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Luxury Goods and the Equity Premium

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Abstract

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Luxury Goods and the Equity Premium

This paper evaluates the equity premium using novel data on the consumption of luxury goods. Specifying household utility as a nonhomothetic function of the consumption of both a luxury good and a basic good, we derive pricing equations and evaluate the risk of holding equity. Household survey and national accounts consumption data overstate the risk aversion necessary to match the observed equity premium because they mostly reflect basic consumption. The risk aversion implied by equity returns and the consumption of luxury goods is more than an order of magnitude less than that implied by national accounts data. For the very rich, the equity premium is much less of a puzzle.

Over the past century in the United States, the average return on the stock market has exceeded the return on short-term government bonds by over six percentage points at an annual rate. Economists have tried to understand this equity premium by appealing to the risks inherent in such an investment. However, as initially demonstrated by Grossman and Shiller (1981), Shiller (1982), and Mehra and Prescott (1985), such a large premium has proven difficult to explain within the canonical consumption-based asset pricing framework. The source of the puzzle is clear: according to the model, asset returns should alter investors' marginal utility; their marginal utility is a function of their consumption; but aggregate consumption moves little with returns. As a result, inordinately high degrees of risk aversion are necessary to reconcile the low variability of consumption with stock returns.

One possible solution to the equity premium puzzle is to modify the canonical specification of the investor's marginal utility. The measured risk of equity can be raised substantially by altering the time-separable power utility framework so that marginal utility is more responsive to asset returns. Prominent examples of this approach include Abel (1990), Constantinides (1990), Epstein and Zin (1991), Bakshi and Chen (1996), and Campbell and Cochrane (1999).

A second solution, pioneered by Mankiw and Zeldes (1991), is to model markets so that only a subset of households hold equity and bear the aggregate risk of the market. Households that are not in the stock market — due to factors such as borrowing restrictions and fixed costs of investing in stocks — contaminate tests of the canonical theory that employ aggregate consumption data. Consumption data for households that hold equity directly confirms that these households do bear more market risk, although typically not enough to completely rationalize the high returns on equity (see Attanasio, Banks, and Tanner (1998), Brav, Constantinides, and Geczy (1999), Vissing-Jørgensen (1999), Cogley (2002), and Parker (2002).)

In this paper, we modify the period utility function, as in the first approach, and evaluate the risk of equity using the marginal utility of the wealthy only, as in the second approach. We modify the canonical utility function, but instead of dropping the assumption of time separability of utility, we drop the assumption that the period utility function is homothetic across goods. Specifically, utility is a function of both the consumption of basic goods, of which a certain amount is required in every period, and the consumption of luxury goods, of which none are consumed when expenditure levels are not high. With such preferences, households consume only basic goods at low levels of total expenditures, and the share of luxury goods in overall consumption rises with expenditures.

In our model, households display a high degree of risk aversion with respect to their consumption of basic goods, consistent with the *subsistence* aspect of basic goods. Cutting down on basic goods is costly in utility terms. For wealthy households, the consumption of luxury goods responds to wealth shocks due to stock returns, consistent with the *discretionary* aspect of luxuries. We derive the Euler equation associated with the consumption of each type of good. Our theory implies that households are more risk averse with respect to the consumption of basic goods, so that the equity premium puzzle – the high degree of risk aversion implied by observed consumption of basic goods – is not inconsistent with our model. The real test of the model lies in the Euler equation for luxury goods, which evaluates the behavior and risk aversion of rich households. Does marginal utility measured by luxury consumption vary sufficiently with stock returns to rationalize the equity premium?

Since no extant datasets measure the consumption of high-end luxury goods, we construct our own data on luxury consumption. We depart from the typical approach of studying how much households spend to one of asking purveyors of luxury goods how much they sell. Household surveys typically contain few wealthy households and measure categories of consumption that do not distinguish between basic and luxury goods. The latter is also the case for national accounts data.

So, while we also evaluate readily-available government statistics, we construct and analyze: U.S. imports data from a consortium of seventy French luxury good manufacturers (Comité Colbert); IRS data on charitable giving by households with adjusted gross income (AGI) over $1 million; US sales of imported luxury automobiles (BMW, Mercedes, Jaguar, and Porsche); and finally sales data for retailers of high-end luxury goods. For this final series, we define a luxury retailer as those companies listed by Morgan Stanley and Merrill Lynch in their analysts' reports on the luxury goods retail sector. The series includes aggregate US sales for seven luxury retailers — Bulgari, Gucci, Hermès, LVMH, Saks, Tiffany, and Waterford Wedgewood. Note that many of the luxury retailers whose names we do not list individually are owned by luxury powerhouses such as LVMH, for whom we have total U.S. sales data. As of 2000, LVMH owns 46 different luxury brand names, whose sales represent 15% of the $68 billion global luxury-goods market, against 6% for Richemont, the next largest.

We find that the consumption of luxuries covaries significantly more with stock returns than aggregate consumption. Our estimates of the coefficient of relative risk aversion are an order of magnitude lower than that found using data on Personal Consumption Expenditures (PCE) of nondurables and services from National Income and Product Accounts (NIPA). Our main series on aggregated luxury retail sales yields a point estimate for risk aversion of 7, and similar results obtain for all of our luxury series. PCE nondurables and services yields point estimates ranging from 50 to 173, depending on data frequency. Given moderate sampling error, we cannot reject the hypothesis that households with completely reasonable levels of risk aversion generated the observed returns and consumption of luxury goods.

Figure 1 depicts this main result. Panel A is a scatter plot of luxury consumption growth, measured by the sales of luxury retailers, against excess returns of CRSP NYSE-AMEX value-weighted portfolio over 3-month T-bills. Panel B is a time series plot of these series. For comparison, we include the growth rate of PCE nondurables and services in both plots. PCE is relatively smooth and almost non-responsive to excess returns. By contrast, the consumption of luxuries is both more volatile and more correlated with excess returns. Luxury consumption spikes down sharply in 1970 and 1974, both bad years for the stock market. Luxury consumption declines in the 1991 recession and experiences strong growth during the bull market of the late 1990's. At the end of the sample, it again dives as the stock market falls in 2001.

One potential concern is that luxury goods sales measure expenditures on durable goods, and so are more volatile than the correct measure, flow consumption. But our results are not driven by the volatility of expenditures. The increases in expenditure four years after an excess return implies even lower risk aversion than the contemporaneous movement in expenditures.

We also show how the *prices* of luxury goods that are in fixed supply can reveal information about the equity premium. As an additional test of our theory, we construct time series on the prices of two high-end luxury goods whose supplies are highly inelastic: pre-war Manhattan coop apartments and Bordeaux wines from the finest châteaux and years. We calculate the equity premium implied by these price indexes given plausible levels of risk aversion. While the Manhattan coop prices covary strongly with returns and yield a point estimate for the equity premium as high as 7.8%, wine prices fail to rationalize the equity premium.

Our findings of reasonable levels of risk aversion based on luxury consumption data lead us to conclude that the single-good assumption that is embodied in most previous studies of asset prices and consumption leads to incorrect inference about the validity of the standard model, at least when applied to wealthy households. In particular, even within the basic power utility paradigm, there is no equity premium puzzle for the households that hold a large fraction of US equity, or at least one not easily explained by sampling uncertainty.[1] Put differently, we find no evidence that

[1] It could also well be that more sophisticated utility specifications such as those incorporating habit formation,

the risk faced by wealthy households does not justify the typical return on equity at reasonable levels of risk aversion.

The rest of the paper is organized as follows. Section 1 lays out our model with nonhomothetic utility and explains how the presence of luxury consumption changes asset pricing equations. In Section 2, we derive the testable implications of our model. The description of our dataset and the main empirical results are in Section 3. In Section 4, we extend our findings in three different directions. First, we consider the durability of luxury goods and argue that our findings are not driven by this issue. Second, we estimate the elasticity intertemporal substitution with our luxury data. Third, we estimate the equity premium using the price of luxury goods whose supply is inelastic. The final section concludes. A complete description of our dataset and lengthy derivations omitted from the main text are in the appendix.

1 Luxury Goods, Basic Consumption and Euler Equations

This section first lays the groundwork for studying the equity premium then presents our modification of the canonical model to include multiple goods with nonlinear Engel curves. We explain the properties of this utility function and the implications for inference based on luxury goods. Finally, we derive the asset pricing Euler equations and the implications for the covariance of aggregate consumption and returns.

1.1 The Equity Premium Puzzle

In the canonical model of investor behavior, households choose consumption expenditures (X_t) and the share of their saving invested in the stock market (ω_t) to maximize the expected present discounted value of utility flows for a given level of initial wealth A_t:

$$\max_{X_t,\omega_t} \quad E\left[\sum_{t=0}^{\infty} \beta^t u(X_t)\right] \tag{1}$$

$$s.t. \quad \sum_{t=0}^{\infty} (\omega_t R_{t+1} + (1-\omega_t) R^f_{t+1})(A_t - X_t) \geq 0 \tag{2}$$

$$X_t \geq 0 \tag{3}$$

where

- $u(\cdot)$ is the period utility function which is increasing, concave, and twice differentiable;

but applied in a two-good world, could go even further towards reconciling the equity premium.

- $\beta \in (0,1)$ is the discount factor;
- A_t is household wealth at the beginning of period t;
- R_{t+1} is the gross real return on stocks between time t and $t+1$;
- R^f_{t+1} is the gross real return on a conditionally riskfree asset between t and $t+1$.

Note that for simplicity, and consistency with the canonical model, we are assuming that households are infinitely lived, leisure is additively separable from consumption, and markets are complete so that labor income risk can be completely diversified. Complete markets also imply that the marginal utility of all agents moves together so that this moment condition can be estimated using aggregate consumption data. As is well-known, this setup is easily extended to accommodate the choice of additional assets without changing the intertemporal conditions that we consider.

Assuming that the maximum of the objective is finite, we can rewrite the household optimization problem as a dynamic program

$$J(A_t|I_t) = \max_{\{X_t,\omega_t\}} \left\{ u(X_t) + E_t \left[\beta J(\widetilde{R}_{t+1}(A_t - X_t)|I_{t+1}) \right] \right\}, \tag{4}$$

where J denotes the value function, I_t the state of the economy at time t, $\widetilde{R}_{t+1} = \omega_t R_{t+1} + (1 - \omega_t)R^f_{t+1}$ is the gross real return on wealth between time t and $t+1$, and the program is subject to constraints (2) and (3). The first-order and envelope conditions imply the conditional moment restriction

$$E_t \left[\frac{\beta u'(X_{t+1})}{u'(X_t)} (R_{t+1} - R^f_{t+1}) \right] = 0 \tag{5}$$

which in turn implies the unconditional version of the same restriction.

Within this canonical model, the equity premium can only be explained by appealing to unappealingly high risk aversion. Given the observed joint stochastic process for the return on stocks, the return on bonds, and aggregate consumption, the coefficient of relative risk aversion implied by this model is implausibly high. Campbell (1999) surveys the last fifteen years of research and shows that the puzzle is robust across countries and time.

1.2 Nonhomothetic Preferences

Our point of departure from the canonical model is to drop the single-good assumption and model within-period utility as a function of two goods. We assume that households consume two types of goods: basic goods, C, and luxury goods, L. We conceptualize the former, which we treat as the numeraire in the economy, as the standard bundle of goods that most households in the US regularly consume and that make up the bulk of the NIPA measure on consumption. The latter, luxury goods, are consumed only by the extremely rich and that is where our hand-constructed data series play a role.

We reinterpret the previous statement of the problem as follows. X represents total consumption expenditure per period, measured in terms of the numeraire (C) and optimally allocated between C and L. The utility function $u(X)$ represents an indirect utility function (with the relative price P of luxury goods suppressed), and the direct utility function $v(C, L)$, which we assume for simplicity is additively separable, is

$$\begin{aligned} X &= C + PL && (6) \\ v(C, L) &= \frac{(Max\{0, C-a\})^{1-\phi}}{1-\phi} + \frac{(L+b)^{1-\psi}}{1-\psi} && (7) \end{aligned}$$

where a, b, ϕ, and ψ, are positive constants with $\phi > \psi$. This implies that the subsistence level (a) is positive for basic goods, and negative (b) for luxury goods.[2]. We add the constraint that $C > 0$ (implying from (3) that $L > 0$).

This specification of utility captures two features of basic and luxury goods. First, luxury goods are not consumed by the "poor": there exists $\underline{C} = a + b^{\psi/\phi} P^{1/\phi} > a$ such that $L = 0$ for all $C \leq \underline{C}$. That is, when the marginal utility of wealth is high, the agent chooses to consume none of the luxury goods. Second, the consumption of the "rich" is dominated by luxuries:

$$\begin{aligned} \lim_{X \to \infty} \frac{C}{X} &= 0, \\ \lim_{X \to \infty} \frac{PL}{X} &= 1. && (8) \end{aligned}$$

The assumption that $\phi > \psi$ implies that as the marginal utility of wealth goes to zero, the budget share of the luxury good approaches one. We prove this claim in Appendix A.1.

This expenditure behavior is illustrated in Figure 2. The limit behavior as X gets large of the expenditure shares are governed by ψ and ϕ; the assumption $\psi < \phi$ delivers luxury consumption in excess of basic consumption at large expenditure levels. The local-to-zero behavior of expenditure

[2] The assumption that utility is separable in C and L strong, but modelling nonseparability is unlikely to matter for our estimation. In order to overturn our results, the nonseparability must cause the marginal utility of luxuries to rise when the consumption of luxuries rises. In that case, the observed high covariance of luxury consumption and stock returns would not resolve the puzzle. Such nonseparability would have to be large because basic consumption is very smooth and moves so little with market returns. Atkeson and Ogaki (1996) and Houthakker (1960) use addilog utility functions that share this separability feature.

shares are governed by a and b; the assumption that $-a < b$ delivers basic consumption in excess of luxury consumption at low expenditure levels.

1.3 Euler Equations and Risk Aversion

We show in Appendix A.2 that the first-order and envelope conditions from the dynamic program for the choice of C and L imply the following two conditional Euler equations

$$E_t\left[\frac{\beta(C_{t+1}-a)^{-\phi}}{(C_t-a)^{-\phi}}(R_{t+1}-R^f_{t+1})\right] = 0, \tag{9}$$

$$E_t\left[\frac{\beta(L_{t+1}+b)^{-\psi}}{(L_t+b)^{-\psi}}\frac{P_t}{P_{t+1}}(R_{t+1}-R^f_{t+1})\right] = 0. \tag{10}$$

The law of iterated expectations implies the unconditional versions of these equations.

The focus of the previous literature is on the unconditional version of equation (5), or if one takes the view that luxuries are not contained in NIPA nondurables consumption, of equation (9). We instead focus on estimation and testing of equation (10). Equation (10) provides a test of whether the consumption Euler equation holds for wealthy households.

