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 WP/17/146

Research Department

Extensive Margin Adjustment of Multi-product Firm and Risk Diversification*

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June 2017

Abstract

Product scope adjustment is a key mechanism through which multi-product firms achieve efficient resource allocations. In this paper, we take a novel perspective to study firms' product scope adjustment behavior through the lens of asset pricing. Using a unique panel scanner data set containing detailed information on products, matched with the financial information of their manufacturers, we find that multi-product firms with higher product turnover have lower financial risks and lower risk premia. To understand this channel, we propose a stylized model with a time-dependent (Calvo-type) product turnover rate to highlight the 'risk absorption channel' of product scope adjustment. In response to an economy-wide shock, a firm that can adjust its product scope more flexibly shows lower excess equity returns and lower asset volatility.

JEL Classification Numbers: G12, L11, L21, L25, L60

Keywords: Product scope, multi-product firms, risk diversification, firm dynamics

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* We are grateful to Ricardo Reis, Michael Weber, Raphael Schoenle, Matt Kleplacz, Ernesto Pasten, Sole Martinez Peria, John Kandrac, Yang Jiao and seminar participants at Columbia and the IMF for most helpful comments. We would also like to thank Ms. Sue Hutchinson and GS1 for providing the concordance table between UPC and manufacturers and Sung Ryong Kim, Dingding Xu for the early stage of data construction. All results are calculated based on data from The Nielsen Company (US), LLC and provided by the Marketing Data Center at The University of Chicago Booth School of Business.
Carvalho: PUC-Rio; Hong: International Monetary Fund; Zhou: Columbia University.

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1 Introduction

Recent studies document that U.S. manufacturing firms are predominantly multi-product firms (for instance, Broda and Weinstein (2010) and Bernard, Redding and Schott (2010)). A defining feature of multi-product firms, according to these studies, is that firms examine their product portfolios regularly and update them when deemed appropriate, by introducing new products to the market and discontinuing some existing products. Such dynamism at the product level, referred to as "product turnover," "product scope adjustment," or "extensive margin adjustment" in the literature, is an essential mechanism through which multi-product firms allocate resources and enhance their productivity (Bernard, Redding and Schott (2010)).

Despite the importance and prevalence of product-level extensive margin adjustments, the exact channel through which flexibility in firms' product scope adjustment leads to an improvement in firms' performance and productivity is much less understood. How do firms with higher flexibility in adjusting product scopes behave differently compared to others with less flexibility? How does flexibility in extensive margin adjustment benefit firms' performance and productivity? In this paper, we shed light on these questions by studying firms' product scope adjustment from an asset pricing point of view, in particular, connecting to firms' financial risk diversification.

We find that firms that can adjust their product scopes more flexibly have lower financial risks, reflected by lower excess asset returns and lower asset volatility. Why do firms with higher product turnover exhibit lower financial risks? A simple framework of consumption-based CAPM (CCAPM) provides an intuition to answer this question. Suppose that a multi-product firm has a profit function in which the product scope (or number of varieties introduced by the firm) enters as a parameter to maximize its profit. In such case, the CCAPM model suggests that a firm with higher rigidity to adjust its product scope in response to shocks has a higher price of risk, thus a higher excess return. This is because the inability of a firm to update its product scope to the new optimal level results in a loss in its profit and in turn, leads to a higher excess return. Conversely, a firm that can adjust its product scope more flexibly (or high product turnover) would not experience such decline in profit, as the firm is able to offset negative shocks by re-setting its product scope to the new optimal level. With no change in its profit, this firm will have lower excess return. In sum, flexibility in product scope adjustment enables firms to respond to adverse shocks more smoothly, and this reduces the price of risks. We call this a 'risk-absorption channel' of firm's extensive margin adjustment, as flexibility in product turnover attenuates firm's financial risks. In a way, this mechanism is similar to Gorodnichenko and Weber (2016) which finds that price rigidity is costly as firms with higher rigidity exhibit higher conditional volatility of stock returns.

Based on a rich scanner data set that covers products sold in many geographic locations in the U.S., we measure firm-specific extensive margin adjustment by counting the number of products per firm at each period, tracing the number of products introduced to the market and disappeared from the market. Specifically, our main measure of firm-specific extensive margin adjustment is *product turnover rates*, as in Broda and Weinstein (2010). A firm's product turnover rate is defined as the sum of its *creation rate* - a ratio of the value created by newly introduced items to its total sales - and its *destruction rate* - a ratio of the value destroyed by discontinued items to its total sales. As introduction and destruction of products are driven not only by supply factors, but also by demand factors, in our regressions, we first confirm that there is no statistical difference between firms' product turnover rates across households income group. In addition, we control for household-specific turnover rates in regressions and find that the results are robust to these controls. Then, we link firm-level extensive margin adjustment measure to the corresponding firm-level financial variables available from the CRSP database and Bloomberg. In particular, from the CRSP data, we construct firms' excess asset returns and asset volatility, which are our key variables to quantify firms' financial riskiness.

Our empirical findings can be summarized in three points. First, there is a cross-sectional variation in product turnover rates across firms. Second, a firm's product turnover rate is 'sticky' over time. That is, firms with high (low) product turnover continue to show high (low) product turnover rates over time. Finally and importantly, consistent with the predictions from the CCAPM model, we find higher product turnover attenuates financial risks at the firm-level. Firms that exhibit higher flexibility in product switching, reflected by the higher product turnover rate, show lower excess asset returns and lower volatility of asset returns. Specifically, we find that one standard deviation increase (about 20 %) in firm's product turnover rate leads to a decline of a 2 percentage point in excess asset returns. Our results are robust to additional controls including a set of standard financial indicators of firms, industry-specific characteristics, and other important characteristics associated with firms' product scope decision, such as R&D expenditure.

To provide a theoretical underpinning of the risk-absorption channel of product scope adjustment, we propose a model which incorporates a time-dependent (Calvo-type) firm-specific product turnover rate. The main difference between the conventional Calvo-pricing model and ours is that in the conventional pricing-model, a time-dependent parameter assigns an exogenous probability to determine the timing of price changes. In our model, a similar parameter instead governs the timing of firms' product scope changes. While firms are allowed to re-optimize their product scopes only at a given frequency, the optimal product scope of each firm is determined endogenously. For this purpose, we introduce the cannibalization effect with a CES aggregator compiling products at three different layers with different within-firm, across-firms and across-sectors elasticities of substitutions as in Hottman, Redding and Weinstein (forthcoming). A crucial element in modeling the competitive effects of multi-product firms, the cannibalization effect also ensures that there exists an upper bound to the optimal size of a firm's product scope. An increase in the number of goods introduced by a firm beyond certain level begins to lower the profit of the firm, as an extra item on the market begins to erode the current market share of the firm. With these ingredients, our model is able to generate a negative correlation between firms' flexibility of product scope adjustment and their excess returns and volatility of asset returns, which are consistent with our empirical findings.

Our paper is related to several important strands of literature. First, it contributes to a longstanding literature in finance that studies risk diversification as the key element to firms' performance and survival (for example, Markowitz (1952), Sharpe (1964)). Simply put, firms are exposed to risks from various sources. In face of such risks, firms maximize their expected returns by assembling their portfolios of financial assets. Analogous to firms' portfolio choice by choosing assets with different riskiness and sensitivity to the market (i.e, capital asset-pricing model) to maximize expected returns, we highlight that risk diversification effect can also result from firms' extensive margin adjustment. This happens as firms examine and update their optimal portfolio of their products, given their exposures to the economy-wide and product-specific shocks. While some recent studies focus more on the optimal mix (or selection) of products based on product characteristics (such as Mayer, Melitz and Ottaviano (2014)), we instead emphasize the importance of firm's ability to update their portfolio of products to respond to shocks.

