

Can Dynamic Goods Explain Asset Returns?

Paul Scanlon*

Trinity College, Dublin.

December 2013

Abstract

I present and test a model where consumers value new goods and product improvements. I show that a two factor macroeconomic model—comprising consumption growth and the growth of *dynamic* goods—explains cross-sectional variation in the 25 Fama-French portfolios as well as the classic three-factor Fama-French (1993) model. In the calculation of the CPI, dynamic goods are those that are routinely replaced with new products. By construction, changes in the consumption of these goods correlate with product introduction and improvements—and therefore capture consumption composition risk. In the time series dimension, I show the model attenuates the equity premium puzzle.

*I am indebted to Peter Kingston and Tony O'Connor for research assistance. Email: scanlop@tcd.ie

Introduction

As well as its movements over time, the size of the expected equity premium is hard to reconcile with standard theory. While it has long been recognized that measurement issues could explain the poor performance of the CCPAM, there has been little concrete effort to redress this. In this paper, I address a specific measurement issue: the bias in the CPI due to the introduction of new goods. Although new and improved products effectively reduce the price of consumption—and therefore reduce marginal utility—current empirical work in asset pricing discounts this possibility. Particularly in a field where relatively small changes in the stochastic process governing consumption frequently has first-order effects on asset prices, such an omission is potentially significant. For a field that values asset returns by their consumption value, new consumption products capture another dimension of consumption risk.

First, I show how widely recognized problems with price indices affect the stochastic discount factor. From the perspective of asset pricing, incorporating product improvements and quality enhancements introduces another risk factor into the CCAPM: as well as pricing standard consumption risk, it now also prices variety risk. Yet, the main contribution of this paper is to quantify this risk factor, and determine its importance in empirical asset pricing. To do this, I use data on product substitution rates from the BLS. To calculate the CPI, the BLS samples thousands of goods each year and records which goods have been replaced on shelves with similar goods and brands. Goods exhibiting high substitution rates are typically those that have been replaced with an improved product or a new brand. Using this data, I construct a basket of *dynamic* goods: these are categories of goods that exhibit a high replacement rate in the construction of the CPI. By contrast, the remaining goods—static goods—are rarely replaced, and such categories have stable product characteristics over time. Because changes in the consumption in dynamic goods—by construction—correlate with product improvement and new goods, dynamic good growth correlates with product variety growth. In this study, dynamic goods mainly comprise consumer durables,

food, and clothing. Together with aggregate consumption growth, I use this basket of dynamic goods to capture consumption risk.

I test the two-factor macroeconomic model. In the spirit of [Hansen and Singleton \(1983\)](#), I estimate the stochastic Euler equation by the general method of moments (GMM), and show that the estimation implies a lower degree of risk aversion; that is, the model attenuates the equity premium puzzle. Using the standard [Fama and MacBeth \(1973\)](#) procedure and GMM, I show that this model can price the 25 Fama-French portfolios almost as well as the benchmark Fama-French three-factor model. Although both risk factors are statistically significant, most of the explanatory power derives from movements in the consumption of the dynamic goods. Why do dynamic goods work better? Empirically, the dynamic basket is more volatile and correlates more highly with equity returns. By contrast, static goods—mainly services—exhibit little volatility. Moreover, and especially for the case of durables, the consumption of dynamic goods more likely covaries with marginal utility and expectations about the future: having spent money on commitment goods—such as health insurance and fuel—dynamic goods are more likely to comprise the marginal unit.

This empirical study is the first to acknowledge the issue of price bias and its implications for asset pricing. Throughout the economic literature, the bias has been widely recognized: the Boskin Commission estimated it to be as high as 1.6% a year. Meanwhile, [Hausman \(2002\)](#) argues forcefully that the new goods bias is first order and existing adjustments are “severely inadequate.” While the BLS performs hedonic adjustment for certain durable goods, such adjustments are non-existent for most goods. More importantly for this study, [Broda and Weinstein \(2010\)](#) find the bias to be highly cyclical. Attesting to considerable product churning, they find that sixty percent of the products in their sample had been introduced over the preceding four-year period. This study shows that the bias has potentially important consequences for consumption-based asset pricing. While much work in empirical finance relies on specific stochastic processes for consumption—such as its precise GARCH specification—the effects of the CPI bias outlined here could swamp the implications of these spec-

ifications. Moreover, with continuing technological progress, the bias will likely get worse.

