\kappa = (1 - \gamma)/(1 - 1/\sigma)$.

B. Firms and Production

The economy consists of two productive sectors, one that produces nondurable goods (including services) and another that produces durable goods.[4] Each sector consists of a representative firm that takes input and output prices as given. Each firm produces output using a common variable factor of production and a sector-specific fixed factor of production.

Aggregate Productivity

Aggregate productivity evolves as a geometric random walk with time-varying drift. Specifically, we assume that aggregate productivity in period t is given by

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

where $e_t \sim \mathbf{N}(0, \sigma_e^2)$ and $v_t \sim \mathbf{N}(0, \sigma_v^2)$ are independently and identically distributed shocks. The variable z_t captures the persistent (or business-cycle) component of aggregate produc-

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[4] For simplicity, we do not model a third sector that produces investment goods. We refer to Papanikolaou (2006) for a theoretical analysis of investment firms.

tivity, which evolves as a first-order autoregression.

Firm Producing Nondurable Goods

In each period t, the nondurable firm rents L_{Ct} units of a variable input at the rental rate W_t and K_{Ct} units of a fixed input at the rental rate W_{Ct}. This latter input is fixed in the sense that the input is only productive in the nondurable sector and is productive with a one period lag. The nondurable firm has the production function

$$C_t = [(X_t L_{Ct})^{\theta_C} K_{C,t-1}^{1-\theta_C}]^{\eta}, \tag{6}$$

where $\theta_C \in (0,1)$ is the elasticity of output with respect to the variable input and $\eta \in (0,1]$ determines the returns of scale.

Define the cash flow of the nondurable firm in period t as

$$\Pi_{Ct} = C_t - W_t L_{Ct} - W_{Ct} K_{Ct}. \tag{7}$$

The value of the firm is the present discounted value of its future cash flow,

$$V_{Ct} = \mathbf{E}_t \left[\sum_{s=1}^{\infty} \prod_{r=1}^{s} M_{t+r} \Pi_{C,t+s} \right], \tag{8}$$

where M_t is the stochastic discount factor in period t. The gross return on a claim to the cash flow of the nondurable firm is

$$R_{C,t+1} = \frac{V_{C,t+1} + \Pi_{C,t+1}}{V_{Ct}}. \tag{9}$$

In each period t, the nondurable firm chooses the quantity of its inputs L_{Ct} and K_{Ct} to maximize its value, $\Pi_{Ct} + V_{Ct}$.

Firm Producing Durable Goods

A key economic property of durable goods is that they can be inventoried, unlike nondurable goods and services. The durable firm's inventory of finished goods evolves according to the law of motion

$$D_{It} = (1-\delta) D_{I,t-1} + E_{It}, \tag{10}$$

where E_{It} is the net investment in inventory.

In each period t, the durable firm rents L_{Et} units of a variable input at the rental rate W_t and K_{Et} units of a fixed input at the rental rate W_{Et}. This latter input is fixed in the sense that the input is only productive in the durable sector and is productive with a one period lag. Let E_{Pt} denote production and E_t denote sales by the durable firm in period t. The durable firm has the production function

$$E_{Pt} = [(X_t^{\lambda} L_{Et})^{\theta_E} K_{E,t-1}^{1-\theta_E-\theta_I} D_{I,t-1}^{\theta_I}]^{\eta}, \tag{11}$$

where $\theta_E \in (0,1)$ is the elasticity of output with respect to the variable input and $\lambda > 0$ determines the relative productivity of the durable sector.

The firm holds inventory because it is a factor of production, following a modeling convention in macroeconomics (Kydland and Prescott 1982). Because the inventory is that of finished goods, our motivation is similar to that of Bils and Kahn (2000), in which inventories of finished goods are necessary to generate sales (e.g., cars in the showroom). We assume that changes in inventory incur an adjustment cost, which introduces a realistic friction between the household sector and the durable firm. In each period, the production of the durable good must equal the sum of sales, changes in inventory, and adjustment costs:

$$E_{Pt} = E_t + E_{It} + \frac{\tau(D_{It} - D_{I,t-1})^2}{2D_{I,t-1}}, \tag{12}$$

where $\tau \geq 0$ determines the degree of adjustment costs.

Define the cash flow of the durable firm in period t as

$$\Pi_{Et} = P_t E_t - W_t L_{Et} - W_{Et} K_{Et}. \tag{13}$$

The value of the firm is the present discounted value of its future cash flow,

$$V_{Et} = \mathbf{E}_t \left[\sum_{s=1}^{\infty} \prod_{r=1}^{s} M_{t+r} \Pi_{E,t+s} \right]. \tag{14}$$

The gross return on a claim to the cash flow of the durable firm is

$$R_{E,t+1} = \frac{V_{E,t+1} + \Pi_{E,t+1}}{V_{Et}}. \tag{15}$$

In each period t, the durable firm chooses the quantity of its inputs L_{Et} and K_{Et} to maximize its value, $\Pi_{Et} + V_{Et}$.

C. Competitive Equilibrium

Household's First-Order Conditions

The sum of equations (7) and (13) imply the household's aggregate budget constraint,

$$C_t + P_t E_t = W_t(L_{Ct} + L_{Et}) + W_{Ct}K_{Ct} + W_{Et}K_{Et} + \Pi_{Ct} + \Pi_{Et}. \tag{16}$$

In words, consumption expenditures must equal the sum of rental and capital income. Let V_{Mt} be the present discounted value of future consumption expenditures,

$$V_{Mt} = \mathbf{E}_t\left[\sum_{s=1}^{\infty}\prod_{r=1}^{s} M_{t+r}(C_{t+s} + P_{t+s}E_{t+s})\right]. \tag{17}$$

The gross return on a claim to the household's consumption expenditures (equivalently, rental and capital income) is

$$R_{M,t+1} = \frac{V_{M,t+1} + C_{t+1} + P_{t+1}E_{t+1}}{V_{Mt}}. \tag{18}$$

The household's wealth consists of the stock of durable goods and the present discounted value of future rental and capital income. Define the gross return on aggregate wealth as

$$R_{W,t+1} = \left(1 - \frac{Q_t D_t}{V_{Mt} + P_t D_t}\right)^{-1}\left(R_{M,t+1} + \frac{P_t D_t}{V_{Mt} + P_t D_t}\left(\frac{(1-\delta)P_{t+1}}{P_t} - R_{M,t+1}\right)\right). \tag{19}$$

In words, the return on wealth is a weighted average of returns on durable goods and the claim to the household's consumption expenditures. If the durable good were to fully depreciate each period (i.e., $\delta = 1$), aggregate wealth would simply be the present value of future consumption expenditures (i.e., $R_{Wt} = R_{Mt}$).

Define the user cost of the service flow from the durable good as

$$Q_t = P_t - (1-\delta)\mathbf{E}_t[M_{t+1}P_{t+1}]. \tag{20}$$

In words, the user cost is equal to the purchase price today minus the present discounted value of the depreciated stock tomorrow. As shown in Yogo (2006, Appendix B), the household's first-order conditions imply that

$$Q_t = \frac{\alpha}{1-\alpha}\left(\frac{D_t}{C_t}\right)^{-1/\rho}. \tag{21}$$

Intuitively, the user cost for the durable good must equal the marginal rate of substitution between the durable and the nondurable good.

Define the household's intertemporal marginal rate of substitution as

$$M_{t+1} = \left[\beta \left(\frac{C_{t+1}}{C_t} \right)^{-1/\sigma} \left(\frac{v(D_{t+1}/C_{t+1})}{v(D_t/C_t)} \right)^{1/\rho - 1/\sigma} R_{W,t+1}^{1-1/\kappa} \right]^{\kappa} . \tag{22}$$

where

$$v\left(\frac{D}{C}\right) = \left[1 - \alpha + \alpha \left(\frac{D}{C} \right)^{1-1/\rho} \right]^{1/(1-1/\rho)} . \tag{23}$$

As is well known, the absence of arbitrage implies that gross asset returns satisfy

$$\mathbf{E}_t[M_{t+1} R_{i,t+1}] = 1, \tag{24}$$

for all assets $i = C, E, M$.