Second, our study also contributes to the recent studies on multi-product firms. In conventional workhorse macroeconomic models, firms are often single-product producers. As a result, an extensive margin adjustment of a firm often refers to a firm's entry and exit, as we often equate a firm with a product. Such assumption can be found in the fields other than macroeconomics. For instance, micro-level studies on endogenous entry and exit of firms also commonly assume that firms are single-product producers (for instance, Jovanovic (1982), Hopenhayn (1992), Ericson and Pakes (1995), Melitz (2003), Bernard et al. (2007) and Bilbiie, Ghironi and Melitz (2012)). More recently, with the availability of micro data sets that provide evidence for the importance of multi-product firms in the economy, studies on multi-product firms have received more attention. Some examples are Midrigan (2011), Bhattarai and Schoenle (2014), Pasten and Schoenle (2016), which study multi-product firms' price-setting behaviors or 'intensive margin' adjustment. Here, studies have linked rational inattention and economy of scale to price adjustments to explain the patterns of price adjustments by multi-product firms. An important distinction between our work and these studies is that these studies look at the implications of multi-product firms price-settings, *given* the number of goods per firm. However, we are interested in the *dynamics* of number of goods per firm over time and the implications from such dynamics. More closely related to our work, some important studies have looked at the extensive margin adjustment of multi-product firms (Bernard, Redding and Schott (2010) and Broda and Weinstein (2010)) mainly establishing the cyclical properties of product turnover rates.

Third, there are studies that connect variety of goods with risk diversification based on endogenous growth theory. In these studies, a technological advancement in the economy enables firms to install inputs with higher quality. In the seminal work by Romer (1990) and Grossman and Helpman (1991), technological progress also influences firms to broaden the variety of inputs to be used for their productions. This results in an improvement of productivity, both at the firm and at the aggregate level, as firms can diversify input-specific risks with a broader set of inputs. More recent work by Koren and Tenreyro (2013) also highlights such channel and refer to this process as 'technological diversification.' In this work, the level of economic development or technological progress endogenously determines the input variety of productions, which in turn influences the volatility at the firm level and at the aggregate level. More specifically, as a country advances in its technological front, the less volatile the trajectory of its income growth becomes.

Finally, recent important studies have utilized the rich information available in various micro data sets to test and further improve theoretical foundations of aggregate fluctuations. For instance, Gorodnichenko and Weber (2016) and Weber (2014, memo) document important facts about nominal rigidity from micro data sets and quantify the costs associated with nominal rigidity from an asset pricing point of view. Relatedly, Herskovic (2015) highlights the importance of market structures and production network in transmitting risks based on micro-level data sets, connecting to firms' asset prices.

The remainder of the paper is structured as follows. Section 2 provides the intuition for the relationship between extensive margin adjustment and asset pricing using a simple CCAPM framework. Section 3 describes the data sets and the variables used for the empirical analysis. Section 4 explains the main empirical findings. Section 5 lays out the model to rationalize the empirical findings. Section 6 concludes.

2 The Relationship between Extensive Margin Adjustment and Asset Price Under CCAPM

Before diving into the empirical examination to assess the relationship between the degree of extensive margin adjustment by a multi-product firm and its asset valuations and market-based riskiness, we rely on a simple consumption-based CAPM (CCAPM) framework to provide some intuition for the risk-absorption mechanism.

In the CCAPM framework, price of an asset is derived from a household's utility maximization problem using stochastic discount factor. We consider a simple case where a representative household has a log-utility function and maximizes its expected life-time utility subject to an inter-temporal budget constraint defined by labor income, consumption expenditure and returns on investment on a group of assets $1, \ldots, J$ as follows:

$$\max_{C_t, B^i_{t+1}} \mathbb{E}\Big[\sum_{t=1}^{\infty} \beta^t \ln C_t\Big]$$

$$s.t. P_t C_t = P_t Y_t + \sum_{j=1}^{J} B^j_t (Q^j_t + D^j_t) - \sum_{j=1}^{J} B^j_{t+1} Q^j_t$$

The return rate of each asset j in the household's portfolio can be written

$$R^j_{t+1} = \frac{Q^j_{t+1} + D^j_{t+1}}{Q^j_t}.$$

The pricing kernel sets the expected return of any asset j to one, as follows

$$1 = \mathbb{E}_t\Big(R^j_{t+1} M_{t+1}\Big),\ \forall j$$

where $M_{t+1} = \beta u'(C_{t+1})/u'(C_t)$ is the stochastic discount factor. As this pricing kernel should be satisfied for all types of assets, one can have an expression for the excess premium of asset i (difference between the return rate of asset i and the rate on risk-free asset) as follows

$$\begin{aligned} \mathbb{E}_t R^j_{t+1} - R^F_{t+1} &= -R^F_{t+1} Cov\Big(R^j_{t+1}, M_{t+1}\Big) \\ &= -R^F_{t+1} \beta Cov\Big(R^j_{t+1}, C_t P_t / C_{t+1} P_{t+1}\Big) \end{aligned}$$

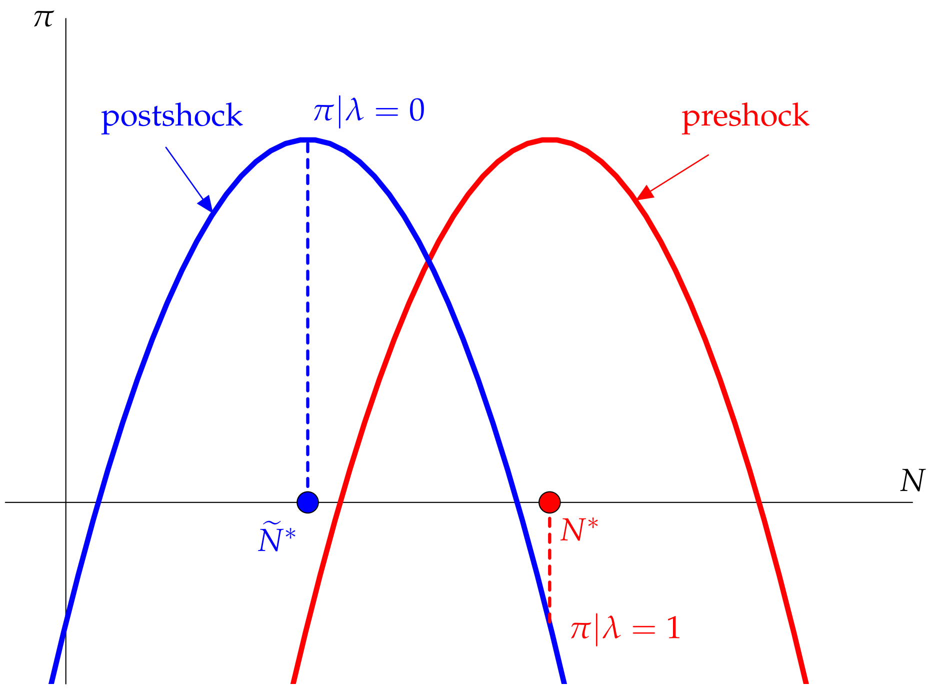
This equation shows that the risk of any asset is proportional to the negative of the covariance of its rate of return and marginal rate of substitution, which is the inverse of the growth rate of consumption expenditure under a logarithmic utility function.

To see the role of extensive margin adjustment in asset pricing, we offer a simple illustration. Assume an economy with a representative multi-product firm who adjusts its product scope to maximize its profit. In the steady states (pre-shock), the optimal number of products per firm is set to equal N^*. Suppose that the economy is in the new steady state (post-shock) with a negative shock. As shown in the figure below, this negative shock shifts the firm's profit curve to the left and hence, N^* is no longer the profit-maximizing optimal product scope. In this new steady state, the optimal number of products per firm that maximizes firm's profits decreases from N^* to $\widetilde{N}^*$, which is smaller than N^*.

Consider the following two firms in the extreme: a firm that can freely adjust its product scope without any rigidity ($\lambda = 0$ type, where λ is the probability of not being able to change product scope). In the new steady state, this firm re-optimizes its product scope, maintains the same level of (maximum) profit as before. On the contrary, another type of firm ($\lambda = 1$ type) exists, which cannot adjust its product scope at all. In the new steady state, this firm will suffer from a loss in its profit, as its product scope is fixed.