Our choice of utility function implies that the relevant curvature parameter that determines a household's attitude toward risk depends on the level of its total expenditures X.[3] Consider the Arrow-Pratt definition of relative risk aversion $\gamma(X) = -Xu''(X)/u'(X)$. The coefficient of relative risk aversion with respect to gambles over C is $\gamma_C(C) = \phi C/(C-a)$, which falls with C and asymptotically approaches ϕ. Hence, for households with sufficiently low levels of X that only consume C, $\gamma(X) = \gamma_C(C)$, so ϕ is the curvature parameter that controls risk aversion. Risk aversion with respect to gambles over L is $\gamma_L(L) = \psi L/(L+b)$, which increases with L and asymptotically approaches ψ. Hence, for households at high levels of X that only consume L on the margin, ψ is the curvature parameter that is relevant for risk aversion. In general, for households that consume both C and L, $\gamma(X)$ is a weighted sum of ϕ and ψ that approaches ψ as X becomes large. Since we estimate ψ, our estimates provide a lower bound on the risk aversion over wealth gambles in the population at large.

This specification has two additional desirable features. First, since risk aversion declines with wealth, our model predicts that the wealthy hold a larger share of their wealth in equity, which is

[3] Risk aversion that varies with wealth is an inherent feature of any non-homothetic intra-period utility function. There is no utility function that admits nonhomothetic Engel curves and delivers constant relative risk aversion (see Hanoch (1977), Stiglitz (1969) and the discussion of the elasticitiy of intertemporal substitution in Browning and Crossley (2000).)

consistent with observed behavior (detailed in the next section). Second, the consumption of basic goods is a smaller share of expenditures for the rich. The distribution of basic consumption, as measured in the Panel Study of Income Dynamics (PSID) or the Consumer Expenditure Survey (CEX), is more equally distributed across households than the distribution of permanent income or wealth (see Huggett and Ventura (2000) and Dynan, Skinner, and Zeldes (2000)). Thus the consumption of the poor and middle class remains a significant share of aggregate consumption despite the skewness in the wealth distribution.

1.4 Why is there an Equity Premium Puzzle for Basic Consumption?

It is important to address why an econometrician using the usual consumption Euler equation (9) to study the return on stocks may not accept the model although the equation holds in equilibrium. Further, why does our Euler equation for luxury consumption (10) leads to the correct test of the theory?

In our model, the intra-period utility function does not exhibit constant relative risk aversion since there is some share of consumption that is necessary for subsistence. For low levels of consumption, households are extremely unwilling to subject consumption to risk, so they hold little equity and have stable consumption. Thus any test that uses an aggregate measure of consumption and assuming $a \approx 0$ calculates risk aversion from a weighted average of this nonresponsive consumption and the consumption of higher wealth households. Since the budget share of basic consumption declines with wealth, poor households are more heavily weighted in this average than their weight in wealth. According to our theory then, inference based on NIPA nondurables consumption data should find high levels of risk aversion. For this explanation to rationalize the low covariance between returns and NIPA consumption would still require extremely large risk aversion for some households.

While not explicit in our model, it is reasonable for marginal utility from the consumption of basic goods to be bounded from above or reach zero (satiation), as in the cases of constant absolute risk aversion utility and quadratic utility, respectively. In either case, the coefficient of relative risk aversion for basic consumption goes to infinity as wealth rises and marginal utility falls. Thus high-wealth households maintain relatively stable basic consumption and react to market returns by changing luxury consumption. If we modified our utility function $v(C, L)$ to exhibit this feature, calculations based on basic consumption growth would find high risk aversion due to the unresponsive basic consumption of the rich as well as the poor.

In addition to the direct implications of nonhomothetic preferences, there are two extant theories which suggest that basic consumption may be inappropriate for measuring asset risk while luxury consumption provides the correct measure. Our study provides a test of both of these classes of theories, which both pass.

The first class of theories models the poor as not holding stocks due to fixed costs of participating in the stock market or due to uninsurable labor income risk. The theory of limited participation (Mankiw and Zeldes (1991)) posits that households must pay a fixed cost in order to invest in the stock market. In this case, non-rich households are not be willing to incur this cost to invest and so their wealth is not directly affected by returns on equity and their consumption covaries less with the market.[4] The theory positing incomplete markets argues that the non-rich do not hold stocks since households face uninsurable idiosyncratic endowment or income risk (see Heaton and Lucas (1996) and Brav, Constantinides, and Geczy (1999).)[5] As with limited participation models, this theory predicts a low covariance between the consumption of the poor or middle-class and stock returns, hence rationalizing the equity premium puzzle. Aggregate consumption includes the consumption of these households, and so the theory predicts an equity premium puzzle with respect to aggregate consumption and stock returns. On the other hand, the consumption of luxury goods is dominated by the rich, who are actually investing in both equity and risk-free assets.

Second, the basic consumption Euler equation may fail because there are costs to adjusting either basic consumption or an item that is nonseparable with basic consumption. Some items in basic consumption require commitment or are subject to direct or indirect adjustment costs associated with changing consumption. Similarly, the marginal utility of some items are not separable from the consumption of goods that have high costs associated with adjusting the level of consumption. For instance, items like transportation or fuels (subcategories of NIPA nondurables consumption) are in part determined by a household's consumption of housing and automobiles, which are subject to large adjustment costs and hence infrequently adjusted. Items like mobile phone service, health club memberships and the like involve a degree of commitment over time.[6]

[4]For additional evidence on this theory see Attanasio, Banks, and Tanner (1998), Vissing-Jørgensen (1999), and Parker (2002). Guvenen (2000) calibrates a model with two types of agents, high risk aversion and low, in which only some agents have access to the stock market. The paper demonstrates that inference based on aggregate consumption in the canonical manner implies an implausibly high risk aversion, but the model has to assume an equity premium an order of magnitude smaller than that observed.

[5]The one caveat we must note is that some rich households receive some share of labor income as stock options. While the idiosyncratic component of such risk is easy to unwind, the employee is often discouraged from doing so.

[6]This is consistent with Parker (2002) who measures the risk of the stock market using a method that is robust

In contrast, such costs and nonseparabilities apply less to the consumption of luxury goods.

By studying the behavior of luxury goods, we test the central predictions of asset pricing in a way that is robust to these deviations from the canonical theory. Conversely, by testing a prediction of asset pricing that is consistent with these modified theories, we provide a test of these theories that is consistent with the presence of luxury goods.

The difficulties just discussed in using basic consumption to study the equity premium do not apply to the consumption of luxury goods. The consumption of necessities by the poor and rich does not contaminate a luxury-based measure of marginal utility; luxury goods are "discretionary." The rich are willing and able to pay any fixed costs for market participation. Moreover, rich households hold most equity and most hold equity. While the latter statement is to some extent tautological, the wealth distribution is so highly skewed that the concentration is extreme. The top 1% of households ranked by non-human wealth own over one-third of all privately-held wealth, over half of stock wealth not held in pension funds, and 47% of all stock wealth. The top 5% of households own over half of all privately-held wealth, over 80% of stock wealth not held in pension funds, and 75% of all stock wealth.[7] It is also the case that most of the very rich own some stock, and investable wealth is a larger share of wealth for the rich than for the typical household, again, almost tautologically.[8] Of the top 1% of households ranked by non-human wealth, 82% hold stock directly; of the top 5% of households, 78% hold stock directly. For the population as a whole, less than 50% hold stock directly (see Heaton and Lucas (2000)).

Finally, we do not require that all rich households consume luxuries or that the no middle class households consume luxuries. If some rich households do not consume luxuries (as argued in Stanley and Danko (1998)'s recipe for becoming a millionaire) then our test prices equity using only the subset of wealthy households that do purchase high-end luxury goods. The remaining households may save for bequests or have a "capitalist spirit" (Bakshi and Chen (1996)) but do not contaminate our main result. Second, if some middle-class households occasionally consume high-

to some of these issues. He finds that, in aggregate data, the ultimate movement of consumption following a return implies nearly an order of magnitude more consumption risk of equity than the contemporaneous movement.

[7]These numbers are from the 1998 Survey of Consumer Finances as calculated and reported in Poterba (2000, Table 2).

[8]Anecdotally, Bill Gates saw his wealth drop from $85 billion to $63 billion between 1999 and 2000, a percentage decrease that closely mirrors that of Microsoft stock. Between 1986 and 2000, the number of millionaires has risen sharply, and the total wealth controlled by households with assets of at least $1 million grew 313% to approximately $8.8 trillion (including Canada, as reported in the Merrill Lynch-Cap Gemini's 2000 World Wealth Report). During the same period, the US stock market rose by 405%.

end luxury goods and if these households do not hold equity, this only implies that our estimates are a lower bound on the risk aversion of the truly rich.

2 Estimating Equations

We seek to evaluate the risk aversion of the rich using equation (10) and observations on high-end luxury goods. We assume that expenditures on any category of luxury goods move in proportion to those on all luxury goods. Thus we can use observations on a subset of luxury goods to evaluate the model.[9]

2.1 Unconditional Euler Equation

Linearizing the unconditional version of the Euler equation for luxury goods, as in Campbell (1999), risk aversion can be derived as a function of population moments

$$\psi = \frac{E[(R_{t+1} - R^f_{t+1})P_t/P_{t+1}]}{Cov[\Delta l_{t+1}, (R_{t+1} - R^f_{t+1})P_t/P_{t+1}]}, \tag{11}$$

where $l_{t+1} \equiv \log L_{t+1}$.[10] Throughout the rest of the paper, lower case letters will be used to denote the logs of the corresponding uppercase variables. Details of this derivation are contained in Appendix A.3. The relative price of luxuries is present in the equation because returns are defined in terms of the price of basic consumption.

There is ample anecdotal evidence that the sales of luxury goods have benefited greatly from the bull market of the last decade, and fallen after the stock market bubble burst in 2001. But higher demand translates into higher consumption of luxury goods only to the extent that the supply is elastic enough so that price inflation does not completely crowd out the increase in nominal consumption of luxury goods.

We estimate risk aversion using the method of moments by replacing the population moments in (11) with sample counterparts. The standard error is estimated by the delta method.

Two practical issues arise in the estimation of ψ through equation (11). The first is the timing convention used to convert the time average of expenditures to consumption flows. In equation (11), $R_{t+1} - R^f_{t+1}$ and Δl_{t+1} are both measured from the end of period t to the end of period $t+1$. In practice, what we observe is total expenditures on the luxury good during period $t+1$, which

[9] The primitive assumptions needed to ensure this are the same aggregation results across goods implicitly assumed to employ aggregate consumption data and imply homothetic Engel curves among luxury goods.

[10] Some luxury goods have highly inelastic supply so that $\Delta l_{t+1} = 0$; we analyze them separately in Section 4.3.

we denote as $\widetilde{l}_{t+1}$. To translate from measured data to the model, we use the "end of the period" timing convention, using $\Delta l_{t+1} \approx \Delta \widetilde{l}_{t+1}$. We make an exception to this rule in the analysis of imports of luxury goods. That is, for US sales of Comité Colbert, sales of BMW and Mercedes, and sales of Jaguar and Porsche, we use the "beginning of the period" convention, using $\Delta l_{t+1} \approx \Delta \widetilde{l}_{t+2}$. This exception is motivated by the shortness of these series and the possibility of shipping delays (in fact, end of period timing shows more reaction to stock returns.)

The second issue that arises in the estimation of the population covariance in the denominator of (11) is the time aggregation in consumption data. Given the timing assumptions above, we are using consumption data that are averages over quarters or years in place of the desired instantaneous flow at a point in time. As shown by Breeden, Gibbons, and Litzenberger (1989), using time aggregated consumption data to estimate covariance can bias the estimated covariance downward by a factor of 1/2, which biases the estimated risk aversion upward by a factor of 2. Thus, we report time aggregation corrected estimates of the risk aversion in addition to the conventional one that does not correct for time aggregation.

2.2 Conditional Euler Equation

In addition to analyzing risk aversion, we estimate the elasticity of intertemporal of substitution (EIS) by linearizing the conditional Euler equation (10)

$$E_t\left[\frac{\beta(L_{t+1}+b)^{-\psi}}{(L_t+b)^{-\psi}}\frac{P_t}{P_{t+1}}R_{t+1}\right]=1$$

to obtain

$$\Delta l_{t+1} = -\frac{\rho}{\psi} + \frac{1}{\psi} r^L_{t+1} - \frac{1}{\psi}\varepsilon_{t+1}, \tag{12}$$

where $\rho \equiv -\log(\beta)$ is the discount rate and $r^L_{t+1} \equiv r_{t+1} - \Delta p_{t+1}$ is the real rate of return in terms of the price of luxuries (see Appendix A.3 for the derivation.)

While $E_t[\varepsilon_{t+1}] = 0$, it is in general the case that $E_t[r^L_{t+1}\varepsilon_{t+1}] \neq 0$. Hence, estimation of $1/\psi$ in this regression requires instruments z_t that are correlated with r^L_{t+1} but uncorrelated ε_{t+1}. The model is identified by the conditional moment restriction $E_t[z_t\varepsilon_{t+1}] = 0$, and the EIS is estimated by two-stage least squares (2SLS). In practice, we use instruments that are dated at $t-1$ to predict r^L_{t+1} thereby avoiding issues with time aggregation in consumption data that can cause the conditional moment restriction to fail (see Hall (1988)).

The practical issue that can arise in estimation of $1/\psi$ is that first-order asymptotic inference can be a poor approximation to the true uncertainty when the instruments are weakly correlated with the endogenous regressor (see Nelson and Startz (1990) and Staiger and Stock (1997)). Weak instruments are a problem in estimating the Euler equation because both consumption growth and asset returns are difficult to predict (see Stock and Wright (2000), Neely, Roy, and Whiteman (2001), and Yogo (2002)). As suggested by Stock, Wright, and Yogo (2002) in a recent survey on weak identification in GMM, we report the first-stage F-statistic to assess whether weak instruments is a problem. We also report confidence intervals based on Moreira's (2002) conditional likelihood ratio (LR) test, which is robust to weak instruments.

3 Risk Aversion and the Consumption of Luxury Goods

This section describes our data on the consumption of luxury goods and presents the associated estimates of risk aversion based on equation (11). A complete description of the source and construction of each series is contained in Appendix B.

Stock returns are measured as the return on value-weighted NYSE-AMEX portfolio from the Center for Research in Security Prices (CRSP). The riskfree return is the yield on the 3-month T-bill from CRSP's Fama Risk Free Rates File. The excess return is the difference of the returns. Real returns, in units of basic consumption, are then computed using the implicit price deflator for PCE nondurables and services. We make use of the annual, quarterly, and monthly CRSP data to match the frequency of data on consumption.