Firms' First-Order Conditions

The firms' first-order conditions imply that the competitive rental rate of the variable input must equal its marginal product,

$$W_t = \frac{\eta \theta_C C_t}{L_{Ct}} = \frac{\eta \theta_E P_t E_{Pt}}{L_{Et}}. \tag{25}$$

Similarly, the rental rate of the fixed input in each sector must equal their respective marginal products,

$$W_{Ct} = \frac{\eta(1-\theta_C)\mathbf{E}_t[M_{t+1} C_{t+1}]}{K_{Ct}}, \tag{26}$$

$$W_{Et} = \frac{\eta(1-\theta_E-\theta_I)\mathbf{E}_t[M_{t+1} P_{t+1} E_{P,t+1}]}{K_{Et}}. \tag{27}$$

Finally, the optimal level of inventory held by the durable firm is determined by the first-order condition

$$\begin{aligned} Q_t = {} & \frac{\eta \theta_I \mathbf{E}_t[M_{t+1} P_{t+1} E_{P,t+1}]}{D_{It}} - \tau P_t \left(\frac{D_{It}}{D_{I,t-1}} - 1 \right) \\ & + \frac{\tau}{2} \mathbf{E}_t \left[M_{t+1} P_{t+1} \left(\left(\frac{D_{I,t+1}}{D_{It}} \right)^2 - 1 \right) \right]. \end{aligned} \tag{28}$$

In words, the user cost of the durable good must equal the marginal product of inventory.

Market Clearing

In each period, the household inelastically supplies the variable input and the sector-specific fixed inputs, which we normalize to one unit each. Market clearing in the input markets requires that

$$1 = L_{Ct} + L_{Et}, \tag{29}$$

$$1 = K_{Ct} = K_{Et}. \tag{30}$$

The goods markets also clear. In each period, the sales of the nondurable firm is equal to the household's nondurable consumption. The sales of the durable firm is equal to the household's durable expenditure.

IV. Asset-Pricing Implications of the Production Economy

A. Calibration of the Model

Table 8 reports the parameters that we use for our calibration. We set the depreciation rate to 5.2 percent, which is the average annual depreciation rate for consumer durable goods and private residential fixed assets.

We must restrict household preferences in order to obtain stationary dynamics, that is, prices and quantities that are stationary with respect to the appropriate power of aggregate productivity. We assume that the household's utility flow in each period is given by the Cobb-Douglas function

$$u(C, D) = C^{1-\alpha} D^{\alpha}, \tag{31}$$

which corresponds to the special case of utility function (2) when $\rho = 1$.[5]

Our choices for the production parameters are dictated by standard choices in macroeconomics. We set the degree of returns to scale to $\eta = 0.9$ (Burnside, Eichenbaum and Rebelo 1995, Basu and Fernald 1997). For the purposes of calibration, we view the variable input as inputs such as labor and the flexible part of capital. We view the fixed input as inputs such as land and the inflexible part of capital. We set the elasticity of output with re-

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[5] We have also restricted preferences to be homothetic by using the Epstein-Zin recursive function, which is also necessary for stationary dynamics. Homothetic preferences suffice for our analysis because the volatility of nondurable and service consumption is similar to that of the stock of durable goods at our level of aggregation. Bils and Klenow (1998) and Pakoš (2004) analyze a model with nonhomothetic preferences, for more disaggregated categories of consumption.

spect to the fixed input to $1-\theta_C = 1-\theta_E-\theta_I = 0.2$ for both the nondurable and the durable firm. For the durable firm, we then choose θ_I to match the mean of the inventory-sales ratio.

Table 9 reports the empirical moments for the macro variables, dividend growth, and stock returns. We report the empirical moments for two sample periods, 1930–2007 and 1951–2007. Although data on asset returns are available since 1927, the start date of 1930 is dictated by the availability of NIPA data. Both nondurable and service consumption and durable expenditure are somewhat more volatile in the longer sample, but otherwise, the empirical moments are quite similar across the two samples. We calibrate our model to the longer sample because the higher volatility of the macro variables in this sample makes the task of explaining asset prices somewhat easier.

We solve the model by numerical dynamic programming as detailed in Appendix C. We simulate the model at annual frequency for 500,000 years to compute the population moments reported in table 9. We compare the cash flow and stock returns of the nondurable firm in the model to those of the service (rather than the nondurable) portfolio in the data, in order to provide a higher hurdle for the model.

B. Implications for Aggregate Consumption

Panel A of table 9 list the macro variables that we target in our calibration:

- $\log(C_t/C_{t-1})$, the log growth rate of real nondurable and service consumption;
- $\log(E_t/E_{t-1})$, the log growth rate of real durable expenditure;
- P_tE_t/C_t, the ratio of durable expenditure to nondurable and service consumption;
- E_t/D_t, the ratio of durable expenditure to its stock;
- D_{It}/E_t, the ratio of inventory to sales for durable goods.

By matching the first two moments and the autocorrelation for these variables, we ensure realistic implications for aggregate consumption and the relative price of durable goods.

Our parameter choices for aggregate productivity are dictated by the mean, the standard deviation, and the autocorrelation of nondurable and service consumption growth. We first set $\mu = 2.58$ percent to match the mean growth rate of nondurable and service consumption, 1.86 percent. Following Bansal and Yaron (2004), we model productivity growth as having a persistent component with an autoregressive parameter $\phi = 0.78$. We then choose the standard deviation of the shocks, σ_e and σ_v, so that $\log(X_t/X_{t-1})$ has the moments

$$\begin{aligned}\text{Standard deviation} &= \left(\sigma_e^2 + \frac{\sigma_v^2}{1-\phi^2}\right)^{1/2} = 0.03,\\ \text{Autocorrelation} &= \frac{\phi}{1+\sigma_e^2(1-\phi^2)/\sigma_v^2} = 0.4.\end{aligned}$$

These choices lead to a standard deviation of 3.20 percent and autocorrelation of 0.23 for nondurable consumption growth in the model.

The relative price of durable goods has steadily fallen, and the real expenditure on durable goods relative to that on nondurable goods and services has steadily risen during our sample period. These facts suggest that the productivity of the durable sector has grown faster than that of the nondurable and service sectors, which we parameterize as $\lambda = 1.35$. This choice leads to a mean growth rate of 2.38 percent for durable expenditure in the model, which matches the data. The standard deviation of durable expenditure growth is 14 percent in the model, which comes close to its empirical target of 17 percent.

The intratemporal first-order condition (21) requires that $\alpha = 0.25$ to match the ratio of durable expenditure to nondurable and service consumption. The ratio of durable expenditure to its stock is simply pinned down by the depreciation rate for durable goods. Finally, the ratio of inventory to sales for durable goods is pinned down by θ_I, the inventory elasticity of output, and τ, the degree of adjustment costs for inventory. We set $\theta_I = 0.13$ to match the mean of the inventory-sales ratio at 67 percent and $\tau = 5$ to match the standard deviation of the inventory-sales ratio at 14 percent.

C. Implications for Cash Flows

Panel B of table 9 reports the mean and the standard deviation of dividend growth in the data and cash-flow growth in the model. One of the key facts established in section II is that durable firms have cash flow that is more volatile and cyclical than that of service and nondurable firms. The model must match this fact in order to have successful implications for the firms' stock returns.

In the model, the standard deviation of cash-flow growth for the nondurable firm is 4 percent, which is higher than 3 percent for the standard deviation of nondurable consumption growth. This is a consequence of the sector-specific fixed input, which generates operating leverage and makes cash flow more volatile than sales. The standard deviation of cash-flow growth for the durable firm is 32 percent, which is significantly higher than 14 percent for the standard deviation of durable expenditure growth. The cash flow of the durable firm is very volatile because the existence of inventory allows the firm to disconnect production from sales. Intuitively, the household has preferences for smooth consumption, which the durable firm can support with very cyclical production smoothed by changes in inventory.