Several recent studies have addressed measurement issues in consumption. An early contribution is [Ait-Sahalia et al. \(2004\)](#), who contend that the marginal unit of consumption comprises luxury goods. Consistent with this, they find that luxury goods have greater pricer power than aggregate consumption. Exemplifying another approach is [Savov \(2011\)](#), who maintains that garbage growth is a useful proxy for consumption growth and avoids many of the aggregation issues associated with aggregate consumption. Proceeding along similar lines, [Da et al. \(2010\)](#) incorporates household production into the CCAPM; [Da and Yun \(2010\)](#) use electricity growth as a proxy for consumption growth; while [Chen and Lu \(2013\)](#) use carbon dioxide omissions. To address the issue of adjustment frictions, [Parker and Julliard \(2005\)](#) use the long-run growth of consumption, while [Jagannathan and Wang \(2007\)](#) use fourth quarter to fourth quarter consumption. In each of these cases, the authors use another measure of consumption or timing convention, which improves the empirical performance of the CCAPM.

I proceed as follows. In Section 1, I present a simple model that highlights the implication of CPI bias for asset pricing. The model is a streamlined version of [Scanlon\(2010\)](#). In particular, I present a consumption basket that incorporates new goods and quality improvement. More importantly, I derive the associated price index and compare the index to what the BLS measure empirically—and therefore highlight what is missing in theory. Having presented the model, in Section 2 I describe my data. In Section 3, I present the results. Following this, Section 4 concludes.

1 The Model

I present a simple model with separable utility and a representative consumer. The consumption basket is

$$c_{jt} \equiv m_t^{v+1-\frac{1}{\alpha}} \left(\int_0^{m_t} (A_t^\gamma c_{jit})^\alpha di \right)^{\frac{1}{\alpha}}, \quad (1)$$

where $c_{jit} \geq 0$, $\alpha \in (0, 1)$, and $m_t > 0$ denotes the number of brands actually consumed. A rise in quality A_t increases the utility derived from the consumption of each brand, and $\gamma > 0$ mediates the taste for quality. For clarity, I set the upper integral limit to m_t and not to infinity, but technically utility is defined over the range $[0, \infty)$ of goods. Since there is a continuum of brands, the elasticity of substitution between brands within each group is $\frac{1}{1-\alpha} \in (1, \infty)$.

Following [Benassy \(1996\)](#), $v \in (0, \infty)$ mediates the taste for brand variety, and governs the elasticity of the marginal utility of consumption with respect to the number of brands consumed. This parameter disentangles the distinct concepts of elasticity of substitution between brands—which also equals the elasticity of demand for each brand—and love of variety.¹ As a result, this formulation can handle situations where the consumer might be highly responsive to price changes, but still have a large taste for variety; or cases where the consumer has little taste for variety, but perceives goods as imperfect substitutes.

Continuing, expected lifetime utility is

$$U = \mathbb{E} \sum_{t=0}^{t=\infty} \frac{c_{jt}^{1-\theta}}{1-\theta}. \quad (2)$$

and the associated stochastic Euler equation for holding an asset with random return \tilde{r}_t between time t and $t + 1$ is

$$V'(C_t) = \beta \mathbb{E}_t[(1 + \tilde{r}_t)V'(C_{t+1})]. \quad (3)$$

Substituting the expression for marginal utility into (3), dividing across by $V'(C_t)$,

¹To see why, suppose consumption expenditure on a group is C_t . Given symmetry and strict concavity, people consume all available brands in equal quantities, so $c_{jt} = m_t^{v+1-\frac{1}{\alpha}} m_t^{\frac{1}{\alpha}-1} A_t^\gamma C_t = m_t^v A_t^\gamma C_t$. The parameter $v > 0$ now mediates the marginal utility gain to consuming additional brands. By comparison, the standard [Dixit and Stiglitz \(1977\)](#) function conflates the degree of love of variety with the elasticity of substitution and implicitly assumes $v = \frac{1}{\alpha} - 1$.

dropping time subscripts, and taking unconditional expectations yields

$$1 = \beta \mathbb{E} \left[(1 + \tilde{r})(1 + \tilde{g}_c)^{-\theta} (1 + \tilde{g}_m)^{v(1-\theta)} (1 + \tilde{g}_A)^{\gamma(1-\theta)} \right]. \quad (4)$$