We construct new series on the consumption of luxury goods because NIPA consumption data are not classified into luxury and basic consumption. Moreover, available household survey data are not suited for this task. While there are a host of issues that arise with all household surveys, the main shortcomings of the commonly used surveys are as follows. The PSID measures only the consumption of food and housing, has only infrequent measures of wealth, and under-samples the wealthy. The Survey of Consumer Finances (SCF), while over-sampling the wealthy, does not collect consumption data beyond the stock of some consumer durable goods and has very small panel dimension as well as short time dimension. The CEX covers very limited categories of wealth, has poor measurement of those that are covered, and topcodes both consumption and wealth. (Wealth consists of four categories each topcoded at $100,000 for most of the survey.) The burden of detailing all consumption, which the CEX requires, is so large that very few high wealth households are in the survey and provide a full accounting of consumption.[11]

[11] The SCF and PSID take great pains to minimize the burden on participants. Since the CEX is designed to collect

3.1 Results from Government Aggregate Data

To begin, we examine publicly-available government series which provide some evidence on the risk aversion implied by the consumption of luxury goods. These series are not entirely satisfactory, so we construct better measures of the consumption of luxury goods, discussed below.

3.1.1 NIPA Personal Consumption Expenditures

We first estimate risk aversion from NIPA data on PCE nondurables and services. The first three rows of Table 1 present the results from this exercise. The columns, from left to right, report: 1) the sample period and size; 2) the correlation between excess returns (deflated by the appropriate price deflator) and consumption growth; 3) the annualized standard deviation of the series; 4) the point estimate and standard error of risk aversion ϕ (ψ in the case of luxury goods); and 5) the estimated risk aversion corrected for time aggregation by a factor of 1/2. As is well-known, the risk aversion implied by PCE nondurables and services is implausibly high, with the point estimate ranging from 50 (annual) to 173 (quarterly) even after corrected for time aggregation. This is the consequence of the fact that nondurables consumption has low correlation with returns and low volatility.

Two subcategories of NIPA PCE capture luxury consumption to some extent: PCE jewelry and watches and PCE boats and aircraft. Unfortunately, both of these series are expenditures on durable goods rather than consumption, and they contain some consumption that should be categorized under basic goods. The consumption of watches includes a significant amount of non-luxury consumption, while PCE boats and aircraft also includes expenditures on "durable toys" and sports equipment. Table 1 shows that these series are significantly more volatile than PCE nondurables and services. However, only three of the six series are positively correlated with returns. These results are broadly consistent with those of Poterba and Samwick (1995), who find weak stock market wealth effects for government series that to some extent focus on luxury expenditures.

3.1.2 Retail Sales and Imports of Jewelry

The last two rows of Table 1 report our results using government data on retail sales of jewelry and imports of jewelry. Data on retail sales of jewelry are available from the Bureau of Economic Analysis (BEA) at monthly frequency since 1967. Data on US imports of jewelry are from the

the distribution of expenditures across goods (although not classified by luxuriousness), complete compliance is quite costly to participants.

World Trade Analyzer. In order to isolate imports of luxury jewelry, we aggregate imports from only France, Italy, and the United Kingdom (UK). These series have shorter time dimensions than the PCE data, but are likely to be better measures of luxury goods.

Monthly retail sales of jewelry has correlation of only 0.11 with excess returns, but has a high level of volatility. This leads to a point estimate for risk aversion of 16 when corrected for time aggregation. The last row of Table 1 reports the estimates for the series on US imports of jewelry. The estimated risk aversion is negative due to the negative correlation between excess returns and the growth rate of imports. Note that imports of jewelry include many items that are not high-end luxury items that we would like to concentrate on. On balance, these consumption series do not move significantly with excess returns.

3.2 Results from High-End Luxury Goods

We now turn to the analysis of measures of luxury good consumption that we have constructed ourselves. These provide strong evidence that nonhomothetic utility is important for understanding the risks of equity.

3.2.1 Sales of Luxury Automobiles

We begin by measuring luxury consumption as the sales of luxury automobiles from *Ward's Automotive Yearbook*. We construct two series on the sales of luxury automobiles: 1) BMW and Mercedes and 2) Jaguar and Porsche. The former is available since 1970, and the latter since 1962. While luxurious, these series are not ideal. Automobile sales measure expenditures on a durable good rather than flow consumption, to which our model refers. Thus, sales data on luxury goods capture expenditures rather than the service flow from the stock of durable goods and as such should be more volatile than the stock (see e.g., Mankiw (1982)).

We deal more formally with the issue of durability in Section 4.1. There, we show how to estimate risk aversion some degree of durability using the change in expenditures over several periods following an innovation to the stock market. In brief, with this adjustment, our main conclusions stand. For now, we treat sales as consumption and present results from our automobile purchases in rows one and two of Table 2.

To the extent that retail sales of luxury automobiles measure the consumption of luxury goods, risk aversion is significantly lower than estimated from NIPA data. The estimated coefficient of relative risk aversion implied by sales of luxury automobiles are 14 and 33 for BMW and Mercedes and Jaguar and Porsche, respectively.

Figure 3A is a time series plot of the growth rate in sales of BMW and Mercedes along with excess returns. There appears to be strong covariation with large negative growth rates in 1987 and 1990, which were bad years for the stock market. More recently, sales of luxury automobiles were strong in the 1990's during the market boom. Figure 3B is a time series plot for the sales of Jaguar and Porsche. Again, there is evidence for covariation with the stock market with large slumps in 1987 and 1990.

3.2.2 Sales of Luxury Retailers

All of the measures considered so far are imperfect along two dimensions. First, the measures include basic goods purchased by middle-class households and do not focus purely on the rich. Second, as noted, due to durability, these series may provide a weak mapping between consumption expenditures and marginal utility.

Thus we turn to sales from the high-end market for luxury consumption goods directly. By doing so we are measuring by definition consumption of very expensive luxuries, which answers the first concern. As far as durability is concerned, it is likely to be less of an issue for high-end luxury goods sold to the super rich by these retailers since fashion is fickle: a Hermès tie, Prada handbag, or designer dress lasts only one season (if not one social event) for those who can afford them. As for our other series, in Section 4.1, we show that our results are not driven by the volatility of expenditures.

We collect data on US sales from luxury retailers, defined as any company listed by Morgan Stanley and Merrill Lynch in their analysts' reports on the luxury goods retail sector. Of these 32 companies, we use sales data for two major US retailers (Saks and Tiffany) and five European retailers (Bulgari, Gucci, Hermès, LVMH, and Waterford Wedgewood): see Appendix B.2.1 for details. We aggregate sales across these seven retailers to create the total sales of luxury goods. Since the goods sold by each retailer are close substitutes, we sum sales across retailers to reduce the volatility of each series arising from idiosyncratic sales shocks. That is any one retailer may misprice products, produce poor (e.g. unfashionable) products in any given season, and so forth, and hence suffer sales movements that are not indicative of total consumption of luxury goods.[12]

The length of time for which sales are observed differs by retailer. The longest series that we have is Tiffany, with sales data going back to 1960. For the other retailers, the series begin mostly

[12] While not an issue for consistency, such noise can artificially inflate a measured covariance in finite samples.

in the early 1990's. To avoid artificial increases in sales as firms enter our dataset, we compute growth rates in sales using the same set of retailers at date t and $t+1$. We also report results using only Tiffany sales since this is the retailer for which we have the longest and most consistent time series. It is consistent in the sense that the nature of the business for the company has not changed significantly over time, which is not the case for a company like Saks which has gone through numerous mergers and acquisitions.

As Figures 1A and 1B show, there is close relationship over time between excess stock returns and sales growth for luxury retailers. As reported in Table 2, the correlation between excess returns and luxury retail sales is 0.3, about twice as large as that for PCE nondurables and services. Luxury retail sales is also quite volatile with standard deviation of about 10%. This level of correlation and volatility implies that the risk aversion of the rich is about 7 (14 without a correction for time aggregation). That is, because stock market risk for the rich is high, when measured with movements in marginal utility of luxury consumption, the high equity premium can be justified with a low degree of risk aversion. This estimate of risk aversion is one to two orders of magnitude less than that implied by PCE nondurables and services used in most previous consumption-based asset pricing models.

Focussing our analysis on the single retailer for which we have a long time series of sales, the results are highly similar. Figure 3C shows the high covariance of excess returns and the growth rate of Tiffany sales. In years that experienced sharp declines in the stock market (1969, 1974, 1990, and 2001), Tiffany sales decline sharply. There appears to be some delay of consumption adjustment for the market shocks in 1969 and 1990 since sales growth bottom out in the subsequent years, 1970 and 1991, respectively. During the bull market of the 1990's, the sales for Tiffany experienced rapid growth, thus confirming anecdotal evidence of strong luxury consumption that was plentiful in the news during that period. This significant covariance implies a risk aversion estimate of about 7m shown in the fourth row of Table 2.

For three of the luxury retailers (Gucci, Saks, and Tiffany) whose equity trade in the US, we are also able to obtain quarterly sales data since 1986; see Appendix B.2.1 for details. As Figure 3D shows, this series also significantly covaries with return. Sales growth experienced large negative shocks in the third quarter of 1998 and 2001, which were, interestingly, bad quarters for the stock market. Starting around the third quarter of 1990, luxury retail sales experienced several quarters of negative growth rates, which appears to be a reaction to the 1991 recession. As shown in Table 2, the quarterly sales of luxury retailers has correlation with excess returns of 0.2 with annualized standard deviation of almost 20%. This results in a point estimate for risk aversion of about 7, which agrees with our results using annual data. As show in row 6 of Table 2 and Figure 3E, the results for quarterly sales of Tiffany are similar to those of all three retailers.

As an final measure of sales on high-end luxury goods, we have obtained data from Comité Colbert, a consortium of seventy French companies that specialize in high end luxury products. Comité Colbert shared with us their total annual exports to the US from 1984 to 1998. Figure 3F plots the growth rate of this series along with excess returns. Although the time series is short, there is significant covariation of US luxury import growth and excess returns. As shown in Table 2, the correlation with excess returns is almost 0.6, and the standard deviation is 11%. This leads to a point estimate for risk aversion of 6.8, when corrected for time aggregation. These results using US imports excluded to Comité Colbert suggest that the lack of evidence for strong covariation using aggregate government data on US imports of jewelry, discussed in Section 3.1.2, may be due to the contamination of imports data by non-luxury items. It appears that movements in the consumption of *high-end* luxury items are very different from movements in broader measures of consumption that include *some* luxury goods.

3.2.3 Charitable Contributions

Despite our attempts to isolate the consumption of the very rich, it is possible that some of the consumption we measure is sales to the middle class. While the middle class probably do not typically consume designer clothing and while to the extent they do, our measured risk aversion is biased *upwards*, we consider an alternative measure of luxury consumption that is even less subject to this criticism. Using the IRS publication *Individual Income Tax Returns*, we obtain data on the charitable contributions of households with AGI over $1m. One strength of this series is its length; the data is available biannually from 1952 through 1972 and annually since 1973.

Treating charitable giving as consumption is not standard in finance, but it is the leading theory explaining the phenomenon. According to these explanations, donating for medical aid to the suffering, endowing chairs in finance departments, donating art to a museum, and so forth provide "warm glow" utility to donors. Andreoni and Miller (2002) show that the "warm glow" theory of charitable giving passes revealed-preference tests. Further, Carroll (2000) argues that bequest giving enters utility as a luxury good.

In our framework, the price of charitable giving, relative to basic goods, is the tax price of charitable giving and varies with the marginal tax rate of the household; see Appendix B.2.3 for details.

Figure 3G is a time series plot of the growth in charitable contributions along with excess stock returns. Charitable contributions by high income households track the stock market closely, with large negative growth rates in 1973 and 1974, and even more significant, 1987, which is the year of the "Black Monday" stock market crash. The excess stock return is clearly negative for 1987, but from a historical perspective on market returns, it is not unusually low.

As reported in the final row of Table 2, the correlation of charitable contributions and excess returns is high at about 0.34, and the standard deviation is over 20%. This high covariance with excess returns leads to a point estimate of risk aversion of 3.7 – a number completely consistent with most economists views on a plausible level of risk aversion. According to this measure, the equilibrium risk of equity for the marginal utility of the rich is sufficient to rationalize the observed equity premium.

In sum, our estimates based on high-end luxury consumption suggest an entirely different picture of the risk of equity than nondurable consumption in the NIPA.

4 Robustness and Extensions

We now turn to robustness checks and extensions of our results. We first argue that durability is not driving the findings of the previous section. Second, we use the conditional Euler equation on our data on luxury consumption to estimate the elasticity of intertemporal substitution of the very rich. Finally, we derive a method for estimating the equity premium implied by the price of luxury goods that are in inelastic supply. We apply this method to the rental prices of luxury pre-war Manhattan coop apartments and the auction prices of high-end Bordeaux wines.

4.1 Dealing with Durability

As we already noted, many of the publicly available series measure the expenditures on expenditures that include some durable goods rather than being entirely flow consumption. To some extent, this criticism contaminates all empirical work in this area, as even NIPA consumption of nondurable goods and services contains items like shoes, financial services, health care, and items that may not be easily adjusted as discussed in section 1.4. One might be concerned that this problem is present even in our measures of sales of high-end luxury goods. In this section we provide some evidence that durability is not driving our results.

Suppose that utility comes from the service flow from the stock of a durable good, K_{t+1}. The stock is related to expenditures L_{t+1} by the equation

$$K_{t+1} = (1-\delta) K_t + L_{t+1} \tag{13}$$

where δ is the rate at which the durable good depreciates. If there are no adjustment costs, then expenditures are volatile as they increase or decrease to adjust the stock, while the stock is relatively stable. If this were the case, we may underestimate risk aversion using expenditures data since risk aversion is decreasing in the covariance of expenditure growth and excess returns.

If the growth rate of consumption is stationary, equation (13) implies that the ratio of expenditures to stock, L_{t+1}/K_t, is stationary. In other words, the stock of the good, and hence its service flow, is cointegrated with expenditures. To the extent that a large positive return at $t+1$ leads to an upwards revision in the stock of a durable good K_{t+1}, this should still be observed a few periods later as higher level of expenditures, which are proportional to K_{t+1}.

Thus we measure the covariance of returns with changes the stock of durable goods using long-run increases in expenditures. In practice our exercise is limited by the length of our sample, so we choose to look at the increase in expenditures from immediately before the excess return to four periods out. That is, we provide an alternative estimate of risk aversion with the equation

$$\psi = \frac{E[(R_{t+1} - R^f_{t+1})P_t/P_{t+1}]}{Cov[l_{t+4} - l_t, (R_{t+1} - R^f_{t+1})P_t/P_{t+1}]}. \tag{14}$$

Parker (2002) shows that this measure of risk aversion is valid both under the same assumptions needed to derive equation (11) and under a variety of other deviations from the canonical model.