D. Implications for Asset Returns

In the model, we compute the one-period riskfree interest rate as

$$R_{ft} = \frac{1}{\mathbf{E}_{t-1}[M_t]}. \tag{32}$$

In order to compare firm returns in the model to stock returns in the data, we must first introduce financial leverage. Equity is a levered claim on the firm's cash flow. 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 levered strategy is

$$\widetilde{R}_{it} = \frac{1}{1-b}R_{it} - \frac{b}{1-b}R_{ft}. \tag{33}$$

In the model, we compute stock returns through this formula using an empirically realistic value for market leverage. We compute the market leverage 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 market leverage varies over time, it is on average 52 percent in the postwar sample. We therefore set $b = 52$ percent in the calibration.

As is well known, it is difficult to generate a high equity premium and high volatility of stock returns in a general equilibrium model, especially in models with production. We borrow from the insights of Bansal and Yaron (2004) and combine persistence in productivity growth with an elasticity of intertemporal substitution greater than one so that asset prices rise in response to a positive productivity shock. Specifically, we choose a fairly high elasticity of intertemporal substitution of $\sigma = 2$, which magnifies the volatility of stock returns while keeping the volatility of the riskfree rate low. To generate a nontrivial equity premium, we choose a fairly high risk aversion of $\gamma = 10$.

Panel C of table 9 reports the first two moments of stock returns implied by the model. The nondurable firm has excess stock returns, over the riskfree rate, with a mean of 5.92 percent and a standard deviation of 9.39 percent. The durable firm has excess stock returns with a mean of 10.64 percent and a standard deviation of 16.90 percent. The spread in average stock returns between the two firms is greater than 4 percent, which is consistent with the empirical evidence. 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 1.23 percent on average with low volatility, which is consistent with the empirical evidence.

E. Predictability of Stock Returns

If we rearrange the accumulation equation (1) and compute the conditional standard deviation of both sides,

$$\frac{D_{t-1}}{E_{t-1}} = \frac{\sigma_{t-1}(E_t/E_{t-1})}{\sigma_{t-1}(D_t/D_{t-1})}. \tag{34}$$

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

The model therefore identifies two channels for generating predictability of stock returns. First, the intertemporal marginal rate of substitution (22) is more volatile when the stock of durable goods is relatively high because it depends on the stock of durable goods as a ratio of nondurable consumption. This common channel is responsible for the predictability of the market portfolio. Second, the conditional volatility of the cash flow of the durable firm is increasing in the existing stock of durable goods. The durable firm must therefore earn a higher expected return when the stock of durable goods is relatively high, as compensation for the higher conditional cash-flow risk. This independent channel is responsible for making the stock returns of the durable firm more predictable than that of the nondurable firm.

To examine these implications of the model, we simulate 10,000 samples, each consisting of 50 annual observations. In each sample, we run a regression of excess stock returns, over the riskfree rate, onto the lagged durable expenditure-stock ratio. Panel A of table 10 reports the mean and the standard deviation of both the regression coefficient and its *t*-statistic across the simulated samples. We find that the regression coefficient is negative for both firms, explained by the common channel of predictability. More importantly, the magnitude of the coefficient for the durable firm is greater than that for the nondurable firm, explained by the independent channel of predictability. Although there is considerable sampling error, as evidenced by the standard deviation of the coefficient across the simulated samples, the model produces results that are consistent with the empirical evidence in table 5.

In panel B, we regress absolute excess stock returns onto the lagged durable expenditure-stock ratio in each of the simulated samples. The regression coefficients for both firms are negative, implying that the conditional volatility of stock returns is decreasing in the lagged durable expenditure-stock ratio. More importantly, the magnitude of the coefficient is greater for the durable firm. These patterns are consistent with the empirical evidence in table 6.

In panel C, we regress absolute cash-flow growth onto the lagged durable expenditure-stock ratio in each of the simulated samples. The regression coefficient for the durable firm is negative, implying that the conditional volatility of cash flow for the durable firm is decreasing in the lagged durable expenditure-stock ratio. In contrast, the conditional volatility of the cash flow for the nondurable firm is increasing in the lagged durable expenditure-stock ratio. These patterns are consistent with the empirical evidence for sales and operating income in table 7.

V. Estimation of the Euler Equations

Section II provided evidence that the durability of output is a source of consumption risk that is priced in both the cross-section and the time series of expected stock returns. This section formalizes that analysis by estimating a model of risk and return using our five industry portfolios. Specifically, we estimate the preference parameters and test the model through the Euler equations (21) and (24). As is well known, the Euler equations must hold even in an economy in which the nature of production is different from the particular model described in section III. Therefore, this procedure provides a fairly general assessment of the model.

Although the estimation exercise here is similar to that reported in Yogo (2006), there are three key differences. First, we incorporate housing in our measure of the stock of durable goods, so that our intertemporal marginal rate of substitution is closer in spirit to that used in Lustig and Van Nieuwerburgh (2005) and Piazzesi et al. (2007). Second, our measure of the return on wealth incorporates the value of consumer durable goods and housing, which were ignored in Yogo (2006). Finally, our main test assets are the five industry portfolios, while Yogo estimated the model on the Fama-French (1992) portfolios and beta-sorted portfolios. Because our industry portfolios generate differences in consumption risk by construction, they provide an arguably tougher test for the consumption-based model.

A. Estimation Methodology

Let R_{ft} denote the three-month T-bill rate, R_{it} $(i = 1, \ldots, 5)$ denote gross returns on the five industry portfolios, and z_t denote an $I \times 1$ vector of instrumental variables known in period t. Using the methodology developed by Hansen and Singleton (1982), we estimate and test the model through the following moment restrictions:

$$
\begin{aligned}
0 &= \mathbf{E}[(M_{t+1}R_{f,t+1} - 1)z_{t-1}], && (35) \\
0 &= \mathbf{E}[M_{t+1}(R_{i,t+1} - R_{f,t+1})z_{t-1}], && (36) \\
0 &= \mathbf{E}\left[\left(1 - \frac{(1-\delta)M_{t+1}P_{t+1}}{P_t} - \frac{\alpha}{(1-\alpha)P_t}\left(\frac{D_t}{C_t}\right)^{-1/\rho}\right)z_{t-1}\right]. && (37)
\end{aligned}
$$

Equation (35) represents I moment restrictions implied by the Euler equation for the three-month T-bill. Equation (36) represents $5I$ moment restrictions implied by the Euler equations for the industry portfolios. Equation (37) represents I moment restrictions implied by the intratemporal first-order condition.

We use quarterly data for the 1951:1–2007:4 sample period because estimates of covariation between consumption and returns are more accurate with higher frequency data. The start date of 1951 is dictated by the apparent non-stationarity in durable expenditure during and immediately after the war. In moment restriction (37), we fix $\delta = 0.088$ to match the quarterly depreciation rate for durable goods. Using equation (19), we construct an empirical proxy for the return on wealth as a weighted average of returns on durable goods and the CRSP value-weighted portfolio of all NYSE, AMEX, and Nasdaq stocks. As detailed in Appendix B, our measure of the stock of durable goods includes private residential fixed assets. In our sample, the average portfolio weight on durable goods is 68 percent of wealth.

We estimate the model by two-step generalized method of moments (GMM). We use the identity weighting matrix in the first stage, and the vector autoregressive heteroskedasticity- and autocorrelation-consistent (VARHAC) covariance matrix estimator in the second stage (Den Haan and Levin 1997).[6] The instruments are second lags of nondurable consumption growth, durable expenditure-stock ratio, return on the wealth portfolio, dividend yield, and a constant. The instruments are lagged twice to account for time aggregation in consumption data (Hall 1988, Heaton 1993). There are a total of 35 moment restrictions to estimate five parameters (β, σ, γ, ρ, and α). Consequently, there are 30 overidentifying restrictions of the model, which we test through the J-test (Hansen 1982).