Taking differences and unconditional expectations of the linearized Euler equations for both the risk-free and risky assets gives the expected equity premium:

$$\mathbb{E}(r - r_f) = \theta \sigma_{r, g_c} + v(\theta - 1) \sigma_{r, g_m} + \gamma(\theta - 1) \sigma_{r, g_A}. \quad (5)$$

Throughout, I refer to this as the *dynamic* CCAPM. Another way to look at the issue is to examine the price index associated with the consumption basket in 2:

$$p_t = A_t^{-\gamma} m_t^{-v-1+\frac{1}{\alpha}} \left(\int_0^{m_t} p_{it}^{\frac{\alpha}{\alpha-1}} di \right)^{\frac{\alpha-1}{\alpha}} \quad (6)$$

As measured, current studies assume no welfare improvement to new goods and that quality adjustments are nonzero (i.e., $\gamma = v = 0$). Because the price index deflates nominal consumption, this leads to omitted terms in the stochastic discount factor and associated stochastic Euler equations. Especially given the evidence in [Broda and Weinstein \(2010\)](#) that the bias is correlated with the business cycle, this omission is potentially significant.

2 Data and Results

Data on aggregate real consumption and consumption categories comes from the Bureau of Economic Analysis (BEA). I measure stock returns by the value-weighted return on the NYSE-AMEX portfolio from the Center for Research in Security Prices (CRSP). The risk-free return is the return on a three-month T-Bill, available from the CRSP database. Throughout, I deflate all returns by the personal consumption deflator. Data on the Fama-French portfolio returns comes from Kenneth French's website. Trademark data comes from the *Historical Statistics of the United States*. To obtain per

capita values, I deflate all quantity series by population data, which is available from the U.S. Census Bureau. Following [Campbell \(2002\)](#), I use the beginning-of-period time convention in the calculation of growth rates; that is, I assume all consumption takes place at the beginning of a time period.

To determine which goods are dynamic, I use product substitution frequencies for the period 1998-2005, available from the appendix of [Nakamura and Steinsson \(2008\)](#). The dynamic consumption basket mainly comprises consumer durables, food, and clothing. To estimate the service flow from durable goods, I assume the consumption services flow from durables is proportional to the stock. To estimate the growth rate of the stock, I follow [Parker and Julliard \(2005\)](#), who maintain that the growth rate of the flow over a number of periods is cointegrated with the growth of the stock over that period. Based on their procedure, I estimate the growth rate of the stock as the six-period growth rate of the flow of expenditure on durables. According to them, this is a more accurate measure of the change in the stock associated with equity returns, and avoids many of the issues that plague the perpetual inventory technique.² To estimate dynamic goods growth, I use expenditure shares to take a weighted average of the growth rates of the basket components. To determine shares, I use a moving average of expenditure shares over the past decade; this way, a fall in one component is not double counted as a fall in the share *and* a fall in the growth rate.

2.1 Time Series Tests

Figure 1 shows the variation in consumption growth and the excess real return on the market index over the period 1951-2012. Figure 2 shows a similar graph with dynamic goods growth. Figure 1 highlights the relative stability of consumption and the difficulty the standard CCAPM has in fitting the data. As a result of this smoothness, only an implausible degree of risk aversion can rationalize expected returns. By contrast,

²Using the standard perpetual inventory technique, I also calculate all results with the growth rate of the stock of durables. Although this procedure leads to significant results with explanatory power for asset returns, the results are weaker.