Table 3 provides evidence that our main findings are not driven by durability. Panel A presents the results for the government data series of Table 1 and shows that, if anything, the estimated coefficients of relative risk aversion are more reasonable. For instance, the point estimate using annual PCE nondurables and services is about 19, which is much lower than the estimate of 100 that we obtained using contemporaneous consumption growth in Table 1. The absolute value of the coefficients tend to be lower compared to Table 1, but the only point estimate that is below 10 is for quarterly PCE boats and aircraft.

For our series on luxury consumption (Panel B of Table 3), the coefficients of relative risk aversion estimated from long-run changes in expenditures are lower than those computed in Table 2 using contemporaneous changes. The point estimates are strikingly similar to those reported in Table 2 using the correction for time aggregation. The one exception is the estimate of the coefficient of relative risk aversion based on sales of BMW and Mercedes, which becomes negative. However, we obtain small and reasonable estimates of risk aversion for all the other series.

Thus, our results are not driven by high volatility of expenditures while service flows and marginal utility are relatively stable. In fact, the low risk aversion implied by the covariance of luxury goods and returns is driven by long-lasting movements in expenditures following excess returns. We conclude that the consumption of luxury goods implies that much lower values of risk aversion are consistent with the premium on equity.

4.2 Elasticity of Intertemporal Substitution

In this section, we turn from the task of measuring risk aversion to estimating its inverse, the elasticity of intertemporal substitution (EIS), using equation (12). In preferences more general than the one in this paper (e.g. Epstein and Zin (1991)), the EIS may not be the inverse of the coefficient of relative risk aversion. However, the coefficient estimated by equation (12) can still be interpreted as the EIS.

Table 4 presents the estimated elasticity using government data (Panel A) and consumption of luxury goods (Panel B). The instruments that we use to predict returns are second lags of the 3-month T-bill return, yield spread, log dividend-price ratio, and luxury price inflation (see Appendix B.3). Our choice of instruments is motivated by empirical evidence that these variables predict stock returns (see Campbell (1987) and Fama and French (1988)).

In Table 4, the first three columns report results when the independent variable in equation (12) is stock returns, and the next three columns are for the riskfree rate. For each of these assets, the first column reports the first-stage F-statistic, the second reports the point estimate and standard error of EIS using 2SLS, and the third reports the 95% confidence interval constructed from the conditional LR test (see Moreira (2002)) that is robust to the weak instrument problem (see Yogo (2002) for details on the implementation of robust confidence intervals for the EIS.) The first three rows of Panel A confirms the well-known result that the measured EIS is small (see Hall (1988)).[13]

In Panel B, we report the estimates of the EIS for consumption of luxury goods. First, note that the first-stage F-statistic is always less than 10, which indicates that inference based on 2SLS is unreliable. Hence, we will focus attention on the robust 95% confidence intervals. Unfortunately, the predictability of stock returns is very low in these samples, with the F-statistic always less than

[13] As reported in Stock, Wright, and Yogo (2002), the F-statistic must be greater than 10 to assure that the bias of TSLS is small and that conventional inference based on its standard error is reliable.

2. This leads to uninformative confidence intervals which indicate that the EIS is not identified using stock returns in the conditional Euler equation. Using the riskfree rate, which is somewhat more predictable than stock returns, we are able to obtain informative confidence intervals for our series on luxury retail sales. They include rather large values of EIS; for instance, the upper end of the confidence interval using the quarterly series on luxury retail sales is 7.4. This suggests the possibility the the EIS is much larger for the consumption of luxuries, but our conclusion must be tentative due to the problem with weak identification.

While not the main focus of our paper, these results suggest that low estimates of the EIS in aggregate data may in part be due to the use of basic consumption rather than luxuries. Indeed, there is evidence from household survey data that the EIS rises with the level of consumption of the household (see Attanasio and Browning (1995) and Vissing-Jørgensen (2001)). Economists have been less concerned with the low EIS estimated on aggregate consumption data than with the equity premium implied by the covariance of returns and consumption. For many applications, however, it may be important that wealthy households have higher EIS than the typical household.

4.3 Equity Premium Implied by the Prices of Luxury Goods in Fixed Supply

In addition to using data on sales, we use the price movements of high-end luxury goods that are in perfectly inelastic supply to evaluate the equity premium. Intuitively, when a luxury good is in fixed supply, its price rises when excess returns are positive as household demand for the goods increases. When there is no increase in supply, this price change can be used as a measure of the change in marginal utility. We show how to use the covariance of excess returns and the prices of luxury goods in fixed supply to construct the implied equity premium.

When $L_t = L_{t+1} = L$, the stochastic discount factor for these goods is β (i.e. $M^L_{t+1} = \beta$), so that the Euler equation (10) becomes

$$E\left[\frac{P_t}{P_{t+1}}(R_{t+1} - R^f_{t+1})\right] = 0.$$

Using the definition of covariance and rearranging, this implies that the equity premium is given by

$$E[R_{t+1} - R^f_{t+1}] = -\frac{Cov[P_t/P_{t+1}, R_{t+1} - R^f_{t+1}]}{E[P_t/P_{t+1}]}. \tag{15}$$

Note that equation (15) does not give information about risk aversion. Instead, our data on the prices of luxury goods directly imply an equity premium independent of preference parameters.

4.3.1 Manhattan Pre-War Coops

We construct price series from two types of goods that are plausibly in fixed supply. The first is quarterly observations on the implied rental prices of Manhattan pre-war coops, which we have obtained from Miller Samuel Inc., a real estate appraisal company in Manhattan. Rents represent the price of flow consumption derived from real estate. Manhattan pre-war coops represent a close-to-ideal market for our analysis since these apartments are in fixed supply by their "pre-war" nature and enjoy clear luxury status in New York City where they represent the high end of the real estate market.

We focus on four data series (dollar values in parentheses represent the average value of the apartments sold in the fourth quarter of 1999): 1) all pre-war coops in Manhattan ($630,356), 2) all pre-war coops in Manhattan with four or more bedrooms ($3,393,750), 3) all pre-war luxury (defined as Central Park West, Park Avenue, and Fifth Avenue) coops ($2,256,618), and 4) all pre-war luxury coops with four or more bedrooms ($4,431,250). See Appendix B.4.1 for further details.

With real estate data, one might be concerned that there are significant adjustment costs for households to change their stock of housing, and this could reduce the estimated premium by reducing the correlation between price and returns. Further, the length of typical rental leases, and the presence of price controls in a limited segment of the New York market, rental prices might not immediately adjust to innovations in marginal utility. However, the effect of adjustment costs is mitigated by the fact that housing is an asset, so its price should reflect expected future demand. We address this concern by inferring rents from sales prices.

Figure 4A plots the time series of the growth rate in the price of luxury pre-war coops along with excess returns. Although there is a significant amount of high frequency noise, there is significant covariation of price and stock returns. For instance, the poor stock market performance in the third quarter of 1990 is matched by a sharp decrease in the price of coops that quarter. As reported in Table 5, the correlation of the price growth rate and excess returns is about 0.33.

Table 5 reports the equity premium estimated using equation (15). For the series on luxury coops with four or more bedrooms, which is the most luxurious market, the implied equity premium is 3.9%. We also report the estimated equity premium that has been corrected for time aggregation (as determined in Section 2.1) in the last column of Table 5. After the adjustment, the equity premium using the price of luxury coops with four or more bedrooms is 7.8%. This is roughly in line with the historical equity premium.

For comparison, the canonical consumption CAPM calibrated to aggregate consumption data with a conservative relative risk aversion $\phi = 10$, implies an equity premium of a mere 0.2% or 0.4% after adjusting for time aggregation, as reported in the first row of Table 5.

4.3.2 US Auction Prices of Fine Bordeaux Wine

The second series we use for the prices of luxury goods is the price of fine Bordeaux wines. We create quarterly indexes from raw data on cases of wine sold in US auctions from 1989 to 1997, provided by Orley Ashenfelter and David Ashmore at Liquid Assets. We construct three indexes: fine, finest, and great. The fine index contains wines from the nine best château. The finest index contains only the best five of the nine château, and the great index only contains the best two. (For details, we refer to Appendix B.4.2.) To give an idea of the quality of these wines, the average price of a case of wine in the fine index was over $2,200 in 1997. For the finest and great indexes, it was over $2,600.

In Figure 4B plots the growth rate for the finest wine price index along with excess returns. The price of these wines is quite noisy, but there doesn't appear to be much covariation with returns. As reported in Table 5, the correlation is actually -0.21. This implies a negative equity premium of -0.5%. For the fine and great wine price indexes, we similarly estimate a negative equity premium. This indicates a rejection of some combination of our assumptions necessary for identifying the equity premium.

Some factors may explain why data on top wines does not imply a significant equity premium. One assumption that may be violated for fine wines is fixed supply, since at least some top wine is ultimately drunk. In addition, there are other fine wines and alcoholic beverages, that are close substitutes to the Bordeaux vintages we consider. These close substitutes may be subject to production shocks and be more responsive to demand shifts. To the extent that when wealth levels rise, the price increase of the good is limited by the increase in the supply of close substitutes, our method may underestimate the equity premium implied by the price movements of luxury goods.

5 Conclusions

Evaluating the risk of equity for a given household requires measuring the marginal utility of that household. We argue that aggregate consumption fails to measure the marginal utility of the representative agent because the poor are quite risk averse, and the rich do not vary their consumption of basic goods, only their consumption of luxury goods. Furthermore, many US households, particularly those with low net worth, do not participate in the stock market. The consumption of these households should not vary much with stock returns, and aggregate consumption, therefore, does not measure the marginal risk of investing in the stock market.

By postulating a non-homothetic utility function, and constructing series on the consumption of high end luxury goods, we show how small modifications to the basic paradigm can go a long way towards reconciling the observed equity premium and the marginal utility of the very rich.

We find that their marginal utility moves significantly with the return on equity. The covariance of luxury goods and excess returns implies a coefficient of relative risk aversion more than an order of magnitude lower than that implied by NIPA consumption. Our main point estimates suggest a level of risk aversion only slightly higher than most economists would believe plausible. Confidence intervals contain plausible estimates of risk aversion.

While this paper shows that the marginal utility of the rich moves enough with the market to justify the large equity premium, the fact remains that the covariance of consumption and stock returns is low for the typical household that only consumes basic goods. If these households are stock owners, our Euler equation for basic goods implies that the risk aversion for these households is implausibly high, leading to the equity premium puzzle. If these households are not investing in stocks, then nonparticipation becomes a puzzle: for a household whose marginal utility moves little with returns, stocks are nearly riskless assets that deliver high returns.

Appendix

A Derivations

A.1 Limiting Consumption Shares

We claim

$$\lim_{X\to\infty} \frac{C}{X} = 0$$
$$\lim_{X\to\infty} \frac{PL}{X} = 1$$

Let $\tilde{C} = C - a$, $\tilde{L} = L + b$, and $\tilde{X} = X - a + Pb$, then the intratemporal first-order condition is $\tilde{C}^{-\phi} = \tilde{L}^{-\psi}/P$ and the budget constraint is $\tilde{X} = \tilde{C} + P\tilde{L}$. It follows that

$$\frac{\tilde{C}}{\tilde{X}} = \frac{1}{1 + P^{1-1/\psi}\tilde{C}^{\phi/\psi-1}} \tag{A.1}$$
$$\frac{P\tilde{L}}{\tilde{X}} = \frac{1}{1 + P^{1/\phi-1}\tilde{L}^{\psi/\phi-1}} \tag{A.2}$$

As $\tilde{X} \to \infty$ either $\tilde{C} \to \infty$ in which case equation (A.1) implies that $\frac{\tilde{C}}{\tilde{X}} \to 0$ or $\tilde{C}$ is bounded and so $\frac{\tilde{C}}{\tilde{X}} \to 0$. Finally, since $\lim_{\tilde{X}\to\infty} \frac{X}{\tilde{X}} = 1$ and $0 < \tilde{C} < C$,

$$0 = \lim_{\tilde{X}\to\infty} \frac{\tilde{C}}{\tilde{X}} = \lim_{E\to\infty} \frac{C}{X} + \frac{a}{X} = \lim_{E\to\infty} \frac{C}{X}.$$

Similar arguments demonstrate the second claim in equation (8).

A.2 First-Order and Envelope Conditions in the Presence of Two Types of Consumption Goods

With the period utility function $v(C, L)$ in (7) written as $v(C, L) = \varpi(C) + \upsilon(L)$, the value function $J_t(W_t)$ satisfies

$$J_t(W_t) = \max_{\{C_t, L_t, \omega_t\}} \{\varpi(C_t) + \upsilon(L_t) + E_t[\beta J_{t+1}(W_{t+1})]\}, \tag{A.3}$$

where $W_{t+1} = (W_t - C_t - P_t L_t)\,\widetilde{R}_{t+1}$. The optimal controls $C_t^*(W_t)$, $L_t^*(W_t)$, and $\omega_t^*(W_t)$ are the solutions of the three first-order conditions with respect to the three controls $\{C_t, L_t, \omega_t\}$

$$\begin{cases} \varpi'(C_t) - \beta E_t\left[J'_{t+1}(W_{t+1})\tilde{R}_{t+1}\right] = 0 \\ \upsilon'(L_t) - \beta E_t\left[J'_{t+1}(W_{t+1})P_t\tilde{R}_{t+1}\right] = 0 \\ E_t\left[J'_{t+1}(W_{t+1})\,(W_t - C_t - P_t L_t)\left(R_{t+1} - R^f_{t+1}\right)\right] = 0 \end{cases} \tag{A.4}$$

Replacing the optimal controls in (A.3) yields

$$J_t(W_t) = \varpi(C_t^*(W_t)) + \upsilon(L_t^*(W_t)) + E_t[\beta J_{t+1}(W_{t+1}^*(W_t))], \tag{A.5}$$

where

$$\begin{aligned} W_{t+1}^*(W_t) &\equiv (W_t - C_t^*(W_t) - P_t L_t^*(W_t))\widetilde{R}_{t+1}^*(W_t), \\ \widetilde{R}_{t+1}^*(W_t) &\equiv R_{t+1}^f + (R_{t+1} - R_{t+1}^f)\omega_t^*(W_t). \end{aligned}$$