B. Estimates of the Preference Parameters

Table 11 reports estimates of the preference parameters. The estimate of the subjective discount factor is $\beta = 0.93$ with a standard error of 0.04. The estimate of the elasticity

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[6] Den Haan and Levin (2000) find that the VARHAC covariance matrix estimator performs better than kernel-based estimators (e.g., Newey and West (1987) and Andrews (1991)) in various Monte Carlo experiments.

of intertemporal substitution is $\sigma = 0.03$ with a standard error of 0.01. The estimate of relative risk aversion is $\gamma = 222$ with a standard error of 23. The estimate of the elasticity of substitution between nondurable and durable goods is $\rho = 0.86$ with a standard error of 0.06. Interestingly, our parameter estimates are consistent with those reported in Yogo (2006) for a different set of test portfolios and instruments.

The Wald test for the hypothesis of additive separability, $\sigma = \rho$, rejects strongly. Similarly, the Wald test for the hypothesis of time separability, $\sigma = 1/\gamma$, rejects strongly. These rejections imply that neither the Epstein-Zin (1991) model nor the nonseparable expected utility model can explain the cross-section or the time series of expected returns on the industry portfolios. In contrast, the J-test fails to reject our model at conventional significance levels.

Although our model successfully explains returns on the industry portfolios, the risk aversion necessary to do so is high because of the equity premium puzzle (Mehra and Prescott 1985). The preference parameters for the elasticity of intertemporal substitution and relative risk aversion estimated here are different from those that are necessary for explaining asset prices in the production economy (see table 8). A potential explanation for this discrepancy is measurement problems with consumption. The contemporaneous correlation between consumption and stock returns can understate the true (long-run) degree of correlation, which tends to bias upward estimates of relative risk aversion (Parker 2001, Parker and Julliard 2005). Because our calibration of the production economy in section IV did not emphasize the contemporaneous correlation between consumption and stock returns, that exercise is potentially more robust to measurement problems with consumption than the estimation of Euler equations.

VI. Conclusion

The literature on the cross-section of stock returns has documented a number of empirical relations between characteristics, which are often directly related to stock prices or returns, 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).

Ultimately, stock prices should not be viewed as characteristics by which to rationalize differences in expected returns. Instead, stock 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 of output is an important determinant of demand that is priced in the cross-section of stock returns. Firms that produce durable goods have higher average stock 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 stock returns.

Appendix A. Construction of the Industry Classification

The construction of the industry classification requires the following tables from the benchmark input-output accounts.

- SIC-IO table: Industry classification of the 1987 benchmark input-output accounts.
- IO table 2: The use of commodities by industries.
- IO table D: Input-output commodity composition of personal consumption expenditures in producers' and purchasers' prices.

The construction of the industry classification proceeds through the following steps.

Link from SIC Code to I-O Code

SIC-IO table is the key table that links each I-O code to related, and potentially multiple, 1987 SIC codes. The link occurs at various levels of detail from two- to four-digit SIC. We exclude the wholesale and retail (SIC 5000–5999) and the financial (SIC 6000–6999) industries. For wholesale and retail, a detailed breakdown of value added by personal consumption expenditure category is not available in the public data. Similarly, the benchmark input-output accounts are not designed to give a precise breakdown of valued added for the financial sector.

Link from I-O Commodity to Final Demand

IO table 2 identifies the I-O commodity composition of each final good measured at producers' prices. The categories of final demand are consumption (I-O code 910000), investment (I-O code 920000–930000), government expenditures (I-O code 960000–993009), and net exports (I-O code 940000–950000). Each I-O commodity potentially contributes to multiple categories of final demand. However, we create a unique link by assigning each I-O commodity to the category of final demand to which it has the highest value added.

We merge the link from SIC code to I-O code with this link from I-O commodity (each identified by an I-O code) to final demand. The merge produces a multiple-to-multiple link between SIC code and final demand. We then aggregate value added over all pairs of SIC and final demand at the two-, three-, and four-digit SIC code. The aggregation produces a one-to-one link between SIC code and final demand.

Link from I-O Commodity to Personal Consumption Expenditures

IO table D identifies the I-O commodity composition of each personal consumption expenditure good measured at producers' prices. The Bureau of Economic Analysis defines personal consumption expenditures through the following categories of durability: durable goods, nondurable goods, services. Each I-O commodity potentially contributes to multiple categories of personal consumption expenditures. However, we create a unique link by assigning each I-O commodity to the category of personal consumption expenditures to which it has the highest value added.

We merge the link from SIC code to I-O code with this link from I-O commodity to personal consumption expenditures. The merge produces a multiple-to-multiple link between SIC code and personal consumption expenditures. We then aggregate value added over all pairs of SIC and personal consumption expenditures at the two-, three-, and four-digit SIC code. The aggregation produces a one-to-one link between SIC code and personal consumption expenditures.

Industry Classification by Final Demand

We first use the link between SIC and final demand to classify each SIC industry into mutually exclusive categories: consumption, investment, government expenditures, and net exports. Within the set of industries that are classified as consumption, we then use the link between SIC and personal consumption expenditures to classify each industry into mutually exclusive categories: durable goods, nondurable goods, and services.

Appendix B. Consumption Data

We work with two samples of consumption data: a longer annual sample for the 1930–2007 period and a shorter quarterly sample for the 1951:1–2007:4 period. We construct our data using the following tables from the Bureau of Economic Analysis.

- NIPA table 1.1.3: Real gross domestic product, quantity indexes.
- NIPA table 1.1.4: Price indexes for gross domestic product.
- NIPA table 1.1.5: Gross domestic product.
- NIPA table 2.3.3: Real personal consumption expenditures by major type of product, quantity indexes.

- 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 5.7.5A: Private inventories and domestic final sales of business by industry.
- NIPA table 5.7.5B: Private inventories and domestic final sales by industry.
- NIPA table 7.1: Selected per capita product and income series in current and chained dollars.
- Fixed assets table 1.1: Current-cost net stock of fixed assets and consumer durable goods.
- Fixed assets table 8.1: Current-cost net stock of consumer durable goods.

Nondurable and service consumption is the properly chain-weighted sum of real personal consumption expenditures on nondurable goods and real personal consumption expenditures on services. Durable expenditure is the properly chain-weighted sum of real personal consumption expenditures on durable goods and real private residential fixed investment. The stock of durable goods is the sum of the net stock of consumer durable goods and the net stock of private residential fixed assets.

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 using quarterly data on real durable expenditure. We do so by computing a constant depreciation rate within each year so that the data satisfy the accumulation equation (1). The average depreciation rate for durable goods, implied by the construction, is about 8.8 percent per quarter.

In constructing the durable expenditure-stock ratio, we isolate consumer durable goods and exclude private residential fixed assets. In other words, the durable expenditure-stock ratio is the ratio of personal consumption expenditures on durable goods to the stock of consumer durable goods. This construction results in a durable expenditure-stock ratio that is stationary in our sample period, and hence, a more reliable variable for predicting stock returns.

We use the price index for nondurable goods and services to deflate all nominal asset returns and cash-flow growth. Note that our deflating methodology is consistent with our modeling convention that the nondurable good is the numeraire in the economy. In computing growth rates, we first 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). That is, the asset return in quarter t is matched to the growth rate in consumption flow from quarter t to $t+1$.

Appendix C. Solution of the General Equilibrium Model

Central Planner's Problem

We first restate the general equilibrium model as a central planner's problem. The central planner chooses optimal nondurable consumption, durable expenditure, and net inventory investment in order to maximize the household's objection function. The Bellman equation for the problem is

$$\begin{aligned} J_t &= J(D_{t-1}, D_{I,t-1}, X_t) \\ &= \max_{C_t, E_t, E_{It}} \{(1-\beta)u(C_t, D_t)^{1-1/\sigma} + \beta \mathbf{E}_t[J_{t+1}^{1-\gamma}]^{1/\kappa}\}^{1/(1-1/\sigma)}. \end{aligned} \tag{C1}$$

The law of motion for the state variables are given by equations (1), (4), and (10).