How does rigidity (or flexibility) in firm's ability to adjust product scope influence pricing of firms' risks? First, it affects the return rate of each firm (the first term of the covariance). That is, for a $\lambda = 0$ type firm, the return rate is unaffected, as the profit level is maintained as the product scope is reset to the new optimal level in the new environment. As a result, the covariance term of $\lambda = 0$ type firm is zero and therefore, the excess asset return also becomes zero. On the contrary, a $\lambda = 1$ type firm experiences a loss in its profit due to its inability to reset its product scope to the new optimal level. Combined with the inverse consumption growth due to the negative shock (the second term of the covariance), a negative shock to a $\lambda = 1$ type firm results in an increase in excess return.

Intuitively, excess returns compensate investors for taking risks - the higher the risk, the higher the excess return. In the context of extensive margin adjustment, other things equal, a $\lambda = 1$ type firm entails higher level of risks, as these firms are not able to weather the shocks as smoothly as a $\lambda = 0$ type firm. From an investors' perspective, the return rate of a $\lambda = 1$ type firm, therefore, should be higher to compensate for the excess risk bearing by the investors. Guided by these predictions from the CCAPM model, the ensuing sections explore this risk-absorption channel, both empirically and theoretically.



3 Data Description

This section describes the datasets used and the key variables in our main empirical analysis. We pool data sets from three different sources - AC Nielsen Homescan Data, Bloomberg and Center for Research in Security Prices (CRSP).

First, the AC Nielsen Homescan data, also used in numerous studies in the literature including Broda and Weinstein (2010), provides detailed information about the products consumed at retail grocery stores operating in the U.S., as well as the household characteristics of those who consume these products. In particular, the Nielsen Homescan data tracks a representative panel of households and their shopping patterns by following their purchases from these retail grocery stores at daily frequency. For each shopping trip, the barcode information for the items purchased by these households are recorded and are then reported to AC Nielsen. From this, Nielsen can identify each household consumption basket by the Universal Product Code (UPC). Other information available from these shopping trips aside from the product information are the transaction prices of the products, the volumes of these purchases and the retailer from which each household shops.

Nielsen samples about 40,000 to 60,000 households over 20,000 zipcodes in the U.S. from 2004 to 2014. To construct a nationally representative sample from these households, AC Nielsen further compares age, income and other demographic information of the households to the census data before applying projection factors to each household. In terms of product coverage, the Homescan data set covers about 700,000 UPCs every quarter and 3.2 million UPCs in total, and the expenditure logged in Homescan constitutes about one third of the total consumer expenditure. For our purpose, matching the products with manufacturer information is crucial. To do so, we identify manufacturers of each UPC using the GS1 Data Hub. [1]

After collecting manufacturer information for each product, we construct our key variables aggregated up to the firm-level for further analysis. For instance, products that belong to the same manufacturer, for instance, Johnson and Johnson, are grouped together. This enables us to construct three main variables to measure firms' extensive margin adjustments, namely, creation rates, destruction rates and product turnover rates. We construct these measures following the definitions used in Broda and Weinstein (2010). Specifically, we count the number of varieties of each firm at annual frequency [2] and calculate extensive margin adjustment using creation and destruction rates defined as follows.

$$\text{creation rate}_t = \left(\frac{\text{Value of New UPCs}_t}{\text{Total Value}_t} \right)$$

$$\text{destruction rate}_t = \left(\frac{\text{Value of Disappearing UPCs}_t}{\text{Total Value}_{t-1}} \right)$$

$$\text{turnover rate}_t = creationrate_t + destructionrate_t$$

The creation rate of a firm is measured as a share of the value created by newly introduced products to its total sale at a given time. The destruction rate, on the other hand, is the ratio of the value coming from the discontinued products to its total sales in the previous period when the goods were still present in the market. Finally, a firm's product turnover rate is the sum of these two measures, capturing the change in the value created by new products and the value destroyed by discontinued products as a share of its total sales.

In addition to the AC Nielsen Homescan data, we obtain firm-level financial variables for listed firms from Bloomberg and CRSP to be matched with firm-level extensive margin adjustment measures constructed from the Homescan data. In particular, we extract stock return information from CRSP and firm-specific financial variables from Bloomberg. Other financial variables used as controls are from the CRSP data. These

[1] GS1 US is the provider of U.P.C. for firms. It serves more than 2 million businesses in 25 industries in the United States. It provides a company with up to 10 barcodes for a $250 initial membership fee and a $50 annual fee. Companies requiring more U.P.C.s (or GTINs) can explore other pricing options at www.gs1us.org/upcs-barcodes-prefixes/get-started-guide/1-get-a-gs1-us-issued-company-prefix

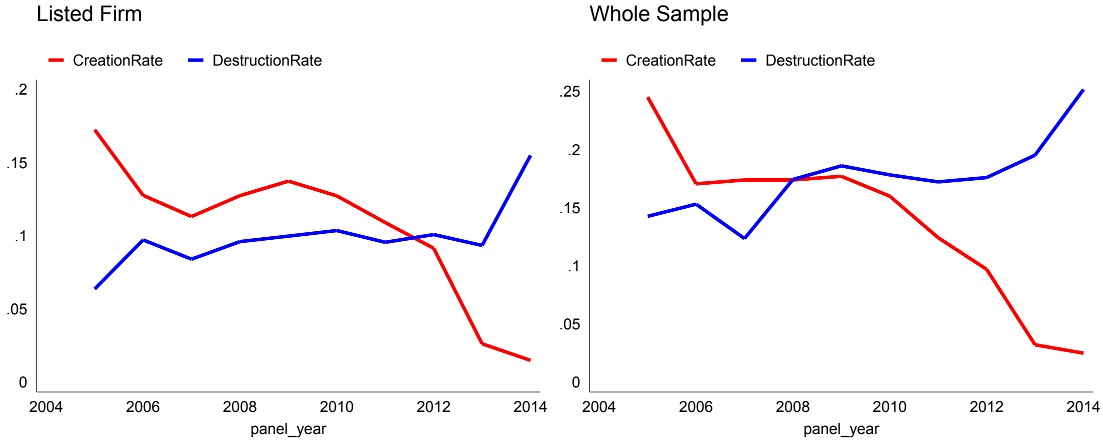
[2] We use annual level to avoid the possible seasonal pattern in product turnover.

include leverage ratio, market value of the firm, book-to-market ratio, market beta, cash flow among others. Two main measures of market-based financial variables are excess stock returns and volatility of asset returns. Using the monthly financial information from Bloomberg and CRSP, we calculate each firm's excess asset returns $return\ rate_{it}$ at annual frequency as follows, with r_{it} representing the monthly excess return for asset i, month $t = 1, 2, ..., 12$, by

$$\text{return rate}_{it} = (1 + r_1)(1 + r_2)...(1 + r_{12}) - 1$$

The matching of three data sets is done by connecting manufacturer identifiers available in each data set. After a careful matching process, we have a sample of 203 firms. The summary statistics of main variables used are shown in Table 4. Since listed firms represent only a fraction of all firms in the Nielsen data, we first check the representativeness of this subsample of listed firms to ensure the validity of our empirical analysis. We begin by comparing the key measures used in our analysis in both the entire sample in the scanner data and the matched data. Figure 1 shows product turnovers in the entire data sample versus a subsample of listed firms (matched). We find that the main variables of product scope adjustments behave in similar ways in these samples in terms of the magnitudes and the time-series patterns of creation rates and destruction rates - creation rates behave more 'cyclical' compared to destruction rates which is consistent with the findings in Broda and Weinstein (2010).

Figure 1: Extensive Margin Adjustment



4 Empirical Findings

In this section, we assess the degree to which a firm's extensive margin adjustment explains its risk diversification. In the first two subsections, we present some stylized facts about extensive margin adjustment behaviors by the firms observed in our dataset.