Differentiating (A.5) with respect to the state variable W_t then yields

$$\begin{aligned} J_t'(W_t) &= \varpi'(C_t^*(W_t))\frac{\partial C_t^*}{\partial W_t} + \upsilon'(L_t^*(W_t))\frac{\partial L_t^*}{\partial W_t} + E_t\left[\beta J_{t+1}'(W_{t+1}^*(W_t)) \times \right. \\ &\left. \left\{\left(1 - \frac{\partial C_t^*}{\partial W_t} - P_t\frac{\partial L_t^*}{\partial W_t}\right)\widetilde{R}_{t+1}^*(W_t) + (W_t - C_t^*(W_t) - P_t L_t^*(W_t))\,(R_{t+1} - R_{t+1}^f)\frac{\partial \omega_t^*}{\partial W_t}\right\}\right], \end{aligned}$$

which after simplification using (A.4) and the fact that all variables subscripted with t are contained in the information set at t, reduces to the envelope conditions

$$\begin{aligned} J_t'(W_t) &= E_t[\beta J_{t+1}'(W_{t+1}^*(W_t))\widetilde{R}_{t+1}^*(W_t)] \\ &= \beta\varpi'(C_t^*(W_t)) \\ &= \beta\upsilon'(L_t^*(W_t))/P_t. \end{aligned}$$

Evaluating the expressions for $J_t'(W_t)$ given by the envelope conditions at $t+1$, and suppressing the superscript $*$ and the dependence of the optimal policies on current wealth, the system of first-order conditions (A.4) becomes

$$\begin{cases} \varpi'(C_t) - \beta E_t\left[\varpi'(C_{t+1})R_{t+1}^f\right] = 0 \\ \upsilon'(L_t) - \beta E_t\left[\upsilon'(L_{t+1})P_t R_{t+1}^f\right] = 0 \\ E_t\left[J_{t+1}'(W_{t+1})\left(R_{t+1} - R_{t+1}^f\right)\right] = 0 \end{cases}$$

From this follow two sets of consumption conditional Euler equations:

$$\begin{aligned} E_t\left[\frac{\beta(C_{t+1}-a)^{-\phi}}{(C_t-a)^{-\phi}}R_{t+1}\right] &= E_t\left[\frac{\beta(C_{t+1}-a)^{-\phi}}{(C_t-a)^{-\phi}}R_{t+1}^f\right] = 1 \\ E_t\left[\frac{\beta(L_{t+1}+b)^{-\psi}}{(L_t+b)^{-\psi}}\frac{P_t}{P_{t+1}}R_{t+1}\right] &= E_t\left[\frac{\beta(L_{t+1}+b)^{-\psi}}{(L_t+b)^{-\psi}}\frac{P_t}{P_{t+1}}R_{t+1}^f\right] = 1 \end{aligned} \tag{A.6}$$

which deliver equations (9) and (10).

A.3 Estimating Equations

A.3.1 Unconditional Euler Equation

Let

$$M_{t+1}^L \equiv \frac{\beta \upsilon'(L_{t+1})}{\upsilon'(L_t)} = \frac{\beta (L_{t+1}+b)^{-\psi}}{(L_t+b)^{-\psi}}$$

denote the marginal rate of substitution for luxury consumption, which is the stochastic discount factor in this case. From (A.6), we have that

$$1 = E_t\left[M_{t+1}^L \frac{P_t}{P_{t+1}} R_{t+1}^f\right] = E_t\left[M_{t+1}^L \frac{P_t}{P_{t+1}}\right] R_{t+1}^f$$

since R_{t+1}^f is known at t. Thus

$$E\left[M_{t+1}^L \frac{P_t}{P_{t+1}}\right] = E\left[\frac{1}{R_{t+1}^f}\right].$$

Then the unconditional version of (10) is

$$\begin{aligned} 0 &= E\left[M_{t+1}^L \frac{P_t}{P_{t+1}}(R_{t+1} - R_{t+1}^f)\right] \\ &= E\left[M_{t+1}^L\right] E\left[\frac{P_t}{P_{t+1}}\left(R_{t+1} - R_{t+1}^f\right)\right] + Cov\left[M_{t+1}^L, \frac{P_t}{P_{t+1}}(R_{t+1} - R_{t+1}^f)\right] \end{aligned} \quad \text{(A.7)}$$

It follows from the Taylor expansion

$$\upsilon'(L_{t+1}) \approx \upsilon'(L_t) + \upsilon''(L_t)(L_{t+1} - L_t)$$

that

$$M_{t+1}^L = \beta\frac{\upsilon'(L_{t+1})}{\upsilon'(L_t)} \approx \beta\left[1 + \frac{\upsilon''(L_t)}{\upsilon'(L_t)}(L_{t+1} - L_t)\right].$$

With our choice of utility function for luxury goods consumption, under the reasonable approximation that $b/L_t \ll 1$, it follows that

$$\frac{\upsilon''(L_t)}{\upsilon'(L_t)} = -\psi\frac{(L_t+b)^{-\psi-1}}{(L_t+b)^{-\psi}} = -\frac{\psi}{(L_t+b)} \approx -\frac{\psi}{L_t}.$$

thus

$$\begin{aligned} M_{t+1}^L &\approx \beta\left[1 - \psi\frac{(L_{t+1} - L_t)}{L_t}\right] \\ &\approx \beta\left[1 - \psi\Delta\ln(L_{t+1})\right]. \end{aligned} \quad \text{(A.8)}$$

Substituting (A.8) in (A.7) yields

$$0 = E\left[M_{t+1}^L\right] E\left[\frac{P_t}{P_{t+1}}\left(R_{t+1} - R_{t+1}^f\right)\right] - \beta\psi Cov\left[\Delta\ln(L_{t+1}), \frac{P_t}{P_{t+1}}(R_{t+1} - R_{t+1}^f)\right]$$

or

$$E\left[\frac{P_t}{P_{t+1}}(R_{t+1}-R^f_{t+1})\right]=\frac{\beta}{E[M^L_{t+1}]}\psi Cov\left[\Delta l_{t+1},\frac{P_t}{P_{t+1}}(R_{t+1}-R^f_{t+1})\right].$$

Finally, under $\beta/E[M^L_{t+1}]\approx 1$, we obtain equation (11).

A.3.2 Conditional Euler Equation

The conditional Euler equation (A.6) is

$$1+\varepsilon_{t+1}=M^L_{t+1}\frac{P_t}{P_{t+1}}R_{t+1},\quad E_t\left[\varepsilon_{t+1}\right]=0.$$

Taking logs, it follows from (A.8) that

$$\ln(1+\varepsilon_{t+1})\approx\ln\beta-\psi\Delta\ln(L_{t+1})-\Delta\ln(P_{t+1})+\ln\left(R_{t+1}\right)$$

which itself is approximated (under $|\varepsilon_{t+1}|\ll 1$, we have $\ln(1+\varepsilon_{t+1})\approx\varepsilon_{t+1}$) by

$$\varepsilon_{t+1}\approx\ln\beta-\psi\Delta\ln(L_{t+1})-\Delta\ln\left(P_{t+1}\right)+\ln(R_{t+1})$$

Rearranging gives equation (12), with $r^L_{t+1}=\ln(R_{t+1})-\Delta\ln\left(P_{t+1}\right)$.

B Data

A detailed description of the source and our use of each data series follows. All standard data series were provided by DRI Webstract unless otherwise noted.

B.1 Government Data

B.1.1 NIPA Data

The series on PCE nondurables and services is the sum of real (chained) "PCE nondurables" and "PCE services," divided by the "population used to calculate per capita income." Using the current dollar value for PCE nondurables and services, we back out the implicit price deflator. The series is available at an annual frequency since 1929, quarterly since 1946, and monthly since 1959. The series on real "PCE jewelry and watches" and PCE boats and aircraft ("PCE pleasure boats and aircraft") are available at annual, quarterly, and monthly frequency since 1959. We divide these series by the population to compute the per capita consumption levels and use their price deflators for the relative price of luxuries.

Unfortunately, PCE jewelry and watches includes many non-luxury items. For instance, most of the consumption of watches is unlikely to represent high-end luxury. Hence, we also use the real "retail sales of jewelry stores" published by the BEA as a measure of aggregate consumption of jewelry. This series and its implicit price deflator, used to compute the relative price, are available at monthly frequency since 1967.

B.1.2 US Imports of Jewelry

Another measure of luxury consumption at an aggregate level is US imports of jewelry (SITC 897, "jewelry, goldsmiths and other art of precious metals"), taken from the World Trade Analyzer CD. This data is reported to the United Nations Statistical Office and compiled by Statistics Canada. To isolate the luxury items, we only aggregate imports from France, Italy, and UK. In 1999, France accounted for 3%, Italy 88%, and UK 9% of the total imports from these three countries. Hence, the series that we construct is mainly driven by imports from Italy. Our choice of these European countries is motivated by our list of foreign luxury retailers, which is described below. To deflate the nominal value of imports, we use the US import price index for SITC 897 (SITC 89 before 1985) from the Bureau of Labor Statistics. We also use this price index as the relative price of luxuries.

B.2 Quantity Data on Luxury Goods in Elastic Supply

B.2.1 US Sales of Luxury Retailers

We initially targeted sales data for a list of 7 US and 25 European luxury retailers based on the list of luxury retailers contained in Morgan Stanley's "Luxury Goods Weekly" (June 9, 2000) and Merrill Lynch's report "Luxury Goods" (June 16, 2000). Of the 32 companies in our list, we consider the sales data for two US retailers and five European retailers. The US retailers are Saks (1991) and Tiffany (1960). The European retailers are Bulgari (1992), Gucci (1991), Hermès (1992), LVMH (1993), and Waterford Wedgewood (1994). The years in parentheses indicate the first year in which we are able to obtain US sales data for these retailers. Nine of the companies in our list are not public and hence do not disclose sales information. Six of the companies have been public for less than five years, and hence we do not have enough observations in order to reliably measure correlations. Nine of the companies did not respond to our (repeated) request for information. The remaining company is Neiman Marcus whose sales data we have since 1984. However, we do not use Neiman Marcus because their fiscal year ends in July rather than December or January for all the other retailers. Hence, we cannot reliably aggregate their sales data with our other retailers.

The sales data for these companies were for the most part collected from the annual reports. For European retailers that report sales in foreign currencies, they are converted to US dollars using the average exchange rate over the fiscal year. For the three companies whose equity trade in US exchanges — Gucci (GUC), Saks (SKS.Z 1991–1997), and Tiffany (TIFF 1960–1977, TIF since 1986) — we were able to obtain sales data from Compustat. For Saks, we only take the part of sales attributed to Saks Fifth Avenue Stores, which is the only luxury component of the parent company Saks Inc. Before Saks Fifth Avenue Stores was acquired by Saks Inc. (formerly Proffitt's) in 1998, it was part of Saks Holdings Inc. In the late 1970's and early 1980's, Tiffany was owned by Avon Products and hence did not report sales separately. However, we were able to obtain sales data for the period 1978–1982 from a *New York Times* article.[14] For the three companies that trade in US — Gucci (1996), Saks (1995), and Tiffany (1986) — we were able to construct a series on quarterly US sales with data from quarterly reports and Compustat. Again, the years in parentheses indicate the first year in which data is available.

The three companies that trade in the US report on a fiscal year which ends in January, whereas the remaining retailers that trade in European stock exchanges report on a fiscal year which ends in December. Since the bulk of sales occur during the holiday season in December, the one month difference in report dates can be ignored in aggregation across retailers. (We obtained essentially the same results isolating sales from only the three companies that trade in the US.) To give a flavor for the cross section of our dataset, in 2001 Saks accounted for 49% of total sales, Tiffany 16%, LVMH 12%, Gucci 10%, Waterford Wedgewood 8%, Hermès 3%, and Bulgari 2%.

Since sales data start in different years for different retailers, we compute growth rates in sales over the same set of retailers to assure that our series is as consistent as possible. For the quarterly data series, seasonality is a dominant feature of the data, mostly due to holiday purchases. Hence, we obtain deseasonalized growth rates by computing growth rate with respect to the same quarter the previous year. This is how quarterly growth rate of sales is typically computed in the retail industry. Since jewelry is the main line of business for many of the companies on our list, we use the implicit price deflator for retail sales of jewelry stores as the deflator for nominal sales since 1967. Before then, we use the price index for PCE jewelry and watches due to data availability. These price series are also used to compute the relative price of luxuries.

[14] "At Tiffany, A Troubled Transition," October 16, 1983, section 3, page 1, column 2.

B.2.2 Comité Colbert: US Imports from French Luxury Retailers

Comité Colbert is a consortium of seventy French companies that specialize in luxury products. We collected data on their total sales as US exports from 1984 through 1998. Among the Comité Colbert members, the sixty companies with US sales are Baccarat, Bernardaud, Champagne Bollinger, Boucheron, Breguet, Bussière, Caron, Céline, Chanel, Parfums Chanel, Château Cheval Blanc, Château Lafite-Rothschild, Château d'Yquem, Christian Dior, Parfums Christian Dior, Christofle, D. Porthault, Daum, Ercuis, Faïenceries de Gien, Flammarion Beaux Livres, Givenchy, Parfums Givenchy, Guerlain, Guy Laroche, Hédiard, Hermès, Parfums Hermès, Jean Patou, Parfums Jean Patou, Jean-Louis Scherrer, Jeanne Lanvin, John Lobb, Champagne Krug, La Chemise Lacoste, Lalique, Lancôme, Parfums Lanvin, Champagne Laurent-Perrier, Lenôtre, Léonard, Champagne Louis Roederer, Louis Vuitton, La Maison du Chocolat, Mauboussin, Mellerio dits Meller, Nina Ricci, Parfums Nina Ricci, Pierre Balmain, Pierre Frey, Puiforcat, Rémy Martin, Revillon, Robert Haviland and C. Parlon, Rochas, Champagne Ruinart, Cristal Saint-Louis, Souleïado, S.T. Dupont, and Champagne Veuve Clicquot Ponsardin. The sales data in French Francs were converted to US dollars using the average exchange rate. The implicit price deflator of jewelry retail stores was used to deflate nominal sales and to compute the relative price of luxuries.

B.2.3 Charitable Contributions of the Wealthy

As a proxy for charitable contributions of the wealthy, we use data on the average contributions for households with adjusted gross income (AGI) over $1 million, which is taken from the IRS publication *Individual Income Tax Returns*. The data is available biannually from 1952 through 1972 and annually since 1973. The nominal values are deflated by the price index for PCE nondurables and services. The relative price for charitable contributions is its tax price, that is $1-\tau$, where τ is the marginal tax rate. For each year, we compute the marginal tax rate for households with AGI over $1 million as

$$\tau = \frac{\text{Tax}_1 - \text{Tax}_{0.5}}{\text{AGI}_1 - \text{AGI}_{0.5}}$$

where Tax_1 ($\text{Tax}_{0.5}$) is the average tax paid per capita for households with AGI over $1 million (AGI $0.5–1 million) and AGI_1 and $\text{AGI}_{0.5}$ are the correspondingly defined average AGI's for each group. Since stock returns are noisy, the tax adjustment makes little difference to the results.