As shown in Yogo (2006, Appendix B), the value of a claim to the household's consumption expenditures is related to the value function through the equation

$$V_{Mt} = \frac{C_t^{1/\sigma} J_t^{1-1/\sigma}}{(1-\beta)(1-\alpha)(D_t/C_t)^{\alpha(1-1/\sigma)}} - C_t - P_t D_t. \tag{C2}$$

Rescaling the General Equilibrium Model

We rescale all policy and state variables by the appropriate power of aggregate productivity in order to make the model stationary. Let $\Delta X_{t+1} = X_{t+1}/X_t$ denote the growth rate of aggregate productivity. Let

$$\begin{aligned} \chi_C &= \eta \theta_C, \\ \chi_E &= \frac{\lambda \eta \theta_E}{1-\eta\theta_I}, \\ \chi_J &= (1-\alpha)\chi_C + \alpha \chi_E. \end{aligned}$$

By homotheticity, we can rescale the value function as

$$\begin{aligned} \widehat{J}_t &= \frac{J_t}{X_t^{\chi_J}} = \widehat{J}(\widehat{D}_{t-1}, \widehat{D}_{I,t-1}, \Delta X_t) \\ &= \max_{\widehat{C}_t, \widehat{E}_t, \widehat{E}_{It}} \{(1-\beta)u(\widehat{C}_t, \widehat{D}_t)^{1-1/\sigma} + \beta \mathbf{E}_t[(\Delta X_{t+1}^{\chi_J} \widehat{J}_{t+1})^{1-\gamma}]^{1/\kappa}\}^{1/(1-1/\sigma)}. \end{aligned} \tag{C3}$$

The law of motion for the state variables are given by

$$\widehat{D}_t = (1-\delta)\frac{\widehat{D}_{t-1}}{\Delta X_t^{\chi_E}} + \widehat{E}_t, \tag{C4}$$

$$\widehat{D}_{It} = (1-\delta)\frac{\widehat{D}_{I,t-1}}{\Delta X_t^{\chi_E}} + \widehat{E}_{It}, \tag{C5}$$

$$\Delta X_t = \exp\{\mu + z_t + e_t\}. \tag{C6}$$

The relative price of durable goods is given by

$$\widehat{P}_t = \frac{P_t}{X_t^{\chi_C-\chi_E}} = \frac{\theta_C \widehat{C}_t^{1-1/\chi_C}}{\theta_E \widehat{E}_{Pt}^{1-1/(\eta\theta_E)}(\widehat{D}_{I,t-1}/\Delta X_t^{\chi_E})^{\theta_I/\theta_E}}, \tag{C7}$$

where

$$\widehat{E}_{Pt} = \widehat{E}_t + \widehat{E}_{It} + \frac{\tau \Delta X_t^{\chi_E}(\widehat{D}_{It} - \widehat{D}_{I,t-1}/\Delta X_t^{\chi_E})^2}{2\widehat{D}_{I,t-1}}. \tag{C8}$$

The user cost of durable goods is given by

$$\widehat{Q}_t = \frac{Q_t}{X_t^{\chi_C-\chi_E}} = \widehat{P}_t - (1-\delta)\mathbf{E}_t[M_{t+1}\Delta X_{t+1}^{\chi_C-\chi_E}\widehat{P}_{t+1}], \tag{C9}$$

where equation (C2) allows us to express the intertemporal marginal rate of substitution as

$$\begin{aligned} M_{t+1} = {} & \beta \left(\frac{\Delta X_{t+1}^{\chi_C}\widehat{C}_{t+1}}{\widehat{C}_t}\right)^{-1/\sigma} \left(\frac{\Delta X_{t+1}^{(\chi_E-\chi_C)\alpha}(\widehat{D}_{t+1}/\widehat{C}_{t+1})^{\alpha}}{(\widehat{D}_t/\widehat{C}_t)^{\alpha}}\right)^{1-1/\sigma} \\ & \times \left(\frac{(\Delta X_{t+1}^{\chi_J}\widehat{J}_{t+1})^{1-1/\sigma}}{\mathbf{E}_t[(\Delta X_{t+1}^{\chi_J}\widehat{J}_{t+1})^{1-\gamma}]^{1/\kappa}}\right)^{\kappa-1}. \end{aligned} \tag{C10}$$

The rental prices for the factors of production are given by

$$\widehat{W}_t = \frac{W_t}{X_t^{\chi_C}} = \eta(\theta_C\widehat{C}_t + \theta_E\widehat{P}_t\widehat{E}_{Pt}), \tag{C11}$$

$$\widehat{W}_{Ct} = \frac{W_{Ct}}{X_t^{\chi_C}} = \eta(1-\theta_C)\mathbf{E}_t[M_{t+1}\Delta X_{t+1}^{\chi_C}\widehat{C}_{t+1}], \tag{C12}$$

$$\widehat{W}_{Et} = \frac{W_{Et}}{X_t^{\chi_C}} = \eta(1-\theta_E-\theta_I)\mathbf{E}_t[M_{t+1}\Delta X_{t+1}^{\chi_C}\widehat{P}_{t+1}\widehat{E}_{P,t+1}]. \tag{C13}$$

The first-order conditions for nondurable consumption, durable expenditure, and net inventory investment are given by

$$\widehat{W}_t = \chi_C \widehat{C}_t^{1-1/\chi_C}, \tag{C14}$$

$$\widehat{Q}_t = \frac{\alpha}{1-\alpha}\left(\frac{\widehat{D}_t}{\widehat{C}_t}\right)^{-1}, \tag{C15}$$

$$\begin{aligned}\widehat{Q}_t = {} & \frac{\eta\theta_I \mathbf{E}_t[M_{t+1}\Delta X_{t+1}^{\chi_C}\widehat{P}_{t+1}\widehat{E}_{P,t+1}]}{\widehat{D}_{It}} - \tau\widehat{P}_t\left(\frac{\Delta X_t^{\chi_E}\widehat{D}_{It}}{\widehat{D}_{I,t-1}} - 1\right) \\ & + \frac{\tau}{2}\mathbf{E}_t\left[M_{t+1}\Delta X_{t+1}^{\chi_C-\chi_E}\widehat{P}_{t+1}\left(\left(\frac{\Delta X_{t+1}^{\chi_E}\widehat{D}_{I,t+1}}{\widehat{D}_{It}}\right)^2 - 1\right)\right].\end{aligned} \tag{C16}$$

Numerical Algorithm

We discretize the state space and numerically solve the central planner's problem. Starting with an initial guess for the policy functions $(\widehat{C}_0, \widehat{E}_0, \widehat{E}_{I0})$, we solve the dynamic program through the following recursion.

1. Iterate on equation (C3) to compute the value function $\widehat{J}_i$ corresponding to the current policy functions $(\widehat{C}_i, \widehat{E}_i, \widehat{E}_{Ii})$.
2. Using the value function $\widehat{J}_i$, update the policy functions $(\widehat{C}_{i+1}, \widehat{E}_{i+1}, \widehat{E}_{I,i+1})$ as a solution to the system of equations (C14), (C15), and (C16).
3. If $\|\widehat{C}_{i+1} - \widehat{C}_i\| + \|\widehat{E}_{i+1} - \widehat{E}_i\| + \|\widehat{E}_{I,i+1} - \widehat{E}_{Ii}\|$ is less than the convergence criteria, stop. Otherwise, return to step 1.