Market Excess Return and Consumption Growth, 1951-2012

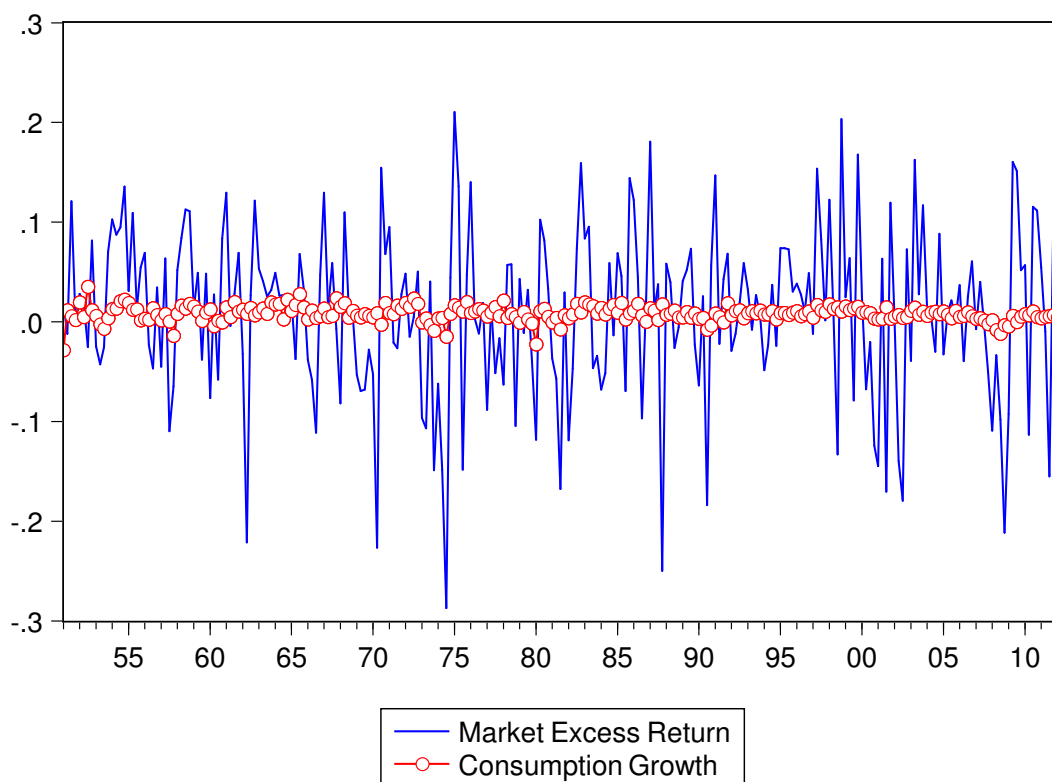


Figure 1: THE EQUITY PREMIUM AND CONSUMPTION GROWTH, 1951-2012
Source: CRSP and BEA