B.2.4 Luxury Automobile Sales

We have obtained data on total US sales of imported luxury automobiles from *Ward's Automotive Yearbook*. We aggregate the quantities sold for BMW and Mercedes since 1970 and for Jaguar and Porsche since 1962. We have aggregated quantities sold in this way under the assumption that these brands are close substitutes. To compute the relative price of luxuries, we use BEA's implicit price deflator for retail sales of automotive dealers.

B.3 Instruments for Expected Returns

The asset returns that we use are real returns on stocks (NYSE-AMEX portfolio) and the riskfree rate (3-month T-bill). Both are deflated using the relevant price deflator for luxuries. As for instruments, the yield spread is the difference between Moody's Seasoned Aaa Corporate Bond Yield and the 1-month T-bill rate from CRSP's Fama Risk Free Rates File. The log dividend-price ratio is computed from CRSP data on returns including and excluding distributions.

B.4 Price Data on Luxury Goods in Inelastic Supply

B.4.1 Manhattan Pre-War Coops

We start with the closing prices of pre-war coops in Manhattan at a quarterly frequency since 1989. We consider four series: 1) all pre-war coops in Manhattan, 2) all pre-war coops in Manhattan with four or more bedrooms, 3) all luxury (Central Park West, Park Avenue, and Fifth Avenue) pre-war coops, and 4) all luxury pre-war coops with four or more bedrooms. Since the price data that we have is the price recorded at the time of closing, there is delay between the time a sales price is negotiated and the time the price is recorded. Hence we lag the price series two quarters, which is the time frame recommended by our data provider Miller Samuel Inc. In other words, we assume that the recorded closing price in the third quarter of 1999 is the effective price of real estate in the first quarter of 1999.

While direct observations on rents in Manhattan are available, the rental market there generally cover the entry to mid-level apartments, rather than the luxury market that we target. Since prices of apartments are closely related to rents, we use the "gross rent monthly multiplier," assumed constant during our period, to map changes in the sales price into changes in the rental price.

The correction for time aggregation reflects the fact that in equation (15), the ratio P_t/P_{t+1} is the ratio of spot prices, whereas we observe prices that have been averaged over apartments sold each quarter. The adjustment factor compensates for the fact that time aggregation biases the estimated equity premium downwards, by a factor of two.

B.4.2 US Auction Prices of Fine Bordeaux Wine

The fine and finest are the Ashmore-Ashenfelter indexes for the finer and finest wines, reconstructed so as to reflect hammer price per dozen 750ml bottles at US auctions only. For more information on the raw data, we refer to www.liquidassets.com. The "finest" index covers wines from Château Lafite, Latour, Margaux, Mouton, and Cheval Blanc. The "fine" index also covers Ducru Beaucaillou, Leoville Lascasses, Palmer, and Pichon Lalande. The "great" index covers only the top two: Lafite and Latour. All three indexes use wines from quite good vintages only: 1961, 1966, 1970, 1975, 1978, 1982, 1983, 1985, and 1986. The price index is constructed from regressions of log price on year, month, vintage, and château dummies. The series are log of nominal price of a constant-quality basket of wines.

References

Abel, Andrew, 1990, Asset prices under habit formation and catching up with the Joneses, *American Economic Review* 80, 38–42.

Andreoni, James, and John Miller, 2002, Giving according to GARP: An experimental test of the consistency of preferences for altruism, *Econometrica* 70, 737–753.

Atkeson, Andrew, and Masao Ogaki, 1996, Wealth-varying intertemporal elasticities of substitution: Evidence from panel and aggregate data, *Journal of Monetary Economics* 38, 507–534.

Attanasio, Orazio, James Banks, and Sarah Tanner, 1998, Asset holding and consumption volatility, *Journal of Political Economy*, forthcoming.

Attanasio, Orazio, and Martin Browning, 1995, Consumption over the life cycle and over the business cycle, *The American Economic Review* 85, 1118–1137.

Bakshi, Gurdip S., and Zhiwu Chen, 1996, The spirit of capitalism and stock-market prices, *The American Economic Review* 86, 133–157.

Brav, Alon, George M. Constantinides, and Christopher C. Geczy, 1999, Asset pricing with heterogeneous consumers and limited participation: Empirical evidence, *Journal of Political Economy*, forthcoming.

Breeden, Douglas T., Michael R. Gibbons, and Robert H. Litzenberger, 1989, Empirical test of the consumption-oriented CAPM, *The Journal of Finance* 44, 231–262.

Browning, Martin, and Thomas F. Crossley, 2000, Luxuries are easier to postpone: A proof, *Journal of Political Economy* 108, 1022–1026.

Campbell, John Y., 1987, Stock returns and the term structure, *Journal of Financial Economics* 18, 373–399.

———, 1999, Asset prices, consumption, and the business cycle, in John B. Taylor, and Michael D. Woodford, ed.: *Handbook of Macroeconomics*, vol. 1C . chap. 19, pp. 1231–1303 (Elsevier Science Publishers: New York).

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

Carroll, Christopher D., 2000, Why do the rich save so much?, in Joel B. Slemrod, ed.: *Does Atlas Shrug? The Economic Consequences of Taxing the Rich* (Harvard University Press: Cambridge).

Cogley, Timothy, 2002, Idiosyncratic risk and the equity premium: Evidence from the consumer expenditure survey, *Journal of Monetary Economics* 49, 309–334.

Constantinides, George M., 1990, Habit formation: A resolution of the equity premium puzzle, *Journal of Political Economy* 98, 519–543.

Dynan, Karen E., Jonathan Skinner, and Stephen P. Zeldes, 2000, Do the rich save more?, Working paper, Columbia University.

Epstein, Larry G., and Stanley E. Zin, 1991, Substitution, risk aversion, and the temporal behavior of consumption and asset returns: An empirical analysis, *Journal of Political Economy* 99, 263–286.

Fama, Eugene F., and Kenneth R. French, 1988, Dividend yields and expected stock returns, *Journal of Financial Economics* 22, 3–24.

Grossman, Sanford J., and Robert J. Shiller, 1981, The determinants of the variability of stock market prices, *The American Economic Review* 71, 222–227.

Guvenen, Muhammet F., 2000, Mismeasurement of the elasticity of intertemporal substitution: The role of limited stock market participation, Working paper, Carnegie Mellon University.

Hall, Robert E., 1988, Intertemporal substitution in consumption, *Journal of Political Economy* 96, 339–357.

Hanoch, Giora, 1977, Risk aversion and consumer preferences, *Econometrica* 45, 413–426.

Heaton, John, and Deborah J. Lucas, 1996, Evaluating the effects of incomplete markets on risk sharing and asset pricing, *Journal of Political Economy* 104, 443–487.

——— , 2000, Stock prices and fundamentals, in Ben S. Bernanke, and Julio Rotemberg, ed.: *NBER Macroeconomics Annual 1999* . chap. 4, pp. 213–242 (MIT Press: Cambridge).

Houthakker, H. S., 1960, Additive preferences, *Econometrica* 28, 244–257.

Huggett, Mark, and Gustavo Ventura, 2000, Understanding why high income households save more than low income households, *Journal of Monetary Economics* 45, 361–397.

Mankiw, N. Gregory, 1982, Hall's consumption hypothesis and durable goods, *Journal of Monetary Economics* 10, 417–425.

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

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

Moreira, Marcelo J., 2002, A conditional likelihood ratio test for structural models, Working paper, University of California, Berkeley.

Neely, Christopher J., Amlan Roy, and Charles H. Whiteman, 2001, Risk aversion versus intertemporal substitution: A case study of identification failure in the intertemporal consumption capital asset pricing model, *Journal of Business & Economic Statistics* 19, 395–403.

Nelson, Charles R., and Richard Startz, 1990, Some further results on the exact small sample properties of the instrumental variable estimator, *Econometrica* 58, 967–976.

Parker, Jonathan A., 2002, The consumption risk of the stock market, *Brookings Papers on Economic Activity* 2, 279–348.

Poterba, James M., 2000, Stock market wealth and consumption, *Journal of Economic Perspectives* 14, 99–118.

——— , and Andrew A. Samwick, 1995, Stock ownership patterns, stock market fluctuations, and consumption, *Brookings Papers on Economic Activity* 2, 295–357.

Shiller, Robert J., 1982, Consumption, asset markets, and macroeconomic fluctuations, *Carnegie Mellon Conference Series on Public Policy* 17, 203–238.

Staiger, Douglas, and James H. Stock, 1997, Instrumental variables regression with weak instruments, *Econometrica* 65, 557–586.

Stanley, Thomas J., and William D. Danko, 1998, *The Millionaire Next Door: The Surprising Secrets of America's Wealthy* (Simon and Schuster: New York).

Stiglitz, Joseph E., 1969, Behavior towards risk with many commodities, *Econometrica* 4, 660–667.

Stock, James H., and Jonathan H. Wright, 2000, GMM with weak identification, *Econometrica* 68, 1055–1096.

——— , and Motohiro Yogo, 2002, A survey of weak instruments and weak identification in generalized method of moments, *Journal of Business & Economic Statistics*, forthcoming.

Vissing-Jørgensen, Annette, 1999, Limited stock market participation and the equity premium puzzle, Working paper, University of Chicago.

——— , 2001, Limited asset market participation and the elasticity of intertemporal substitution, *Journal of Political Economy*, forthcoming.

Yogo, Motohiro, 2002, Estimating the elasticity of intertemporal substitution when instruments are weak, Working paper, Harvard University.

Table 1: Risk Aversion Implied by Government Data

The table reports properties of consumption growth for government data. (A), (Q), and (M) denote annual, quarterly, and monthly frequencies, respectively. Correlation is with respect to excess stock returns deflated by the appropriate price deflator. Standard deviation of consumption growth is reported at an annual rate. (For instance, by multiplying the quarterly rate by 2.) The last two columns report the coefficient of relative risk aversion estimated by method of moments. The first estimate is the conventional one that uses the sample covariance, and the second estimate corrects for time aggregation (TA) in consumption data by a factor of 1/2. Standard error in parentheses.

Series	Period	Correlation	Std Dev	Risk Aversion	
	(Obs)			Sample	TA Correct
PCE Nondur. & Serv. (A)	1930–2001	0.173	0.023	100.029	50.015
	(72)			(118.072)	(59.036)
PCE Nondur. & Serv. (Q)	1947–2001	0.137	0.011	346.556	173.278
	(219)			(185.747)	(92.873)
PCE Nondur. & Serv. (M)	1959–2001	0.147	0.013	210.597	105.298
	(515)			(104.842)	(52.421)
PCE Jewelry & Watches (A)	1960–2001	-0.147	0.063	-41.813	-20.906
	(42)			(56.729)	(28.364)
PCE Jewelry & Watches (Q)	1959–2001	-0.029	0.079	-161.359	-80.680
	(171)			(419.576)	(209.788)
PCE Jewelry & Watches (M)	1959–2001	0.085	0.102	47.352	23.676
	(515)			(33.909)	(16.955)
PCE Boats & Aircraft (A)	1960–2001	0.027	0.138	106.084	53.042
	(42)			(715.485)	(357.742)
PCE Boats & Aircraft (Q)	1959–2001	0.076	0.194	25.330	12.665
	(171)			(30.852)	(15.426)
PCE Boats & Aircraft (M)	1959–2001	-0.053	0.363	-21.312	-10.656
	(515)			(20.939)	(10.470)
Jewelry Retail Sales	1967–2001	0.109	0.118	31.811	15.906
	(411)			(20.508)	(10.254)
Jewelry Imports	1981–1999	-0.021	0.167	-206.961	-103.480
	(19)			(2768.212)	(1384.106)

Table 2: Risk Aversion Implied by Consumption of Luxury Goods

The table reports properties of consumption growth for luxury goods data. (A) and (Q) denote annual and quarterly frequencies, respectively. Correlation is with respect to excess stock returns deflated by the appropriate price deflator. Standard deviation of consumption growth is reported at an annual rate. (For instance, by multiplying the quarterly rate by 2.) The last two columns report the coefficient of relative risk aversion estimated by method of moments. The first estimate is the conventional one that uses the sample covariance, and the second estimate corrects for time aggregation (TA) in consumption data by a factor of 1/2. Standard error in parentheses.

Series	Period	Correlation	Std Dev	Risk Aversion	
	(Obs)			Sample	TA Correct
BMW & Mercedes Sales	1970–1999	0.232	0.108	27.964	13.982
	(30)			(23.040)	(11.520)
Jaguar & Porsche Sales	1962–1999	0.039	0.236	66.895	33.447
	(38)			(301.545)	(150.772)
Luxury Retail Sales (A)	1961–2001	0.299	0.095	13.984	6.992
	(41)			(11.151)	(5.575)
Tiffany Sales (A)	1961–2001	0.288	0.098	14.072	7.036
	(41)			(11.550)	(5.775)
Luxury Retail Sales (Q)	1987–2001	0.199	0.196	14.339	7.170
	(60)			(13.685)	(6.842)
Tiffany Sales (Q)	1987–2001	0.221	0.217	11.677	5.838
	(60)			(10.078)	(5.039)
Cómite Colbert	1984–1997	0.587	0.110	13.558	6.779
	(14)			(8.838)	(4.419)
Charitable Contributions	1954–1999	0.339	0.204	7.388	3.694
	(37)			(5.208)	(2.604)

Table 3: Risk Aversion Implied by Consumption Growth over Four Periods

The table reports properties of consumption growth measured over four periods. (A), (Q), and (M) denote annual, quarterly, and monthly frequencies, respectively. Correlation is with respect to excess stock returns deflated by the appropriate price deflator. The last two columns report the point estimate and Newey-West standard error for the coefficient of relative risk aversion estimated by method of moments.