We use the solution to the central planner's problem to compute the intertemporal marginal rate of substitution (C10) and firm cash flows,

$$\widehat{\Pi}_{Ct} = \frac{\Pi_{Ct}}{X_t^{\chi_C}} = (1-\eta\theta_C)\widehat{C}_t - \widehat{W}_{Ct}, \tag{C17}$$

$$\widehat{\Pi}_{Et} = \frac{\Pi_{Et}}{X_t^{\chi_C}} = \widehat{P}_t\widehat{E}_t - \eta\theta_E\widehat{P}_t\widehat{E}_{Pt} - \widehat{W}_{Et}. \tag{C18}$$

We then compute firm value by iterating on the Euler equations

$$\begin{aligned}\widehat{V}_{Ct} &= \frac{V_{Ct}}{X_t^{\chi_C}} = \widehat{V}_C(\widehat{D}_{t-1}, \widehat{D}_{I,t-1}, \Delta X_t) \\ &= \mathbf{E}_t[M_{t+1}\Delta X_{t+1}^{\chi_C}(\widehat{V}_{C,t+1} + \widehat{\Pi}_{C,t+1})],\end{aligned} \tag{C19}$$

$$\begin{aligned}\widehat{V}_{Et} &= \frac{V_{Et}}{X_t^{\chi_C}} = \widehat{V}_E(\widehat{D}_{t-1}, \widehat{D}_{I,t-1}, \Delta X_t) \\ &= \mathbf{E}_t[M_{t+1}\Delta X_{t+1}^{\chi_C}(\widehat{V}_{E,t+1} + \widehat{\Pi}_{E,t+1})].\end{aligned} \tag{C20}$$

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Table 1: Characteristics of the Industry Portfolios

Variable	Services	Nondurables	Durables	Investment	Other
	A. 1927–2007 Sample Period				
Number of firms	410	426	190	633	1273
Percent of market equity	14.6	35.2	15.5	17.7	17.0
Dividend yield (%)	5.4	4.6	5.1	4.0	4.1
Book-to-market equity (%)	112.1	66.4	62.7	76.8	62.8
	B. 1951–2007 Sample Period				
Number of firms	534	524	233	826	1734
Percent of market equity	10.1	39.1	15.3	18.2	17.3
Dividend yield (%)	5.3	4.4	4.8	3.5	3.7
Book-to-market equity (%)	87.3	53.4	62.4	56.4	60.6
Market leverage (%)	51.6	30.2	47.5	34.2	63.7

Note.—We define industries based on their primary contribution to final demand according to the benchmark input-output accounts. We sort the universe of NYSE, AMEX, and Nasdaq stocks into five industry portfolios based on their SIC codes. We compute portfolio characteristics in December of each year and report the time-series average over the indicated sample period.

Table 2: Sales and Operating Income for the Industry Portfolios

Statistic	Services	Nondurables	Durables
		A. Sales	
Mean (%)	5.43	4.41	2.78
Standard deviation (%)	5.54	5.90	8.07
Correlation with growth rate of			
Service consumption	0.22	0.10	0.51
Nondurable consumption	0.14	0.04	0.62
Durable expenditure	0.02	-0.16	0.74
		B. Operating Income	
Mean (%)	5.50	4.59	2.55
Standard deviation (%)	5.61	5.88	12.74
Correlation with growth rate of			
Service consumption	0.20	0.33	0.42
Nondurable consumption	0.26	0.29	0.57
Durable expenditure	0.27	0.17	0.75

Note.—Sales and the cost of goods sold are from Compustat and are deflated by the price index for nondurable goods and services. Operating income is sales minus the cost of goods sold. The table reports descriptive statistics for the log annual growth rate of sales and operating income for the industry portfolios. Correlation is with the log growth rate of real service consumption, real nondurable consumption, and real durable expenditure. The sample period is 1951–2007.

Table 3: Dividends for the Industry Portfolios

Statistic	Services	Nondurables	Durables
	A. 1930–2007 Sample Period		
Mean (%)	0.08	3.55	2.13
Standard deviation (%)	13.63	13.22	25.67
Correlation with growth rate of			
Service consumption	-0.12	-0.03	0.13
Nondurable consumption	-0.07	-0.01	0.21
Durable expenditure	-0.21	0.04	0.24
Correlation with 2-year growth rate of			
Service consumption	0.08	0.07	0.24
Nondurable consumption	0.15	0.08	0.33
Durable expenditure	0.02	0.15	0.31
	B. 1951–2007 Sample Period		
Mean (%)	1.00	3.97	1.51
Standard deviation (%)	12.54	12.66	22.45
Correlation with growth rate of			
Service consumption	-0.06	0.01	0.17
Nondurable consumption	0.07	0.09	0.23
Durable expenditure	-0.12	-0.03	0.25
Correlation with 2-year growth rate of			
Service consumption	0.13	0.05	0.28
Nondurable consumption	0.23	0.21	0.36
Durable expenditure	0.09	0.15	0.39

Note.—Dividends are deflated by the price index for nondurable goods and services. The table reports descriptive statistics for the log annual growth rate of dividends for the industry portfolios. Correlation is with the log growth rate of real service consumption, real nondurable consumption, and real durable expenditure. The two-year growth rate refers to the growth rate over the contemporaneous and subsequent year.

Table 4: Excess Stock Returns on the Industry Portfolios

Sample Period	Services	Nondurables	Durables	Investment	Other	Durables−Services
	A. Average Excess Stock Returns (%)					
1927–2007	6.11	8.81	10.30	8.75	8.43	4.19
	(2.05)	(2.06)	(3.15)	(3.14)	(2.49)	(2.08)
1927–1936	5.48	8.37	19.36	16.57	11.78	13.88
1937–1946	7.53	7.95	7.87	6.89	8.69	0.34
1947–1956	9.75	16.74	20.92	20.10	14.91	11.17
1957–1966	8.94	6.90	7.65	8.71	5.83	-1.29
1967–1976	0.14	3.21	3.84	3.00	3.00	3.70
1977–1986	6.13	8.44	4.88	0.47	6.92	-1.25
1987–1996	7.37	11.98	10.36	5.56	10.93	2.99
1997–2007	3.77	7.04	7.76	8.70	5.67	3.99
	B. Standard Deviation of Excess Stock Returns (%)					
1927–2007	18.46	18.51	28.38	28.30	22.43	18.69
1927–1936	28.58	30.97	54.38	52.90	38.38	38.92
1937–1946	23.13	18.90	30.05	24.44	23.86	14.12
1947–1956	10.95	15.13	20.49	22.70	16.45	11.98
1957–1966	16.95	15.84	24.08	26.29	19.09	17.49
1967–1976	20.41	19.29	32.26	26.73	26.05	14.80
1977–1986	8.81	17.21	18.75	16.89	15.00	14.75
1985–1996	17.10	15.57	16.05	12.54	19.01	12.89
1997–2007	19.18	13.89	17.24	30.32	19.26	9.30

Note.—We define industries based on their primary contribution to final demand according to the benchmark input-output accounts. We sort the universe of NYSE, AMEX, and Nasdaq stocks into five industry portfolios based on their SIC codes. The table reports the mean and the standard deviation of annual excess stock returns over the three-month T-bill. Standard errors are reported in parentheses.

Table 5: Predictability of Excess Stock Returns

Lagged Predictor	Services		Nondurables		Durables		Durables−Market	
	A. 1927–2007 Sample Period							
Durable expenditure-stock ratio	-1.02*	-0.69	-0.75	-0.46	-1.78*	-1.93*	-0.69	-0.74
	(0.58)	(0.58)	(0.62)	(0.49)	(1.06)	(1.03)	(0.55)	(0.54)
Dividend yield		3.25**		5.43**		3.91**		1.61*
		(1.17)		(1.28)		(1.66)		(0.90)
R^2 (%)	4.74	11.76	2.56	16.81	6.12	11.73	4.49	9.19
	B. 1951–2007 Sample Period							
Durable expenditure-stock ratio	-2.71*	-2.25*	-0.46	-0.11	-3.78*	-4.12*	-1.98**	-2.10**
	(1.12)	(1.15)	(1.32)	(1.18)	(1.70)	(1.64)	(0.77)	(0.76)
Dividend yield		1.69		4.49*		3.00*		1.08
		(1.26)		(1.15)		(1.56)		0.84
R^2 (%)	9.45	12.34	0.27	13.96	9.73	14.81	11.91	14.87

Note.—The table reports predictive regressions for annual excess stock returns on the industry portfolios, over the three-month T-bill. The lagged predictor variables are the durable expenditure-stock ratio and each portfolio's own dividend yield. Heteroskedasticity-consistent standard errors are reported in parentheses.

* Significant at the 10 percent level.