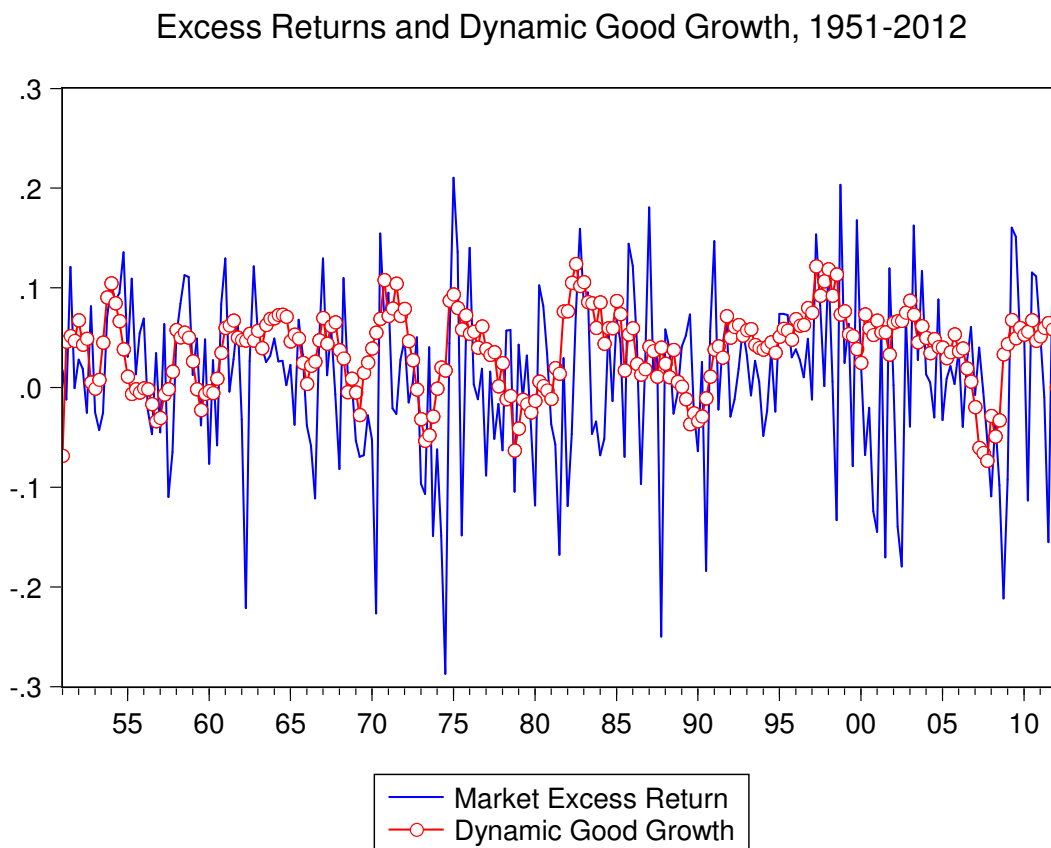


Figure 2: THE EQUITY PREMIUM AND DYNAMIC GOOD GROWTH, 1951-2012

Source: CRSP and BEA

incorporating dynamic goods introduces more variation in the stochastic discount factor. To formalize this discussion, I use the general method of moments (henceforth *GMM*) to estimate the stochastic Euler equation; in particular, I estimate the discount factor, β , and the coefficient of relative risk aversion, θ .³ As instruments I use the lagged market return, the default spread on corporate bonds, and the book-to-market ratio (the ratio of book value to market value for the Dow Jones Industrial Average). ? show that these variables perform well in predicting returns. I present results for

³Rotemberg and Woodford (1991) cite markups of between 20 and 40 percent, corresponding to elasticities of demand between 3.5 and 6. Based on these findings, I use an elasticity of 5 as a baseline, implying $\nu \approx .3$. I assume this value in the GMM estimation. Klenow (2003) recommends a value of $\gamma = 1$, which I impose.

Table 1: Euler Equation GMM Estimation with Market Excess Returns

	(1)	(2)	(3)	(4)
Model	CCAPM	DynCCAPM	StatCCAPM	PJ
β	1.02*** (0.03)	1.04*** (0.03)	1.10*** (0.09)	1.05*** (0.05)
θ	3.83 (2.56)	1.92*** (0.62)	11.58 (8.62)	1.20 (0.97)
Observations	191	190	190	190
Hansen J	0.41	0.62	.52	.42

Standard errors in parentheses

*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

both standard CCAPM, the dynamic CCAPM (DynCCAPM), and a model with static goods only (StatCCAPM). Finally, to compare results to a popular consumption measure, I also present results for the Parker–Julliard (PJ) measure of consumption (i.e., “long-run” consumption growth over six quarters). Confirming the pictorial evidence, the two-factor model implies a lower level of risk aversion; that is, the model attenuates the equity premium puzzle. Although the model is overidentified, the Hansen-J test fails to reject the overidentification restrictions—suggesting the instruments are valid. However, as is common in similar Euler equation tests, the confidence intervals for the parameter values are large. Tests with annual data produce similar results.⁴

⁴Because time-aggregation tends to smooth consumption, these estimates tend to overestimate risk-aversion; see e.g., [Breedon et al. \(1989\)](#). A related point is because I am using lags as instruments, I am testing the conditional CCAPM; as a result, the estimation produces levels of risk aversion lower than that of an unconditional model.

2.2 Cross-Sectional Variation in Returns

For the cross-sectional analysis, I test whether the model can explain the cross-sectional variation in the 25 size and book-to-market Fama-French portfolios. There are two reasons for choosing these portfolios. First, these portfolios exhibit a large cross-sectional variation in returns. Second, the use of these portfolios has become a benchmark test of asset pricing models. Table 2 shows the results of the Fama-MacBeth regressions for quarterly data over the period 1951-2012. Because the betas from the first-stage regression are estimates, I also use [Shanken \(1992\)](#) standard errors, but results change little. I also present results for the classic three-factor [Fama and French \(1993\)](#) model; SMB and HML refer to the Fama-French mimicking portfolios related to size and book-to-market equity ratios.⁵ Figures 3 and 4 presents graphs, showing the respective fits of the standard CCAPM and dynamic CCAPM in quarterly data. Table 3 presents the Fama-MacBeth results for annual data. For comparison, I also include the successful [Jagannathan and Wang \(2007\)](#) measure of consumption growth (JW); this measures annual consumption growth as fourth-quarter to fourth-quarter consumption growth. Finally, in the final column, I estimate the trademark stock and use it as a proxy for dynamic good growth.⁶