		Risk Aversion	
Series	Correlation	Point Est	SE
Panel A: Government Data			
PCE Nondur. & Serv. (A)	0.409	18.850	17.348
PCE Nondur. & Serv. (Q)	0.228	87.264	36.640
PCE Nondur. & Serv. (M)	0.180	97.120	48.327
PCE Jewelry & Watches (A)	-0.034	-74.126	344.789
PCE Jewelry & Watches (Q)	0.091	27.276	23.045
PCE Jewelry & Watches (M)	0.058	39.535	34.273
PCE Boats & Aircraft (A)	0.039	38.583	118.711
PCE Boats & Aircraft (Q)	0.105	9.822	8.413
PCE Boats & Aircraft (M)	0.021	39.697	92.692
Jewelry Retail Sales	0.113	20.554	14.228
Jewelry Imports	-0.166	-11.782	23.756
Panel B: Consumption of Luxury Goods			
BMW & Mercedes Sales	-0.018	-129.035	825.551
Jaguar & Porsche Sales	0.036	25.914	85.260
Luxury Retail Sales (A)	0.206	10.033	6.474
Tiffany Sales (A)	0.268	6.917	3.814
Luxury Retail Sales (Q)	0.200	5.078	4.207
Tiffany Sales (Q)	0.195	4.310	3.348
Cómite Colbert	0.345	12.818	9.369
Charitable Contributions	0.227	4.346	3.191

Table 4: Estimates of the Elasticity of Intertemporal Substitution

The table reports the elasticity of intertemporal substitution (EIS), estimated by the conditional Euler equation. Stock return is the real return on NYSE-AMEX portfolio, and riskfree rate is the return on 3-month T-bill. From left to right, the table reports the first-stage F-statistic, the EIS estimated by two-stage least squares (TSLS) with standard error in parentheses, and the 95% confidence interval for EIS constructed using the conditional likelihood ratio (LR) test. Instruments include second lags of 3-month T-bill return, yield spread, log dividend-price ratio, and luxury price inflation.

	Stock return			Riskfree rate		
Series	F	TSLS	Cond LR	F	TSLS	Cond LR
Panel A: Government Data						
PCE Nondur. & Serv. (A)	1.019	-0.084	[0,∞]	8.591	-0.145	[-0.373,0.140]
		(0.071)			(0.111)	
PCE Nondur. & Serv. (Q)	4.669	0.015	[-0.032,0.076]	39.481	0.013	[-0.191,0.196]
		(0.016)			(0.093)	
PCE Nondur. & Serv. (M)	2.702	0.058	[0.011,0.603]	38.983	-0.112	[-0.474,0.226]
		(0.030)			(0.166)	
PCE Jewelry & Watches (A)	0.378	-0.382	[0,∞]	1.926	-0.375	[-17.098,0.418]
		(0.437)			(0.629)	
PCE Jewelry & Watches (Q)	1.851	0.298	[0,∞]	10.566	0.387	[-0.863,1.237]
		(0.209)			(0.444)	
PCE Jewelry & Watches (M)	2.175	0.203	[0,∞]	3.326	0.276	[-4.349,2.208]
		(0.227)			(0.752)	
PCE Boats & Aircraft (A)	2.207	0.000	[0,∞]	1.377	-0.849	[0,∞]
		(0.305)			(1.469)	
PCE Boats & Aircraft (Q)	3.364	0.016	[-1.311,1.050]	6.166	-0.471	[-4.343,2.602]
		(0.331)			(1.403)	
PCE Boats & Aircraft (M)	3.023	-0.040	[-2.385,2.295]	2.570	-1.327	[-17.764,6.816]
		(0.685)			(2.927)	
Jewelry Retail Sales	2.190	0.360	[-0.491,57.503]	5.792	0.486	[-1.582,2.073]
		(0.262)			(0.679)	
Jewelry Imports	0.760	-0.147	[0,∞]	1.019	1.610	[0,∞]
		(0.715)			(0.957)	

	Stock return			Riskfree rate		
Series	F	TSLS	Cond LR	F	TSLS	Cond LR
Panel B: Consumption of Luxury Goods						
BMW & Mercedes Sales	1.008	0.335	[0,∞]	2.024	-0.586	[0,∞]
		(0.357)			(1.190)	
Jaguar & Porsche Sales	0.843	1.445	[0,∞]	1.537	-0.794	[0,∞]
		(1.105)			(3.115)	
Luxury Retail Sales (A)	0.629	-0.112	[0,∞]	2.438	-0.579	[-8.459,0.857]
		(0.419)			(0.825)	
Tiffany (A)	0.629	-0.084	[0,∞]	2.438	-0.371	[-11.713,1.087]
		(0.424)			(0.824)	
Luxury Retail Sales (Q)	1.381	0.100	[0,∞]	2.509	0.133	[-7.315,7.367]
		(0.548)			(1.652)	
Tiffany (Q)	1.381	-0.028	[0,∞]	2.509	1.782	[-4.068,23.704]
		(0.617)			(1.869)	
Cómite Colbert	1.740	0.092	[-31.989,0.693]	0.226	-0.128	[0,∞]
		(0.349)			(2.819)	
Charitable Contributions	0.151	2.040	[0,∞]	1.626	1.476	[0,∞]
		(2.105)			(1.025)	

Table 5: Equity Premium Implied by the Price of Luxury Goods in Inelastic Supply

The table reports properties of price growth for luxury goods in inelastic supply. Correlation is with respect to excess stock returns. Standard deviation of price growth is reported at an annual rate. (Since all series are quarterly, we multiply by 2.) The last two columns report the equity premium (in annualized percentage points) estimated by method of moments. The first estimate is the conventional one that uses the sample covariance, and the second estimate corrects for time aggregation (TA) in price data by a factor of 2. Standard error in parentheses.

Series	Period (Obs)	Correlation	Std Dev	Equity Premium (%) Sample	Equity Premium (%) TA Correct
PCE Nondur. & Serv. ($\phi = 10$)	1947–2001	0.137	0.108	0.218	0.437
	(219)			(0.109)	(0.219)
Manhattan Coops	1988–1999	0.095	0.294	0.370	0.740
	(45)			(0.540)	(1.080)
Manhattan Coops (4+ bed)	1988–1999	0.265	0.405	1.554	3.108
	(45)			(1.129)	(2.257)
Manhattan Luxury Coops	1988–1999	0.329	0.373	1.679	3.358
	(45)			(1.152)	(2.303)
Manhattan Luxury Coops (4+ bed)	1988–1999	0.333	0.635	3.920	7.841
	(45)			(2.301)	(4.603)
Fine Wine	1989–1997	-0.249	0.225	-0.573	-1.147
	(32)			(0.521)	(1.042)
Finest Wine	1989–1997	-0.210	0.225	-0.456	-0.912
	(32)			(0.473)	(0.946)
Great Wine	1989–1997	-0.157	0.214	-0.342	-0.684
	(32)			(0.367)	(0.734)

Figure Captions

Figure 1. Response of basic and luxury consumption to stock returns. A) Scatter plot of the growth rate for PCE nondurables & services and sales of luxury retailers against excess stock returns (CRSP NYSE-AMEX value-weighted portfolio over 3-month T-bills). The thin (thick) line is the least squares regression line for PCE nondurables & services (sales of luxury retailers). B) Time series plot of the growth rate for PCE nondurables & services, growth rate for sales of luxury retailers, and excess stock returns. All three series have been normalized to have zero mean and are reported in percentage points.

Figure 2. Consumption of basic and luxury goods with nonhomothetic utility. The figure plots the consumption of basic goods (C) and luxury goods (L) as a function of total expenditures (X) under extended addilog utility.

Figure 3. Response of luxury consumption to stock returns. Time series plot of excess stock returns (CRSP NYSE-AMEX value-weighted portfolio over 3-month T-bills) and the growth rate for A) US sales of imported BMW & Mercedes, B) US sales of imported Jaguar & Porsche, C) annual sales of Tiffany, D) quarterly sales of luxury retailers, E) quarterly sales of Tiffany, F) US sales of Cómite Colbert, and G) charitable contributions by households with AGI over $1m. All series have been normalized to have zero mean and are reported in percentage points.

Figure 4. Response of price of luxury goods in inelastic supply to stock returns. Time series plot of excess stock returns (CRSP NYSE-AMEX value-weighted portfolio over 3-month T-bills) and the growth rate for A) price of luxury (Central Park West, Park Avenue, and Fifth Avenue) Manhattan pre-war coop apartments and B) finest Bordeaux wine price index. All series have been normalized to have zero mean and are reported in percentage points.