** Significant at the 5 percent level.

Table 6: Predictability of Absolute Excess Stock Returns

Lagged Predictor	Services		Nondurables		Durables		Durables−Market	
	A. 1927–2007 Sample Period							
Durable expenditure-stock ratio	-0.78**	-0.80**	-0.60	-0.48	-1.82**	-1.92**	-0.73*	-0.78*
	(0.39)	(0.41)	(0.52)	(0.45)	(0.86)	(0.82)	(0.45)	(0.44)
Dividend yield		-0.31		2.18**		2.81**		1.25*
		(0.83)		(1.12)		(1.22)		(0.70)
R^2 (%)	6.75	6.77	3.70	8.95	14.60	21.46	9.81	15.31
	B. 1951–2007 Sample Period							
Durable expenditure-stock ratio	0.25	0.24	0.63	0.75	-1.22	-1.32	-0.97	-1.02
	(0.63)	(0.65)	(0.67)	(0.65)	(0.95)	(0.99)	(0.59)	(0.63)
Dividend yield		-0.03		1.55**		0.89		0.49
		(0.86)		(0.78)		(1.12)		(0.57)
R^2 (%)	0.18	0.18	1.18	5.08	2.64	3.80	6.48	7.90

Note.—The table reports predictive regressions for the absolute value of annual excess stock returns on the industry portfolios, over the three-month T-bill. The lagged predictor variables are the durable expenditure-stock ratio and each portfolio's own dividend yield. Heteroskedasticity-consistent standard errors are reported in parentheses.

* Significant at the 10 percent level.

** Significant at the 5 percent level.

Table 7: Predictability of the Volatility of Cash-Flow Growth

Lagged Predictor	Services		Nondurables		Durables	
	A. Absolute Sales Growth					
Durable expenditure-stock ratio	0.57*	0.27	0.90**	0.89**	-0.98**	-1.03**
	(0.30)	(0.24)	(0.32)	(0.31)	(0.32)	(0.34)
Dividend yield		-1.09**		-0.20		0.41
		(0.38)		(0.44)		(0.39)
R^2 (%)	5.65	21.71	15.35	15.75	12.28	14.11
	B. Absolute Operating-Income Growth					
Durable expenditure-stock ratio	-0.03	-0.13	0.64**	0.62**	-0.86	-0.97
	(0.39)	(0.43)	(0.26)	(0.26)	(0.60)	(0.61)
Dividend yield		-0.39		-0.25		0.94
		(0.35)		(0.37)		(0.78)
R^2 (%)	0.01	1.82	8.28	8.97	3.77	7.51
	C. Absolute 5-Year Dividend Growth					
Durable expenditure-stock ratio	1.89	0.79	-3.17**	-3.11**	-5.46**	-5.28**
	(1.24)	(1.09)	(1.15)	(1.12)	(1.71)	(1.69)
Dividend yield		-4.34**		0.77		-1.35
		(1.66)		(1.22)		(2.72)
R^2 (%)	3.10	15.70	12.47	12.86	15.03	15.78

Note.—The table reports predictive regressions for the absolute value of log annual sales growth, log annual operating-income growth, and log five-year dividend growth for the industry portfolios. The lagged predictor variables are the durable expenditure-stock ratio and each portfolio's own dividend yield. Heteroskedasticity-consistent standard errors are reported in parentheses. The sample period is 1951–2007.

* Significant at the 10 percent level.

** Significant at the 5 percent level.

Table 8: Parameters Used in the Calibrated Model

Parameter	Symbol	Value
Depreciation rate of durable good	δ	5.20%
Preferences:		
Discount factor	β	0.98
Elasticity of intertemporal subsitution	σ	2
Relative risk aversion	γ	10
Elasticity of subsitution across goods	ρ	1
Utility weight on durable good	α	0.25
Technology:		
Growth rate	μ	2.58%
Standard deviation of i.i.d. component	σ_e	2.91%
Standard deviation of shock to persistent component	σ_v	1.87%
Autocorrelation of persistent component	ϕ	0.78
Relative productivity of durable firm	λ	1.35
Production:		
Returns to scale	η	0.90
Variable-input elasticity for nondurable firm	θ_C	0.80
Variable-input elasticity for durable firm	θ_E	0.67
Inventory elasticity for durable firm	θ_I	0.13
Adjustment cost for inventory	τ	5.00
Financial leverage	b	52%

Table 9: Comparison of Empirical Moments with Moments in the Simulated Model

Variable	Statistic	Sample Period		Model
		1930–2007	1951–2007	
	A. Consumption Growth			
Nondurable & service consumption	Mean (%)	1.86	2.04	1.86
	SD (%)	2.22	1.17	3.20
	Autocorrelation	0.39	0.26	0.23
Durable expenditure	Mean (%)	2.39	2.21	2.38
	SD (%)	16.68	8.14	13.92
	Autocorrelation	0.29	0.16	-0.21
Durable-nondurable expenditure ratio	Mean (%)	21.39	23.52	20.54
	SD (%)	5.22	2.32	6.10
	Autocorrelation	0.88	0.70	0.86
Durable expenditure-stock ratio	Mean (%)	8.59	9.36	7.42
	SD (%)	1.93	0.84	1.92
	Autocorrelation	0.88	0.70	0.90
Durable inventory-sales ratio	Mean (%)	67.90	68.58	66.53
	SD (%)	11.86	11.92	13.94
	Autocorrelation	0.85	0.86	0.76
	B. Dividend (Cash-Flow) Growth			
Market portfolio	Mean (%)	2.33	2.66	1.86
	SD (%)	13.66	12.62	9.47
Services portfolio (Nondurable firm)	Mean (%)	0.08	1.00	1.86
	SD (%)	13.63	12.54	3.67
Durables portfolio (Durable firm)	Mean (%)	2.13	1.51	1.86
	SD (%)	25.67	22.45	32.09
	C. Excess Stock Returns			
Market portfolio	Mean (%)	7.29	7.05	6.68
	SD (%)	19.97	16.86	10.58
Services portfolio (Nondurable firm)	Mean (%)	5.43	5.87	5.92
	SD (%)	18.24	15.58	9.39
Durables portfolio (Durable firm)	Mean (%)	9.46	8.50	10.64
	SD (%)	27.05	21.32	16.90
T-bill (Riskfree asset)	Mean (%)	0.93	1.62	1.23
	SD (%)	4.19	2.25	1.16

Note.—Panel A reports the mean, the standard deviation, and the autocorrelation for various macroeconomic variables in the data and the simulated model. The variables 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 nondurable and service consumption, the ratio of durable expenditure to its stock, and the ratio of inventory to sales for durable goods. Panel B reports moments for the log growth rate of real dividends (cash flow in the model). Panel C reports moments for real excess stock returns over the three-month T-bill (over the riskfree asset in the model). Table 8 reports the parameters of the calibrated model.

Table 10: Predictability of Excess Stock Returns in the Simulated Model

Statistic	Market Porfolio	Nondurable Firm	Durable Firm
	A. Excess Stock Returns		
Coefficient	-1.08	-0.97	-1.81
	(1.20)	(1.07)	(1.96)
t-statistic	-0.94	-0.95	-0.98
	(1.02)	(1.02)	(1.04)
	B. Absolute Excess Stock Returns		
Coefficient	-0.62	-0.56	-1.11
	(0.84)	(0.73)	(1.40)
t-statistic	-0.76	-0.79	-0.86
	(1.06)	(1.06)	(1.09)
	C. Absolute Cash-Flow Growth		
Coefficient	-0.90	0.24	-5.48
	(0.93)	(0.27)	(3.48)
t-statistic	-1.31	1.40	-2.34
	(1.27)	(1.50)	(1.34)

Note.—We use the calibrated model to simulate 10,000 samples, each consisting of 50 annual observations. We run a regression of excess stock returns, over the riskfree rate, onto the lagged durable expenditure-stock ratio in each sample. In panel A, we report the mean and the standard deviation (in parentheses) of the regression coefficient as well as the *t*-statistic across the simulated samples. Panel B repeats the same exercise for the absolute value of excess stock returns, and panel C repeats the same exercise for the absolute value of log cash-flow growth. Table 8 reports the parameters of the calibrated model.