As recommended by [Cochrane \(2005\)](#), I also estimate the quarterly system by two-stage GMM as a robustness check; I use the identity matrix in the first stage, and the optimal weighting matrix in the second. Yet, one issue with GMM estimation in this context is there is limited data to estimate a 25-equation system with over a hundred moments. For this reason, I estimate the means and variances of portfolio returns sepa-

⁵By regressing consumption and dynamic good growth over time on the returns of the *six* Fama-French portfolios (see Kenneth French's website), I also estimate mimicking portfolios and use these in the tests. Because mimicking portfolios—by construction—produce better fits, the results are stronger for this estimation. Here, I restrict my presentation to the standard tests of the CCAPM.

⁶Because trademark data is only available annually, I only use this measure in the annual estimation. Using the perpetual inventory technique, I estimate the trademark stock from the annual number of trademark registrations and renewals. Yet, there are problems with trademark data. Throughout the period of estimation, trademark legislation changed, leading to a discontinuities in the data (which I control for.) In addition, a single firm could issue a number of products under the same existing trademark; and this would likely be the case for large existing firms, which indeed produce most new products ([Broda and Weinstein \(2010\)](#)).

Table 2: Quarterly Fama-MacBeth Regressions with 25 Fama-French Portfolios

Model	(1) CCAPM	(2) DynCCAPM	(3) StatCCAPM	(4) FF
Consump.	.003 (0.004)	0.002 (0.002)		
Dyn.		0.056*** (0.009)		
Stat.			-.0003 (0.003)	
S&P				-0.007 (0.01)
HML				0.014*** (0.002)
SMB				0.005** (0.002)
Constant	0.005 (0.01)	-0.007 (0.007)	0.017 (0.011)	0.017 (0.011)
Observations	246	246	246	246
R^2	0.04	0.67	.001	0.69

Standard errors in parentheses

*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

rately. As noted by [Savov \(2011\)](#), this enhances the efficiency of estimation; otherwise, in an attempt to find betas to match cross-sectional variation, standard GMM estimation would produce distorted means and variances of returns. Table 4 presents the results of this estimation for the dynamic CCAPM model. Throughout, the coefficient on dynamic goods growth is highly significant and relatively robust to different time-frames and methodologies.

Table 3: Annual Fama-MacBeth Regressions with 25 Fama-French Portfolios

Model	(1) CCAPM	(2) DynCCAPM	(3) StatCCAPM	(4) FF	(5) JW	(6) Trade.
Consump.	.003** (0.004)	0.013*** (0.002)			.028*** (0.004)	0.015*** 0.001
Dyn.		0.060*** (0.005)				0.021*** 0.004
Stat.			.006 (0.007)			
S&P				-0.033 (0.027)		
HML				0.05*** (0.009)		
SMB				0.021*** (0.006)		
Constant	-0.019 (0.03)	-0.005 (0.01)	0.034 (0.041)	0.07*** (0.025)	-0.044*** (.014)	-0.012 .015
Observations	62	62	62	62	62	
R ²	0.33	0.76	.07	0.80	.61	

Standard errors in parentheses

*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

3 Discussion

The empirical work suggests that changes in dynamic goods growth is a significant risk factor. Changes in dynamic goods growth correlates with the unmeasured welfare improvements associated with new products and quality improvements and therefore captures a component of consumption risk. While the BLS perform some hedonic adjustment for a limited number of goods, no attempt is made to measure the consumer surplus improvement associated with new products. As shown by [Hausman \(1996\)](#), this can be significant even for goods such as new breakfast cereals. The volatility of dynamic goods growth, coupled with the cyclical nature of product introduction suggests that existing models are failing to capture this dimension of consumption risk. A related issue is whether the framework can address return predictability and volatility. Unreported work indicates heteroskedasticity in the stochastic process for dynamic

Table 4: Two-Stage Cross-Sectional GMM Estimation with 25 Fama-French Portfolios

Factor	
Constant	.010*** (0.004)
Dyn.	0.059*** (0.0006)
Cons.	-.006*** (0.001)
Observations	189
Hansen J	0.94