Figure 1A

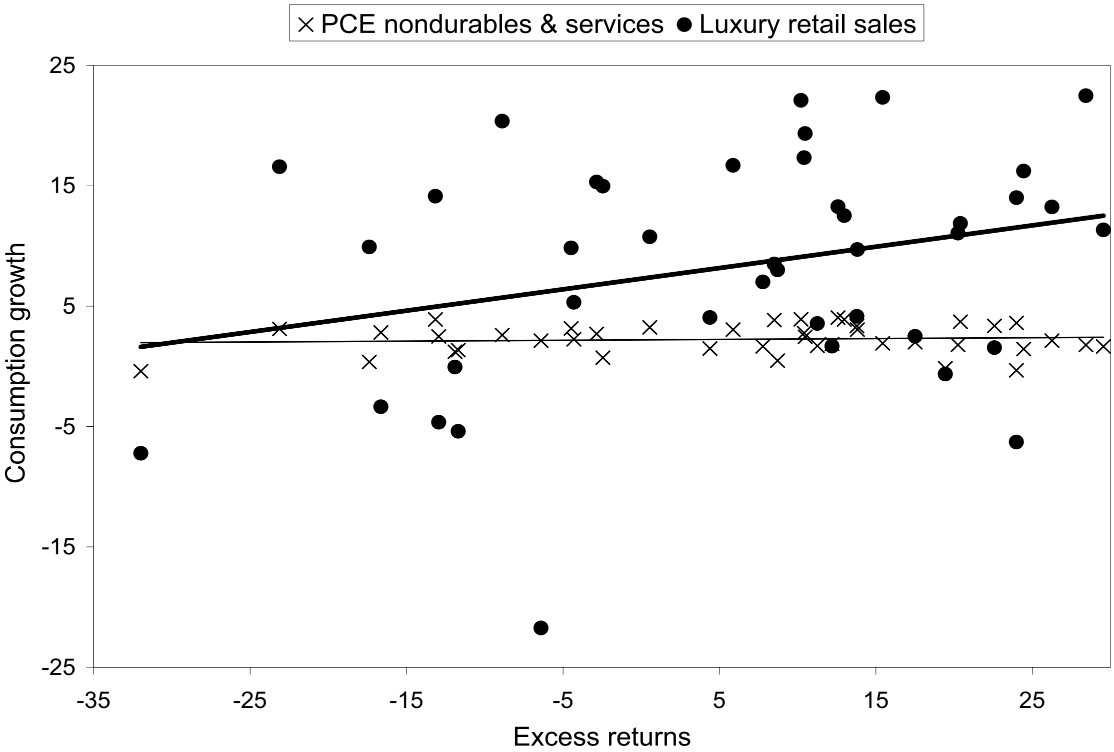


Figure 1B

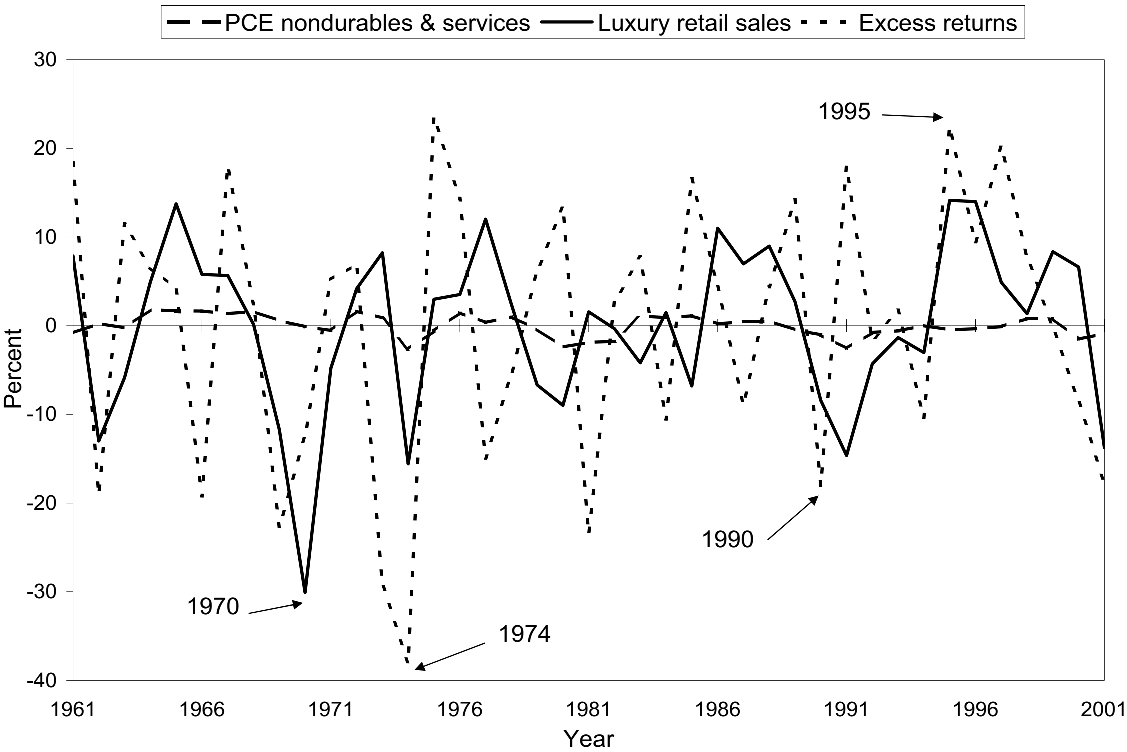


Figure 2

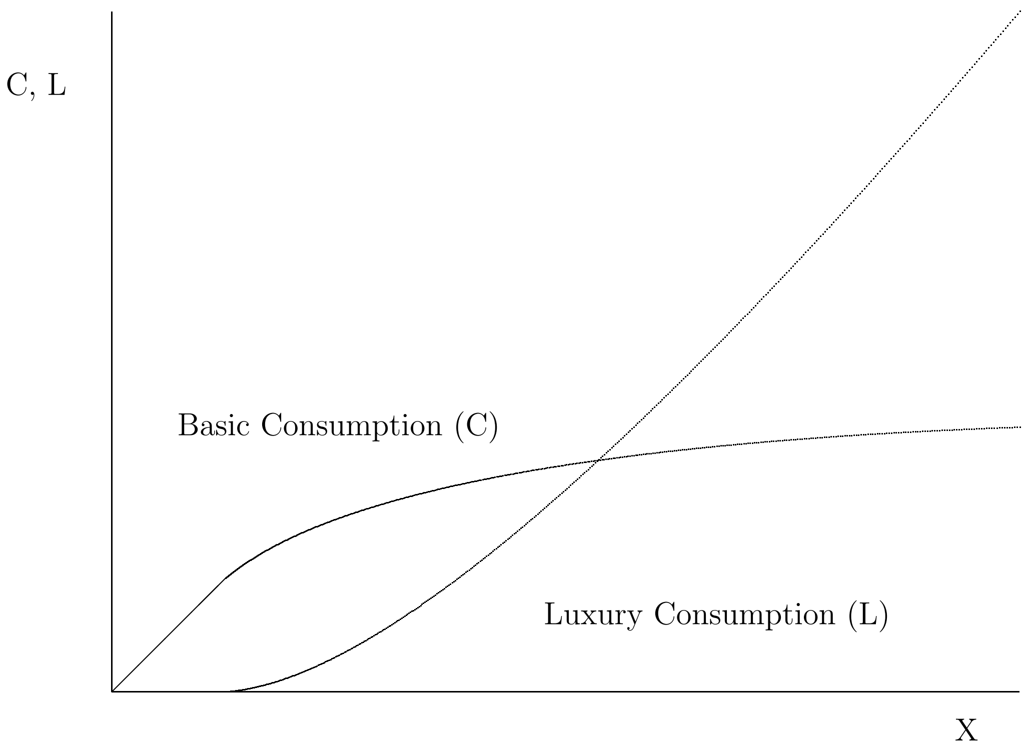


Figure 3A

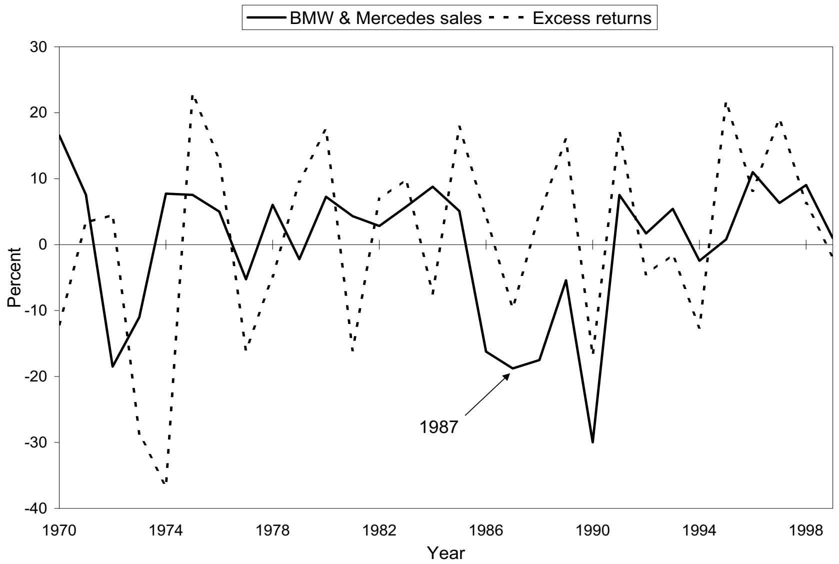
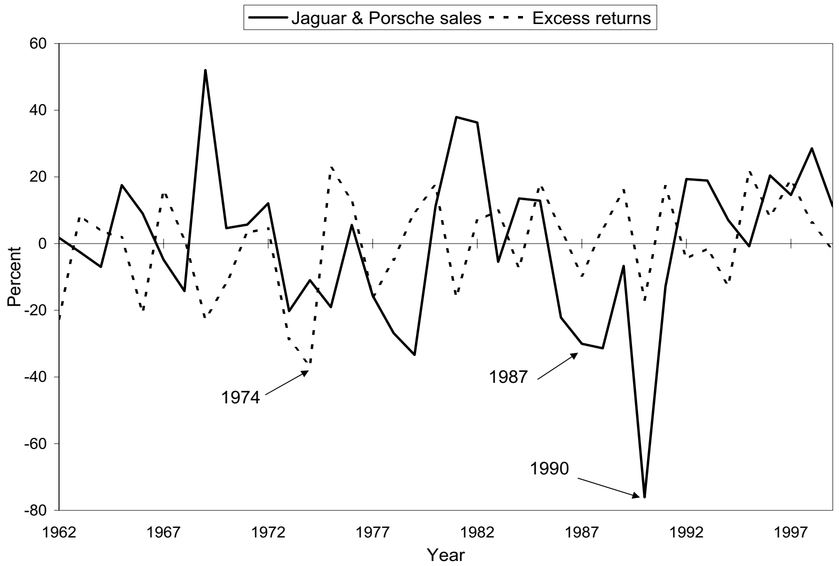


Figure 3B



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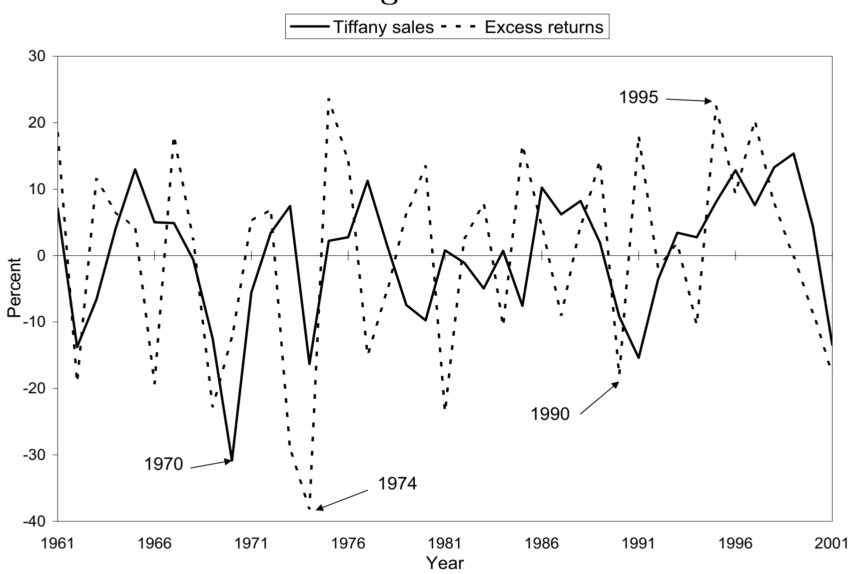

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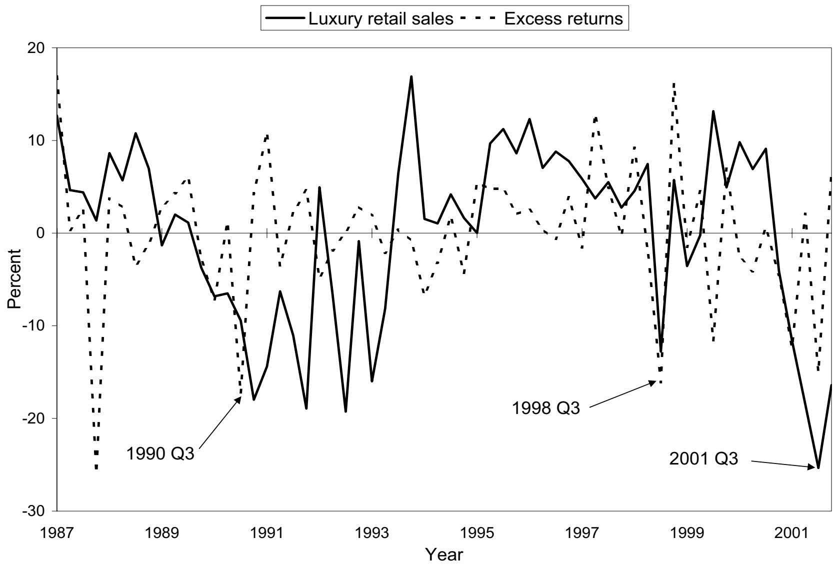

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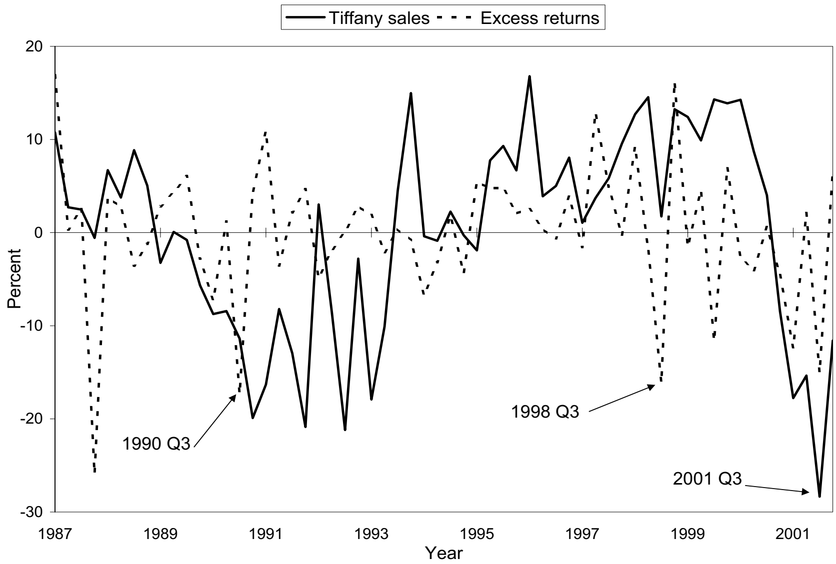

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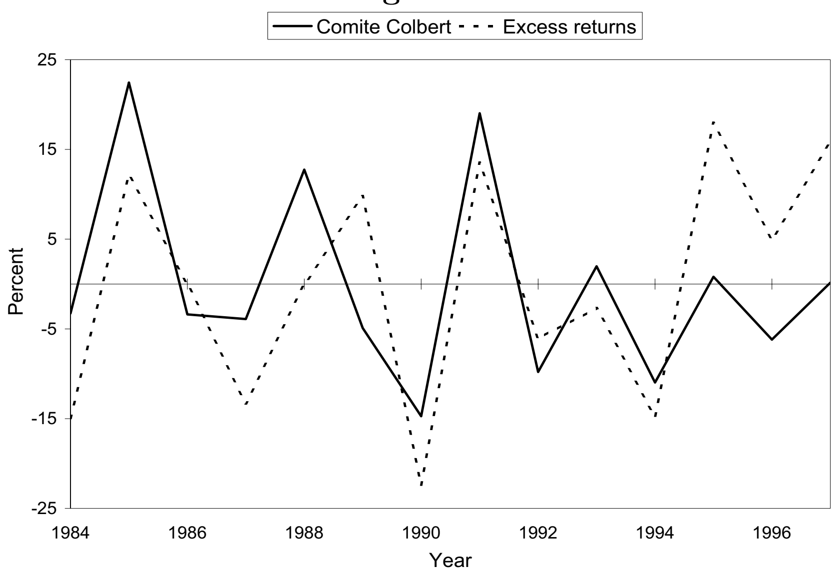

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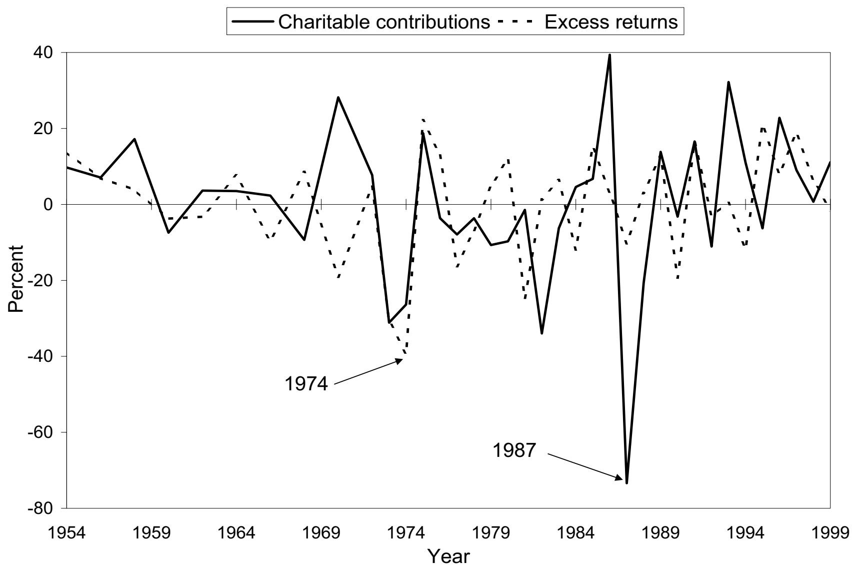

Charitable contributions
Excess returns
40
20
0
-20
-40
-60
-80
Percent
1974
1987
1954
1959
1964
1969
1974
1979
1984
1989
1994
1999
Year

Figure 4A

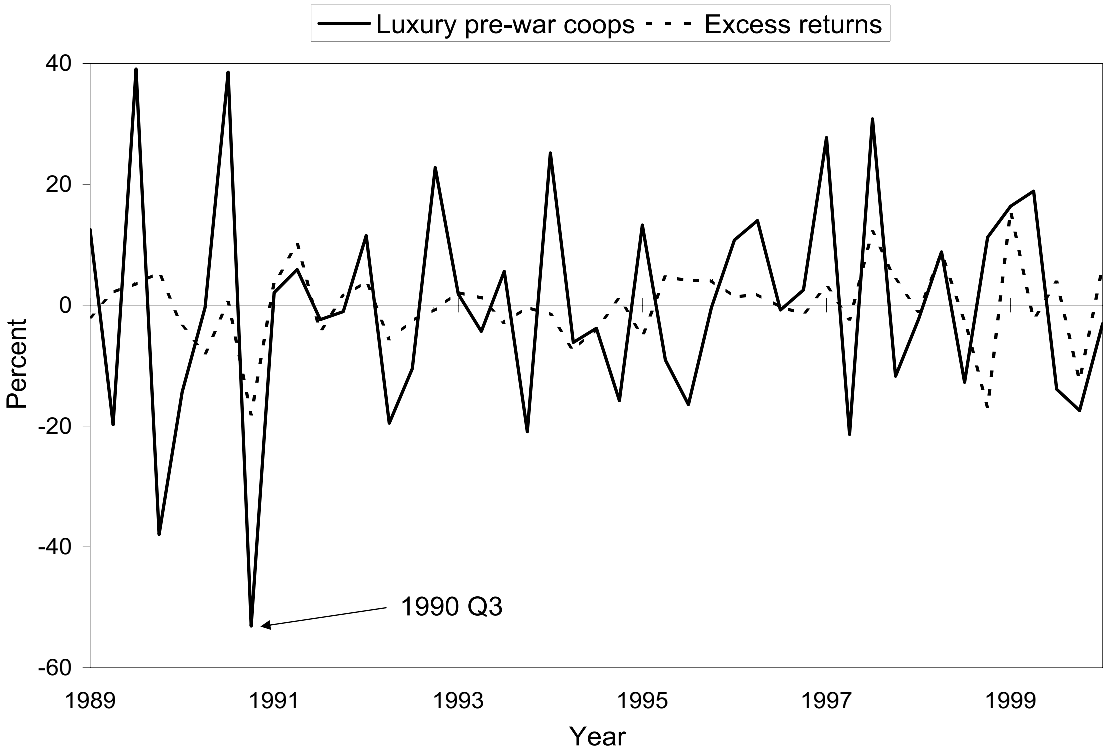

Figure 4B