The rest of the section, we investigate the relationship between extensive margin adjustment and firms' stock excess return and volatility of asset returns.

4.1 Extensive Margin Adjustment Rate is "Sticky"

Here, we explore cross-sectional aspects of product turnover observed in the data set. First, we check if a firm's extensive margin adjustment is 'sticky' in the sense that a firm's ability to adjust its product scope is stable over time. If confirmed, it could motivate our theoretical approach as a product turnover rate can be attributed as a firm-specific feature. In addition, we check if there exists a significant cross-sectional variation in flexibility (or rigidity) in firm's extensive adjustment margin across firms.

To formally test for the "stickiness" in firms' product turnover rates in our data, we divide firms into two groups based on the measures of firms' extensive margin adjustments constructed in the previous section. The grouping of firms is done separately based on creation rates, destruction rates and turnover rates. To control for sectoral factors that may influence product turnover rates, we conduct a within-industry grouping of firms. Table 1 is the transition matrix based on these groupings that shows probabilities of firms switching to another group versus staying in the same group over time. The diagonal terms represent the probabilities of firms staying in the same state over time, while the off-diagonal terms represent the probabilities of firms switching from one group to another. Evident from these calculations, we find that the 'stayers' are more dominant than 'switchers' in our sample, providing support that firms' product turnover rates are quite persistent. For instance, about 70% of firms with low product turnover rates stay in the same low bin. Also, over 90% of firms with high product turnover rates exhibit higher product turnover rates over time than the rest. This suggests that the there is a stable distribution of firms when the firms are ranked based on their flexibility of extensive margin adjustments.

Stability in product turnover at the firm-level is a desirable feature when understanding the role of product turnover as a potential source of propagation mechanism. To the extent that extensive margin adjustment can be considered as a firm-specific attribute, the existence of a variation in product turnover across firms works as an important amplification generating heterogeneous effects in response to an aggregate, common shock.

4.2 Comparison between High vs Low Product Turnover Groups

In this subsection, we look at firm and consumer characteristics that could potentially be associated with product turnover rates. Are there firm-level characteristics that may be correlated with product turnover rates? For instance, does a firm with a larger set of goods conduct higher product turnover compared to others? This is to address potential concerns for endogeneity, as firms with higher (or lower) turnover rates may exhibit certain firm characteristics or serve households with certain features that enable them to deal better with aggregate shocks.

The concerns for endogeneity issue may arise. For instance, one could be concerned that firms with higher product turn over have healthier balance sheets comparing to their low turnover counterparts and this could enables them to cope better with aggregate shocks using extensive margin. Alternatively, products of certain firms may appeal to certain types of households. Firms from a high turnover bin may serve wealthier households whose demands for goods are usually less sensitive to aggregate shocks. In such case, facing less price-elastic demands may lead to higher product turnover rates, especially in bad times, as firms less cyclicality (or larger drops) in sales experience less disruptions in their normal operations including product introductions and destructions. Another point of concern can be a potential endogenous matching between retailers and manufacturers. For instance, some high-end retailers might have superior stock management and promotion strategies that offset the negative demand shocks for their associated goods providers, which eventually work to benefit firms' performance in introducing and destroying products.

To address the first potential concern whereby some intrinsic firm-specific characteristics may drive both financial riskiness and product turnover rates, we collect firm-level balance sheet information using Bloomberg. For the rest of concerns mentioned above, we take advantage of the detailed information available from the Nielsen Homescan on purchaser's demographics and retailer information. Each year, Nielsen asks the panelist for detailed information on household demographics including households income, composition of households, race, family members' ages, education level, occupation and the availability of facilities in their residence etc. The Homescan data also provides the retailer information. Although less easy to collect time-varying information on the location of retailers, based on the panelist's each shopping trip data, we track the retailers from which the goods were purchased and calculate the effective sales per each retailer, based on the total expenditure information of the panelists.

Table 2 presents the results of the two-group comparison. In the first panel, we list the results of firm characteristics' comparison based on firm's size, book-to-market ratio, beta, leverage, cash flow, stock turnover and spread. The results consistently show that the high product turnover group is not significantly and systematically different from the low product turnover counterpart in all of the key aspects of financial information. In the second panel, we conduct a similar exercise based on the purchaser characteristics. Here, we include variables such as household income, size, presence of child, and detailed information on household head. As Nielsen provide multiple choice question for several variables to the panelists, we summarize these information by introducing dummy variables to facilitate the comparisons. For instance, in the original data, household income is divided into 10 different bins from which panelists can choose. Instead, we take the median of these values, also consistent with the national median household income level, to construct the "income lower than median" variable; in a similar vein, we summarize the education level of household head to "higher than high school" based on education achievement categories from grade school to post-grad school. The p-values show that the two groups of firms are not distinguishable from another in terms of their demands. For instance, the representative income levels for two categories of firms are very close and the household size is as close as to 0.01 standard deviation. In the last exercise, we compare the sales of retailers based on household shopping data, which also shows that there is no significant difference between the top and bottom groups based on firms' product turnover rates.

Overall, the analysis confirms that that the high product turnover firms are not intrinsically or systematically different from the low turnover firms, in several key dimensions of firms' financial health, consumer types and retailers to which firms provide products.

4.3 Portfolio Analysis

Here, based on portfolio analysis, we assess the relationship between firms' extensive margin adjustment and market-based risks. Specifically, we construct firm-level asset returns constructed by CAPM, Fama-French 3-factor and 5-factor models, respectively, and we compare firms' asset returns and product turnover rates.

We first rank firms based on their flexibility in extensive margin adjustments, separately for their creation rates, destruction rates and product turnover rates. Then, based on these rankings, we group firms into three portfolios from the least flexible on their extensive margin to the most flexible. After determining the portfolio composition, we construct the market price for each portfolio as the weighted average of its underlying stocks' prices, weighted by individual stock's market value. Table 5 reports the results. It shows average return rates calculated by each of the three models for the bottom (firms with bottom third turnover rates) and the top (firms with top third turnover rates) bins. Then, the last two columns report the differences in return rates between the bottom and the top bins and the statistical significances (p-values) of these differences.

In the first panel, we find that the difference in excess return rates between firms with high creation rates and those with low creation rates is statistically significant. Specifically, firms with higher creation rates exhibit low asset returns, and thus, lower excess returns, compared to those with lower creation rates. We also find that it is robust to other portfolio analysis, including Fama-French 3 factor and 5 factor models. In the second panel, interestingly, we find that such differences across firm groups disappear when the firms are categorized based on destruction rates. In other words, we do not find that there exist statistically significant differences in return rates between bins with different destruction rates. The finding is also robust to other portfolio analysis as in the first panel. The results for destruction rates are not surprising for at least two reasons; first, the lack of dynamics observed for destruction rates over time in Figure 1 and second, the findings in the existing literature that product turnover rates mainly driven by product creation rates, but not by product destruction rates as in Broda and Weinstein (2010).

4.4 Extensive Margin Adjustment and Risk

Here, we turn to a firm-level panel analysis to establish the relationship between firm's ability to adjust its product scope and its market-based financial riskiness. Our baseline specification is (1). Our main dependent variables are the market-based measures of firm's financial riskiness, namely, the excess stock returns and asset volatility. The main independent variables are those related to firms' extensive margin adjustment, namely, creation rates, destruction rates and turnover rates. In addition to our key control variables, we also control for a set of standard financial indicators of firms provided by Bloomberg. These variables include leverage, book-to-market ratio, price-to-cost margin, cash flow, market beta, spread, gross margin and industry portfolio rate of return and book-to-market ratio.

$$\text{return rate}_{it} = \beta_1 \text{creation rate}_{it} + \beta_2 \text{destruction rate}_{it} + \mathbb{X}_{it} + \epsilon_{it} \tag{1}$$

Table 6 presents our first set of results. We find that a higher creation rate is significantly negatively correlated with excess asset returns. On the other hand, the relationship is not statistically significant when using the destruction rates, consistent with the findings in the previous subsection. Column (1) presents the benchmark regression results with year fixed effects. Such time fixed-effects are included to control for a time-varying portion of aggregate and common components of shocks. When controlling further for financial variables that could affect the excess returns, the coefficient on the creation rate is negative and significant. This implies that those firms with higher extensive margin adjustment show less excess risks compared to the risk taken by a benchmark portfolio. Specifically, that one standard deviation decrease in product creation rate (about 16%) leads to about a 1.6 percentage point increase in excess return. On the other hand, we do not find any meaningful correlation between excess return and firm's destruction rate. Again, this finding is consistent with the empirical finding documented by Broda and Weinstein (2010), who shows the lack of cyclical pattern of destruction rate.