Table 11: Estimation of the Preference Parameters through the Euler Equations

Parameter	Estimate
β	0.93
	(0.04)
σ	0.03
	(0.01)
γ	222.34
	(23.20)
ρ	0.86
	(0.06)
α	0.63
	(0.04)
Wald test of $\sigma = \rho$	225.95
	(0.00)
Wald test of $\sigma = 1/\gamma$	16.05
	(0.00)
J-test	10.60
	(1.00)

Note.—We use the conditional moment restrictions implied by the Euler equations to estimate the preference parameters of the model by two-step GMM. The test assets are the three-month T-bill and five industry portfolios sorted by their primary contribution to final demand according to the benchmark input-output accounts. All nominal returns are deflated by the price index for nondurable goods and services. The instruments are second lags of nondurable consumption growth, durable expenditure-stock ratio, return on the wealth portfolio, dividend yield, and a constant. Standard errors (in parentheses) are based on the VARHAC covariance matrix estimator with automatic lag length selection by the Akaike information criteria (maximum lag length of two quarters). The p-values for the Wald test for additive separability ($\sigma = \rho$), the Wald test for time separability ($\sigma = 1/\gamma$), and the J-test (test of overidentifying restrictions) are reported in parentheses. The sample period is 1951:1–2007:4.

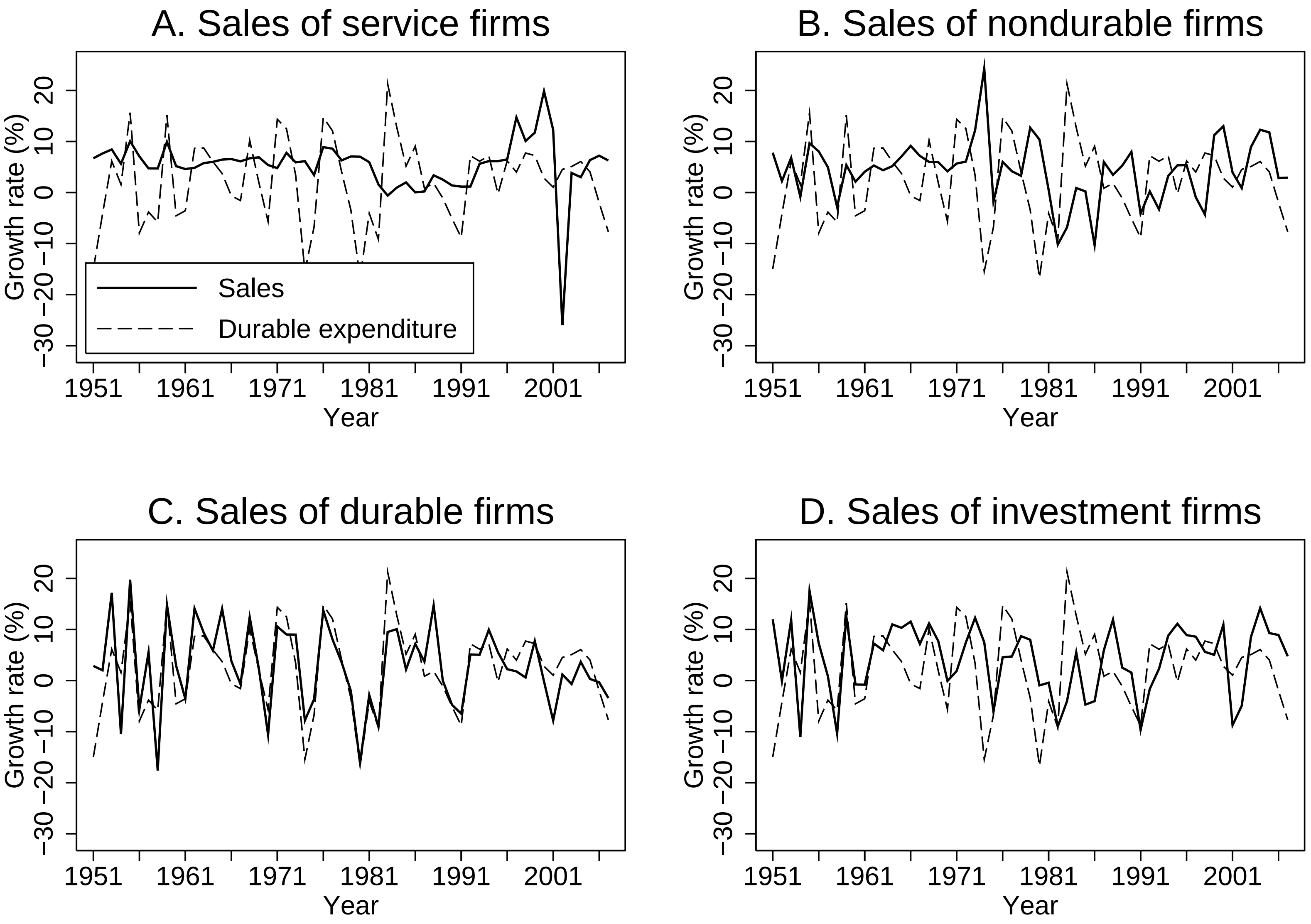

Figure 1: Log annual growth rate of sales for the industry portfolios. Sales are from Compustat and are deflated by the price index for nondurable goods and services. The dashed line in each panel is the log growth rate of real durable expenditure (consumer durable goods plus private residential fixed investment). The sample period is 1951–2007.

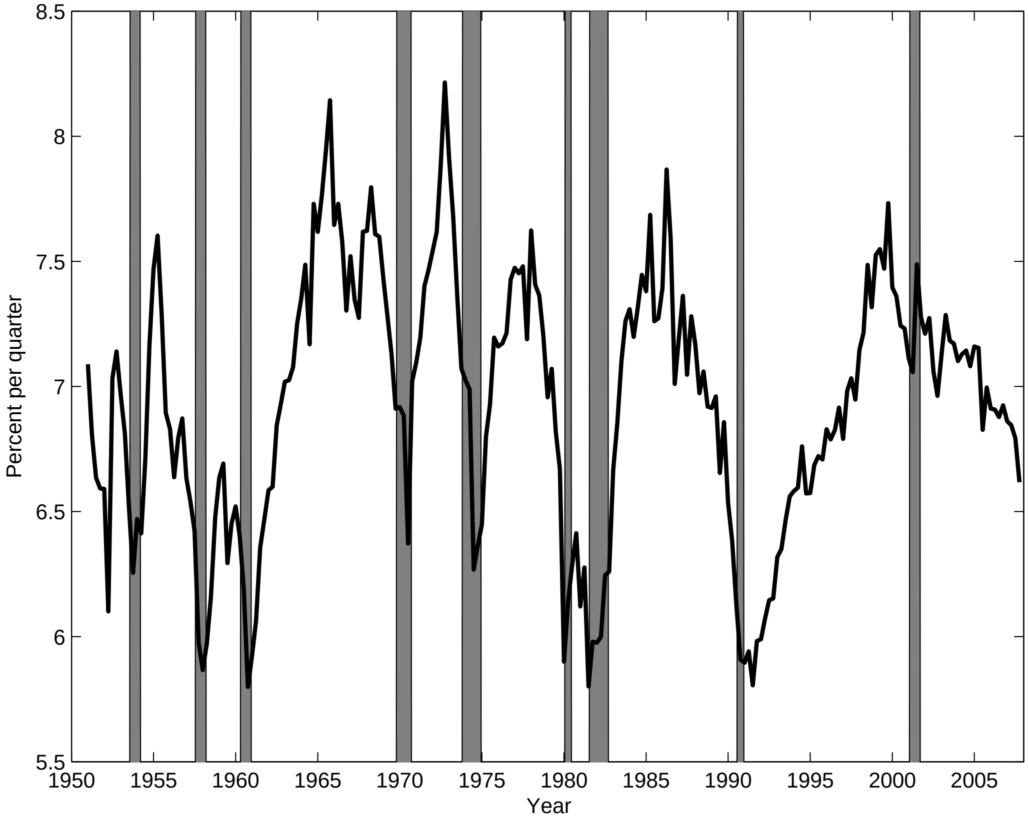

Figure 2: Ratio of personal consumption expenditures on durable goods to the stock of consumer durable goods. The sample period is 1951:1-2007:4. The shaded regions are recessions as dated by the National Bureau of Economic Research.