Standard errors in parentheses
 *** p<0.01, ** p<0.05, * p<0.1

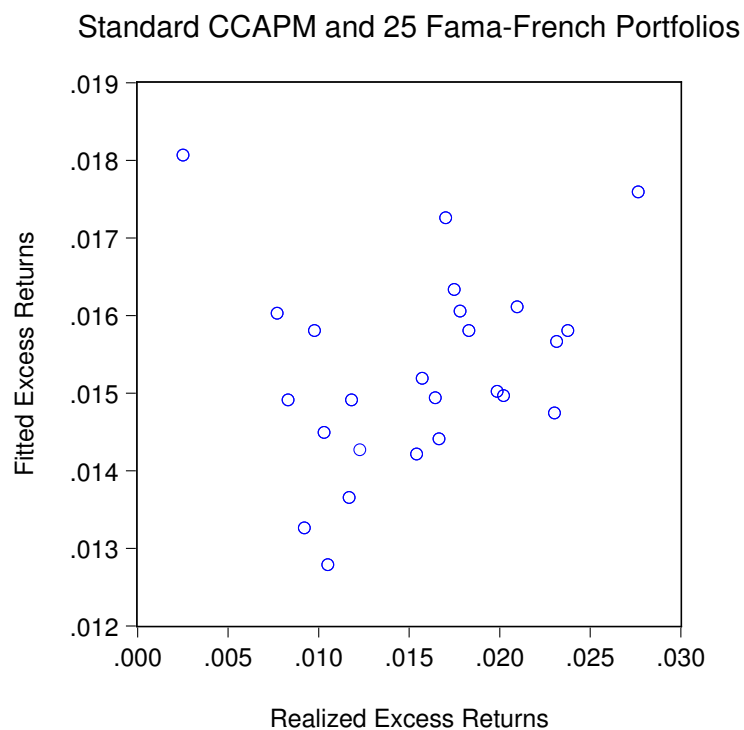


Figure 3: THE FIT OF THE STANDARD CCAPM, 1951-2012 (QUARTERLY DATA)
 Source: CRSP and BEA

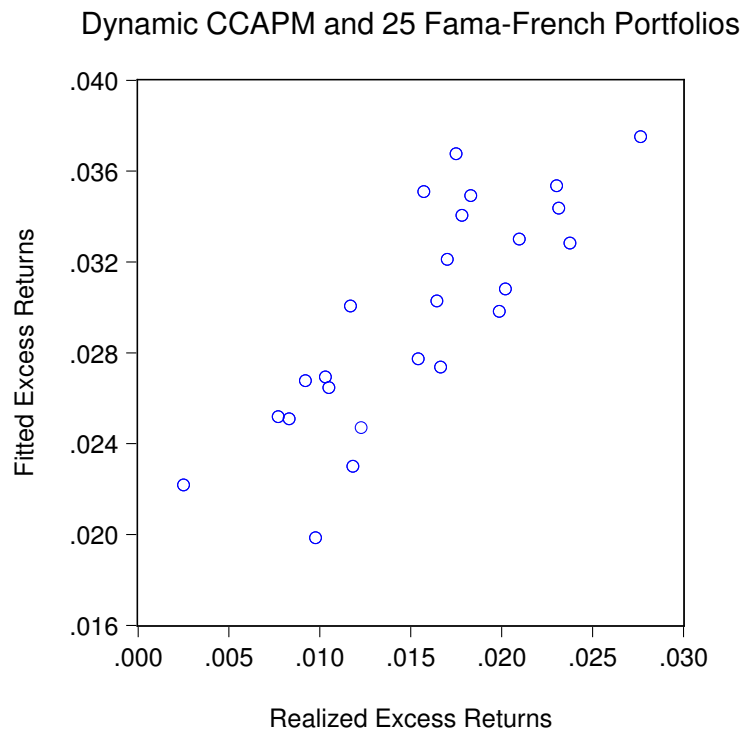


Figure 4: THE FIT OF THE DYNAMIC CCAPM, 1951-2012 (QUARTERLY DATA)
 Source: CRSP and BEA

goods growth; this suggests the framework would yield a time-varying risk premium. Moreover, the introduction of habit persistence at the level of goods as in [Ravn et al. \(2007\)](#) would improve the asset pricing properties of the framework.