The ensuing columns report the results with additional controls. These robustness checks include controlling for industry-specific characteristics (column (2)), R&D expenditure (column (3)) and total number of UPCs (column (4)). Throughout, negative and significant relationship between the excess asset return and the creation rate can be found in all of these alternative specifications. It is worth noting that in Column (4), the coefficient on the total number of UPCs also show negative and significant, which could imply that not only the change of product scope but also the magnitude of product scope play a role in the risk diversification mechanism. In column (5), we use the turnover rate as the main independent variable instead of the creation rate. In this specification, we also find that the firms with high turnover rates exhibit lower excess asset returns.

In Table 7, we use the second measure of market-based financial riskiness of firms, which is the volatility of asset returns. Controlling for a set of firm-specific financial variables, we also find that firms with higher creation and turnover rate show a significantly lower volatility of asset returns. In particular, a decline of creation rate by one standard deviation leads to 0.16 percentage point decline in volatility of firm's asset returns. Compared with the results in Table 6, we find qualitatively similar result. Here again, we also find that firm's destruction rate is not meaningfully related to firm's volatility of asset returns. Controlling for various financial variables that could affect asset volatility, the coefficient on the creation rate is consistently negative and significant. The robustness check carried out are analogous to the previous exercise, as industry portfolio and R&D expenditure in Column (2) and (3), respectively. Column (4) shows that again the importance of the total number of products that a firm produces on top of the product creation rate. Finally, column (5) shows that higher products turnover rate, which uses the total number of UPCs over time, is related to lower asset volatility and that the correlation is similar to introduction rate in magnitude.

Another route to investigate the relationship between extensive margin adjustment and asset return is to directly test the predictions from the CCAPM framework. In the CCAPM framework, firms with higher rigidity adjust their product scopes have negative correlation with inverse consumption expenditure growth, implying higher excess asset returns. Unlike the case of return rate which can be observed at a higher frequency, in order to calculate the covariance term, one would need a sufficiently long time series data. For this reason, we instead look at the cross-sectional variations across firms to test our hypothesis: that is, whether firms with higher turnover rate indeed show a higher covariance with the inverse of the consumption expenditure growth compared to the firms with low turnover rates. Particularly, we employ the specification as (2), where the covariance is calculated using the monthly return of firms and the monthly private consumption in the U.S. from FRED.

$$cov(R_i, \frac{\Delta C}{C}) = \beta_1 \text{creation rate}_i + \beta_2 \text{destruction rate}_i + \mathbb{X}_i + \epsilon_i \quad (2)$$

Table 8 shows the results on the relationship between firms' extensive margin adjustment and the covariance term (proxy for excess asset returns). The benchmark regression results are reported in the first column. Here, one standard deviation increase in the product introduction rate leads to an increase of asset volatility by about one standard deviation increase in covariance. Controlling for various financial variables that could affect asset volatility, the coefficient on the creation rate is consistently positive and significant. The robustness check carried out are analogous to the previous exercise, as R&D expenditure in Column (2). Column (3) shows that again the importance of the total number of products that a firm produces on top of the product creation rate. Finally, column (4) and (5) show that higher products turnover rate, which uses the total number of UPCs over time, is related to higher covariance and the magnitude is similar to introduction rate.

4.5 Robustness Check

This section addresses the concern for potential roles played by retailers and households in determining firm-level product scope adjustment decisions. Goldberg and Hellerstein (2012) and Hong and Li (2017) highlight the importance of retailers in setting the prices in understanding pass-through of underlying shocks to retail prices. It is important to take into account the role of retailers in the decision-making of the extensive margin at the retail stores, as some of these decisions can be due to factors that are unrelated to the manufacturer's risk-diversification. Similarly, households may enter in firms' product scope adjustment decisions. Bems and Di Giovanni (2014), Coibion, Gorodnichenko and Hong (2015) and Handbury (2013) provide evidence for non-homothetic preferences and the income-dependent product switching behavior of household. Therefore, the observed product turnover could be resulted from household's preference change, which is not directly related with manufacturer's ability of adjusting product scope. Although we have shown in the two-group comparison that the high product turnover firms are not significantly different from those in the low groups in the aspect of demand and retailer, we would conduct additional checks using the granular firm data.

First, to isolate manufacturer's role in product turnover, we construct two sets of control variables. The first set of variables is the household-specific product creation and destruction rates. The second set is the retailer-specific product creation and destruction rates. Household-specific creation and destruction rates are constructed using the household-specific identifiers and the history of product purchases associated with the identifiers available in the data set. As the sample tracks households' shopping histories at the item level, we first link these items to their manufacturers. Then, using various measures of firms' flexibility in product scope adjustment (creation rates, destruction rates and product turnover rates) for each manufacturer, we construct household-specific creation and destruction rates. In other words, suppose a household i consumes goods $C_i^1, C_i^2, C_i^3, ...C_i^N$, where 1, 2, ...,N are UPCs. Manufacturers of UPCs (1, 2, ..., N) can be identified and have their specific time-varying creation and destruction rates. Households, in turn, have time-varying construction and destruction rates based on the consumption basket. Retailer-specific creation and destruction ratios are constructed in a similar way, by linking the items carried by a retailer to their manufacturers, and further to manufacturer-specific creation and destruction rates.

The following Table 10 reports the results using additional sets of controls. Column (1) controls for a set of retailer-specific extensive margin measures, Column (2) adds a set of household-specific extensive margin measures as controls, and Column (3) contains both. Negative coefficients on different measures of product turnover rates confirm that the risk-diversification channel via firms' extensive margin adjustments observed in the baseline regressions is robust, even after controlling for potential confounding factors due to retailer-specific and households-specific characteristics. In addition, Table 11 reports the results for similar robustness checks, directly testing for CCAPM-related variable, namely, the covariance between return rates and inverse consumption expenditure growth, as the main dependent variable. We find that the results are robust in this specification as well.

Another potential concern is that retailers or households might treat different firms differently. More specifically, if there is a systematic matching between retailers-firms or households-firms, retailer- or household-specific turnover rates cannot serve as valid proxies. To check to what extent retailers and households treat firms selectively, we conduct the following "co-integration"-type test. The idea is that, if retailers (or households) differ significantly in "adding" or "dropping" products of the same firm, then retailer-(household-) firm specific turnover rates will be remarkably different from each other. We construct annual turnover rates for each retailer-firm pair and zip code-firm pair[3]t.

$$\text{Turnover Rate}_{itj} = \alpha + \text{Turnover Rate}_{it,-j} + \epsilon_{itj} \tag{3}$$

To test whether the difference is statistically significant, we construct the leave-one-out mean of the retailer-(household-) firm specific turnover rates using (3) for each firm and each year to see its correlation with the very retailer (household). The test resembles the idea of "cointegration" of time series analysis - if there is no significant variation within the panel, then each identity should cointegrate the panel average well. The results are reported in Table 9. We observe that the coefficients for the leave-one-out mean is almost one, which strongly supports that there is no difference across retailers (households) in treating products from different firms. In fact, this result suggests that the main driver of the variations across product turnover rates is across-firm variations, instead of across retailers or households.

5 A Dynamic Model of Extensive Margin Adjustment

In this section, we propose a model that explains the relationship between product scope adjustment and financial risk diversification, measured as excess stock returns and asset volatility. Before specifying the model in detail, we introduce two main ingredients of our model. The first ingredient is a time-dependent (Calvo-type) product turnover rate. That is, firms in our model are able to reset their optimal product scopes only with a fixed probability. It is analogous to the time-dependent price-setting mechanism in the literature, where firms can reset their optimal prices with a fixed probability. The second key ingredient of our model is the cannibalization effects, as introduced by Feenstra and Ma (2008), Eckel and Neary (2010) and more recently by Hottman, Redding and Weinstein (forthcoming). That is, an introduction of new products, after a certain point, can reduce the profit of a firm, as new products erode the market shares of the existing products. Measured as the partial elasticity of the sales of existing products with respect to the introduction of new products, the cannibalization effect also enables the optimal product scope of a multi-product firm to be finite. Our model shows that flexibility in firms' product scope adjustment can help these firms to diversify and absorb shocks. Firms with higher rigidity to re-optimize product scopes (due to a high value of time-dependent parameter) will have higher excess asset returns and higher asset volatility, compensating for not being able to maximize profits at all

[3]Ideally, we could construct household-firm pair turnover rates, but the sample will be too large to handle. Therefore, we assume that households within the same zip code share similar preference based on their location choice, e.g. income, occupation, etc.

times. For the remaining part of the section, we will evaluate this channel by illustrating the model and the simulation results.

5.1 Household

The set-up of the optimal product scope in our model is close to Hottman, Redding and Weinstein (forthcoming). The households in our economy have GHH preferences with consumption and labor. In each period, they work, consume and trade bonds in the nominal bond market (B) and collect profits from all firms ($\{D_{fkt}\}$). Total consumption is determined by a CES aggregator with three layers of compilations. The first layer is on a continuum of groups ($k \in [0,1]$) represented by the unit interval, the second layer (inter-firm) is on a unit interval of firms ($f \in [0,1]$) [4], and the third layer (intra-firm) is on the current product scope $u \in [0, N_{fkt}]$ of the firm.

σ_f, σ_f, σ_u represents the elascities across groups, firms and products, respectively. We assume that products the inter-firm elasticity σ_f is smaller than intra-firm elasticity σ_u; that is, $\sigma_f \leq \sigma_u$. While products introduced by the same firm are not perfect substitutes, we assume that the products introduced by the same firm will be more substitutable than those introduced by different firms. In this way, product differentiation is intimately related to the cannibalization effects. As will be clear in the ensuing section, such multi-layer consumption aggregator helps with product dynamics of a multi-product firm. In addition, this set-up enables us to connect firm-level extensive margin adjustment to asset pricing aspects.

A household's optimization problem can be specified as follows: a household allocates consumption (to the level of product) and work subject to income from labor, bond holding and profit rebates by the firms.

$$\max \quad \sum_{t=0}^{\infty} \beta^t \left[\ln C_t - \chi \frac{L_t^{1+1/\phi}}{1+\frac{1}{\phi}} \right]$$

$$s.t. \quad P_t C_t + B_{t+1} = W_t L_t + (1+i_t) B_t + \int_0^1 \int_0^1 D_{fkt} df dk$$

$$C_t = \left[\int_0^1 C_{kt}^{\frac{\sigma_k - 1}{\sigma_k}} dk \right]^{\frac{\sigma_k}{\sigma_k - 1}}$$

$$C_{kt} = \left[\int_0^1 C_{fkt}^{\frac{\sigma_f - 1}{\sigma_f}} df \right]^{\frac{\sigma_f}{\sigma_f - 1}}$$

$$C_{fkt} = \left[\int_0^{N_{fkt}} C_{ufkt}^{\frac{\sigma_u - 1}{\sigma_u}} du \right]^{\frac{\sigma_u}{\sigma_u - 1}}$$

[4] Since the focus of the model is the product turnover, it abstracts away from firm entry and exit at this moment.

5.2 Price of the Product

To highlight the role of introducing the friction on extensive margin adjustment, we first begin by introducing a benchmark model without any friction on extensive margin adjustment. The results are similar to those in a fully flexible price-setting framework in the literature. The only difference between a fully flexible price-setting framework and ours is the demand structure, as our demand structure has three layers of price indices due to the specific CES aggregator introduced to capture the cannibalization effect. In each period, firms have linear production function using only labor as their inputs, with productivity Z_t. We assume that firms can freely set price to the desired level at any given time. The optimal price level for this firm is a constant markup over cost (Proposition 1).

$$\text{technology}: Y_{ufkt} = Z_t L_{ufkt}$$
$$\text{s.t. demand}: C_{ufkt} = C_t P_t^{\sigma_k} P_{kt}^{\sigma_f-\sigma_k} P_{fkt}^{\sigma_u-\sigma_f} P_{ufkt}^{-\sigma_u}$$

Proposition 1. *The optimal price is* $P_{ufkt} = \frac{\sigma_f}{\sigma_f-1}\frac{W_t}{Z_t}$

The optimal price is similar to the simple case of profit-maximization absent of price rigidity, where firms always set their optimal price equal to a constant markup. However, since firms are subject to cannibalization effect, i.e. substitution within firm across products, the markup is based on firm elasticity σ_f instead of product elasticity σ_u ($P_{ufkt} = \frac{\sigma_u}{\sigma_u-1}\frac{W_t}{Z_t}$). In other words, when firm takes the effect of setting product's price on firm's price, $P_{fkt}^{\sigma_u-\sigma_f} P_{ufkt}^{-\sigma_u}$ becomes the choice variable rather than $P_{ufkt}^{-\sigma_u}$.

5.3 Firm's Decision on Optimal Product Scope: Without Friction

Now we turn to firms' decision on optimal product scope. We first begin with a case where firms can freely adjust their product scopes to optimal levels without any friction. In a similar logic as optimal price setting by equalizing margin cost to margin revenue, the optimal product scope is derived when margin cost is equal to the marginal revenue from changing product variety. For simplicity, we follow Bergin and Corsetti (2008) and assume that there is a fixed cost, F units of effective labor, to maintain the product scope (or varieties) in each period, which becomes our marginal cost. This fixed cost which is introduced every period can be interpreted as capital associated with the product of the variety fully depreciating each period. On the margin revenue side, it involves more elements due to the introduction of cannibalization effect. The total marginal revenue of changing product scope N is comprised of two parts: first, the product-level consumption change due to the substitution effect between the products that stay and those newly introduced or disappear from the market, and the second, the consumption specifically associated with the marginal product. The magnitudes of the two effects are illustrated by Proposition 2.

Proposition 2. *Cannibalization effect*

- *product level:* $-\frac{dC_{ufkt}}{dN_{fkt}}\frac{N_{fkt}}{C_{ufkt}} = \frac{\sigma_u - \sigma_f}{\sigma_u - 1}$
- *firm level:* $\frac{dC_{fkt}}{dN_{fkt}}\frac{N_{fkt}}{C_{fkt}} = \frac{\sigma_f}{\sigma_u - 1}$

Proposition 2 summarizes the two levels of cannibalization effect. On the product level, the substitution effect depends on the relative magnitude between the between-product elasticity and between-firm elasticity. To illustrate, two special cases are worth mentioning on the product-level cannibalization: first, product-level cannibalization effect is zero when the consumers treat the products within the firm in the same way as the firms within groups, i.e. $\sigma_u = \sigma_f$. This implies a complete switching of consumption away from existing products to the newly introduced product by a different firm. Secondly, product-level cannibalization is 100% if the products of the same firm are perfect substitutes, i.e. $\sigma_u \to \infty$. This happens when the consumption change associated with the marginal product is completed offset by other products of the same firm. On the firm-level, under the assumption that substitution effect between products within firm dominates the substitution effect across firm ($\sigma_u > \sigma_f$), the product-level cannibalization effect is negative while the firm-level cannibalization effect is positive ("love of variety").