4 Conclusion

I present a theory incorporating new product introduction in asset pricing. So far, consumption-based asset pricing has paid no attention to this issue. Yet, for a theory that revolves around the *value* of an extra unit of consumption, incorporating new types of consumption is an important consideration. Consistent with the theory, the model performs well empirically and can explain most of the variation in the 25 Fama-French size and book-to-market portfolios. Recent empirical work has lent support to

the CCAPM; rather than substituting for this work, this approach here complements it. Notwithstanding its limitations, the findings suggest this topic deserves more attention. Ultimately, all economic growth is about product innovation; it would be surprising if there was little connection between asset returns and product innovation.

References

- Ait-Sahalia, Y., J. A. Parker, and M. Yogo (2004, December). Luxury Goods and the Equity Premium. *Journal of Finance* 59(6), 2959–3004.
- Benassy, J.-P. (1996, July). Taste for variety and optimum production patterns in monopolistic competition. *Economics Letters* 52(1), 41–47.
- Breeden, D. T., M. R. Gibbons, and R. H. Litzenberger (1989, June). Empirical Tests of the Consumption-Oriented Capm. *Journal of Finance* 44(2), 231–262.
- Broda, C. and D. E. Weinstein (2010). Product Creation and Destruction: Evidence and Price Implications. *American Economic Review* 100(3), 691–723.
- Campbell, J. Y. (2002). Consumption-Based Asset Pricing. Technical report.
- Chen, Z. and A. Lu (2013). Carbox Dioxide omissions and Asset Pricing. Working Papers 11310, Kellogg School of Management.
- Cochrane, J. (2005). *Asset Pricing*. Princeton: Princeton University Press.
- Da, Z., W. Yang, and H. Yun (2010). Household Production and Asset Prices. Working Papers 11310, Mendoza College of Business.
- Da, Z. and H. Yun (2010). Electricity Consumption and Asset Prices. Working Papers 11310, Mendoza College of Business.
- Dixit, A. K. and J. E. Stiglitz (1977, June). Monopolistic competition and optimum product diversity. *American Economic Review* 67(3), 297–308.
- Fama, E. F. and K. R. French (1993, February). Common Risk Factors in the Returns on Stocks and Bonds. *Journal of Financial Economics* 33(1), 3–56.
- Fama, E. F. and J. D. MacBeth (1973, May-June). Risk, Return, and Equilibrium: Empirical Tests. *Journal of Political Economy* 81(3), 607–36.
- Hansen, L. P. and K. J. Singleton (1983, April). Stochastic Consumption, Risk Aversion, and the Temporal Behavior of Asset Returns. *Journal of Political Economy* 91(2), 249–65.
- Hausman, J. (2002, October). Sources of Bias and Solutions to Bias in the Cpi. NBER Working Papers 9298, National Bureau of Economic Research, Inc.

- Hausman, J. A. (1996, September). Valuation of new goods under perfect and imperfect competition. In *The Economics of New Goods*, NBER Chapters, pp. 207–248. National Bureau of Economic Research, Inc.
- Jagannathan, R. and Y. Wang (2007, 08). Lazy investors, Discretionary Consumption, and the Cross-Section of Stock Returns. *Journal of Finance* 62(4), 1623–1661.
- Klenow, P. J. (2003). Measuring consumption growth: the impact of new and better products. *Quarterly Review* (Win), 10–23.
- Nakamura, E. and J. Steinsson (2008, November). Five facts about prices: A reevaluation of menu cost models. *The Quarterly Journal of Economics* 123(4), 1415–1464.
- Parker, J. A. and C. Julliard (2005, February). Consumption Risk and the Cross-Section of Expected Returns. *Journal of Political Economy* 113(1), 185–222.
- Ravn, M. O., S. Schmitt-Groh, and M. Uribe (2007, May). Pricing to habits and the law of one price. *American Economic Review* 97(2), 232–238.
- Rotemberg, J. J. and M. Woodford (1991, September). Markups and the business cycle. In *NBER Macroeconomics Annual 1991, Volume 6*, NBER Chapters, pp. 63–140. National Bureau of Economic Research, Inc.
- Savov, A. (2011, 02). Asset Pricing with Garbage. *Journal of Finance* 66(1), 177–201.
- Shanken, J. (1992). On the Estimation of Beta-Pricing Models. *Review of Financial Studies* 5(1), 1–33.