Equating the marginal cost and revenue of product scope adjustment yields the optimal number of products under fully flexible product scope adjustment. The optimal product scope is positively correlated with firm-level consumption, because a higher demand leads to a higher profit. At the same time, the optimal product scope is negatively correlated with fixed cost of variety maintaining and between-product substitution effect, as these two increases the maginal cost and decreases the marginal revenue, respectively.

$$N_{fkt} = \left[\frac{C_{fkt}}{F(\sigma_u - 1)}\right]^{\frac{\sigma_u - 1}{\sigma_u}}$$

5.4 Firm's Decision on Optimal Product Scope: A Calvo-type Model

As mentioned before, we introduce a time-dependent parameter (Calvo-type) in firm's product scope adjustment: firm in group k can adjust product scope with probability $= 1 - \lambda_k$ in each period. The existence of two types simplifies the cross-sectional variations in product turnovers observed in the dataset. However, by considering the extreme two cases, we aim to highlight the implications of rigidity (or flexibility) in product scope adjustment on firm dynamics. Specifically, in each period, if a firm is allowed to reset its varieties at a given time, it will set $\widetilde{N}_{fkt}$ to maximize the expected profit (Λ is the Lagrange multiplier for household's budget constraint.)

$$\max_{\widetilde{N}_{fkt}} \sum_{j=0}^{\infty} \lambda_k^j \mathbb{E}_t \Big\{ \frac{\Lambda_{t+j}}{\Lambda_t} \Big[\int_0^{\widetilde{N}_{fkt}} \Big(P_{ufkt+j} - MC_{t+j} \Big) C_{ufkt+j} du - F\widetilde{N}_{fkt} MC_{t+j} \Big] \Big\}$$
$$s.t. C_{ufkt+j} = C_{t+j} P_{t+j}^{\sigma_k} P_{kt+j}^{\sigma_f - \sigma_k} P_{fkt+j}^{\sigma_u - \sigma_f} P_{ufkt+j}^{-\sigma_u}$$

Proposition 3. *Optimal product scope with frictions:*

$$(\sigma_u - 1)\widetilde{N}_{fkt}^{\frac{\sigma_u - \sigma_f}{\sigma_u - 1}} = \frac{\sum_{j=0}^{\infty} \lambda_k^j \mathbb{E}_t \Big[\Lambda_{t+j} MC_{t+j} C_{t+j} P_{t+j}^{\sigma_k} P_{kt+j}^{\sigma_f - \sigma_k} MC_{t+j}^{-\sigma_f} \Big]}{\sum_{j=0}^{\infty} \lambda_k^j \mathbb{E}_t \Big[\Lambda_{t+j} MC_{t+j} F \Big]}$$

Proposition 3 shows the optimal scope of a firm f at time t when firms face rigidity in adjusting their product scopes. Inheriting the properties of Calvo-type price-setting models, the optimal product scope in our set-up exhibits a similar presentation to the optimal price level in a standard Calvo-pricing model. That is, the optimal product scope is positively correlated with the discounted present value of the revenue if the product scope is not going to be allowed to changed forever, and it is negatively correlated with the discounted present value of the marginal cost if the product scope is permanently set.

5.5 Model Summary

Combining the pieces together, the competitive equilibrium of the model can be defined by 15 variables $\{\frac{P_{kt}}{P_t}, \frac{\widetilde{P}_{kt}}{P_t}, \widetilde{N}_{kt}, S_{kt}, PVR_{kt}, PVC_{kt}, \pi_t (\equiv \frac{P_t}{P_{t-1}}), C_t, S_t, L_t, i_t, \frac{W_t}{P_t}, \frac{\Lambda_{t+1}}{\Lambda_t}\}$ plus 2 exogenous processes $\{Z_t, \nu_t\}$ satisfying the following conditions. Although the aggregate conditions align with the traditional New Keynesian model in most aspects, the group-specific conditions highlight firms' decision on their product scopes.

Group-specific conditions

optimal reset variety
$$\widetilde{N}_{kt}^{\frac{\sigma_u - \sigma_f}{\sigma_u - 1}} = \frac{\sigma_f^{-\sigma_f}}{(\sigma_f - 1)^{-\sigma_f}(\sigma_u - 1)} \frac{PVR_{kt}}{PVC_{kt}} \tag{4}$$

$$PVR_{kt} = \Big(\frac{W_t}{Z_t P_t}\Big)^{1-\sigma_f} \Big(\frac{P_{kt}}{P_t}\Big)^{\sigma_f - \sigma_k} C_t + \beta \lambda_k \mathbb{E}_t \Big[\frac{\Lambda_{t+1}}{\Lambda_t} \pi_{t+1} PVR_{kt+1} \Big] \tag{5}$$

$$PVC_{kt} = \frac{W_t F}{Z_t P_t} + \beta \lambda_k \mathbb{E}_t \Big[\frac{\Lambda_{t+1}}{\Lambda_t} \pi_{t+1} PVC_{kt+1} \Big] \tag{6}$$

optimal reset price
$$\frac{\widetilde{P}_{kt}}{P_t} = \widetilde{N}_{kt}^{\frac{1}{1-\sigma_u}} \frac{\sigma_f}{\sigma_f - 1} \frac{W_t}{Z_t P_t} \tag{7}$$

group price
$$\frac{P_{kt}}{P_t} = \left[(1-\lambda_k)\left(\frac{\widetilde{P}_{kt}}{P_t}\right)^{1-\sigma_f} + \lambda_k\left(\frac{P_{kt-1}}{P_{t-1}\pi_t}\frac{W_t/Z_tP_t}{W_{t-1}/Z_{t-1}P_{t-1}}\right)^{1-\sigma_f}\right]^{\frac{1}{1-\sigma_f}} \tag{8}$$

group price dispersion
$$\begin{aligned} S_{kt} &\equiv \int_0^1 \left(\frac{P_{fkt}}{P_{kt}}\right)^{-\sigma_f} \mathrm{d}f = (1-\lambda_k)\left(\frac{\widetilde{P}_{kt}}{P_{kt}}\right)^{-\sigma_f} \\ &\quad + \lambda_k\left(\frac{P_{kt-1}}{P_{kt}}\frac{W_t/Z_tP_t}{W_{t-1}/Z_{t-1}P_{t-1}}\right)^{-\sigma_f} S_{kt-1} \\ &= (1-\lambda_k)\left(\frac{\widetilde{P}_{kt}}{P_{kt}}\right)^{-\sigma_f} + \lambda_k\left(\frac{P_{kt-1}/P_{t-1}}{P_{kt}/P_t}\frac{1}{\pi_t}\frac{W_t/Z_tP_t}{W_{t-1}/Z_{t-1}P_{t-1}}\right)^{-\sigma_f} S_{kt-1} \end{aligned} \tag{9}$$

Aggregate conditions

aggregate price
$$1 = \left[\int_0^1 \left(\frac{P_{kt}}{P_t}\right)^{1-\sigma_k} \mathrm{d}k\right]^{\frac{1}{1-\sigma_k}} \tag{10}$$

aggregate price dispersion
$$S_t \equiv \int_0^1 \left(\frac{P_{kt}}{P_t}\right)^{-\sigma_k} S_{kt}\mathrm{d}k \tag{11}$$

labor demand
$$C_t = \frac{Z_tL_t}{S_t} \tag{12}$$

labor supply
$$\chi L_t^{1/\phi} = \frac{W_t}{C_tP_t} \tag{13}$$

Euler equation
$$1 = \beta\mathbb{E}_t\left[\frac{(1+i_t)\Lambda_{t+1}}{\Lambda_t}\right] \tag{14}$$

subjective discount factor
$$\frac{\Lambda_{t+1}}{\Lambda_t} = \frac{C_t}{C_{t+1}\pi_{t+1}} \tag{15}$$

Taylor Rule
$$\ln i_t = \phi_i \ln i_{t-1} + (1-\phi_i)\ln\left[\bar{i} + \phi_\pi\left(\frac{P_t}{P_{t-1}} - 1\right) + \phi_y(C_t - \bar{C})\right] + \ln\nu_t \tag{16}$$

Exogenous Processes

productivity
$$\ln Z_t = \rho_z \ln Z_{t-1} + \epsilon_t^z \tag{17}$$

monetary policy shock
$$\ln \nu_t = \rho_\nu \ln \nu_{t-1} + \epsilon_t^\nu \tag{18}$$

5.6 Return Rate

So far, we have looked at firm dynamics when firms decide on optimal number of products to produce at each period. In this section, we continue by connecting firms' product scope with the dynamics of the asset pricing of firms. To begin, we present the structure of a firm's product scope starting with variety N_{fkt} with binomial tree in Figure 2. This yields the value of the firm in a recursive way. Particularly, the colored paths (blue, red and green) stand for the value of a firm whose product scopes at time t is permanently set to N_{fkt}, $\widetilde{N}_{fkt+1}$ and $\widetilde{N}_{fkt+2}$, respectively. From the previous section on the optimal product scope choice with friction, the real value (deflated by P_t) of the path ($VS_t(N_{fkt})$) can be written as follows.

$$VS_t(N_{fkt}) = N_{fkt}^{\frac{1-\sigma_f}{1-\sigma_u}} RS_{kt} - N_{fkt} CS_{kt} \tag{19}$$

$$\text{where} \quad RS_{kt} = \frac{\sigma_f^{-\sigma_f}}{(\sigma_f - 1)^{-\sigma_f}(\sigma_f - 1)} MC_t^{1-\sigma_f} P_t^{\sigma_k - 1} P_{kt}^{\sigma_f - \sigma_k} C_t + \beta\lambda_k \frac{\Lambda_{t+1}}{\Lambda_t} \pi_{t+1} RS_{kt+1}$$

$$CS_{kt} = \frac{F \cdot MC_t}{P_t} + \beta\lambda_k \frac{\Lambda_{t+1}}{\Lambda_t} \pi_{t+1} CS_{kt+1}$$

Furthermore, comparing two firms in group k starting with N_k' and N_k'' at t, we assume that the only difference between the two structures is the path where the firm never gets the opportunity to change product scope.

$$V_t(N_k') = V_t(N_k'') - VS_t(N_k'') + VS_t(N_k') \tag{20}$$

Given that the dividend of firm is equal to the profit of the firm, the return rate of the stock is given as follows,

$$R_t(N_{fkt}, N_{fkt-1}) = \frac{V_t(N_{fkt})}{V_{t-1}(N_{fkt-1}) - Div_{t-1}(N_{fkt-1})} \cdot \pi_t$$

$$= \frac{V_t(\widetilde{N}_{fkt}) - VS_t(\widetilde{N}_{fkt}) + VS_t(N_{fkt})}{V_{t-1}(\widetilde{N}_{fkt-1}) - VS_{t-1}(\widetilde{N}_{fkt-1}) + VS_{t-1}(N_{fkt-1}) - Div_{t-1}(N_{fkt-1})} \cdot \pi_t$$

$$\text{where} \quad Div_t(N) = \frac{\sigma_f^{-\sigma_f}}{(\sigma_f - 1)^{-\sigma_f}(\sigma_f - 1)} MC_t^{1-\sigma_f} P_t^{\sigma_k - 1} P_{kt}^{\sigma_f - \sigma_k} C_t \cdot N^{\frac{1-\sigma_f}{1-\sigma_u}} - N \cdot \frac{MC_t F}{P_t}$$

Therefore, to calculate the return rate of a firm for any two arbitrary product scopes, subsequently having values of $N_{fkt-1} and\ N_{fkt}$, we only need $VS(N)$ (the value of the firm of permanent product scope N, from 19) and $V_t(\widetilde{N}_{fkt})$ (the value of the firm with optimal product scope $\widetilde{N}_{fkt}$, from 20, as following).

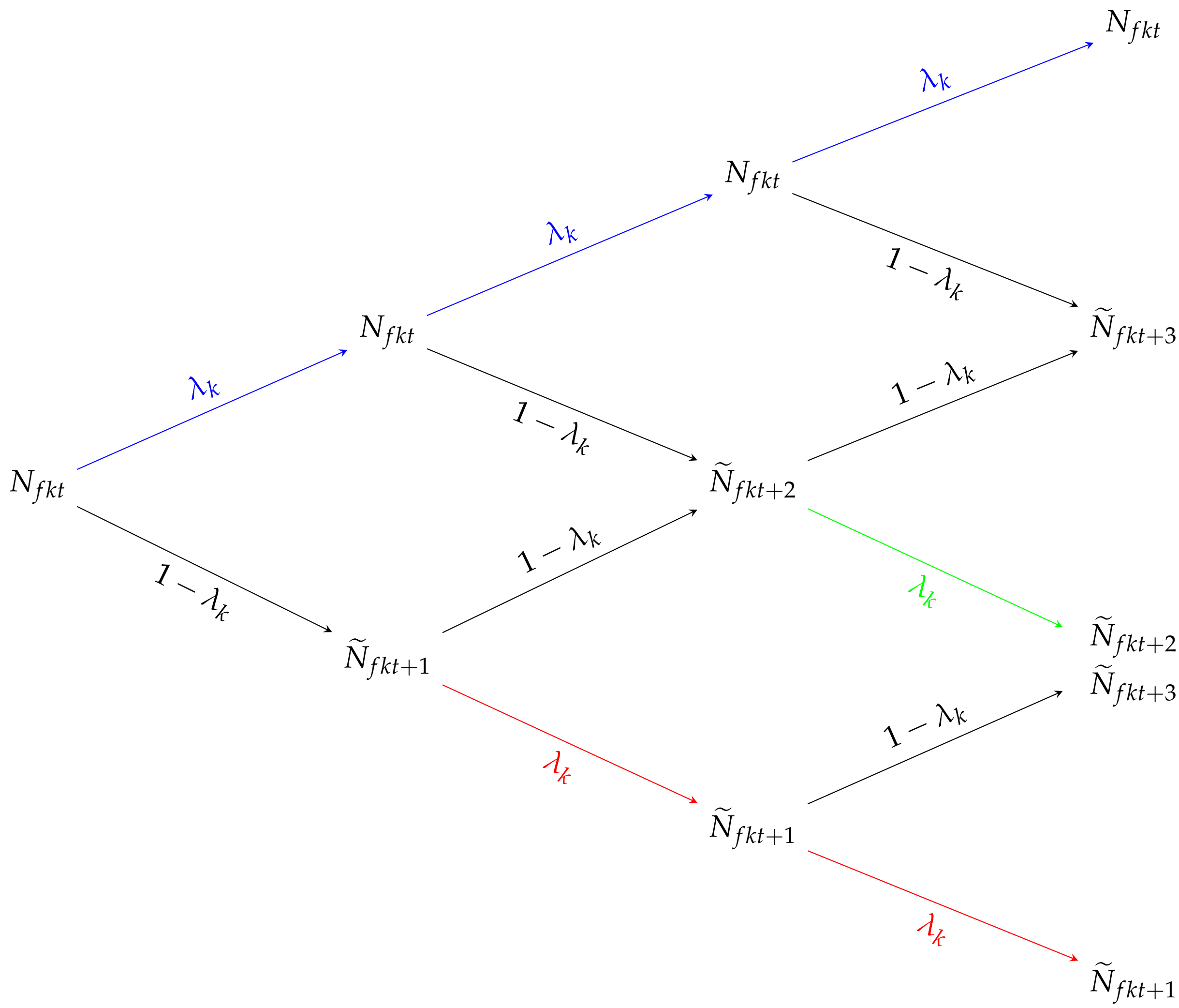
$$V_t(\widetilde{N}_{fkt}) = Div_t(\widetilde{N}_{fkt}) + \frac{\lambda_k}{1+r_t} V_{t+1}(\widetilde{N}_{fkt}) + \frac{(1-\lambda_)}{1+r_t} V_{t+1}(\widetilde{N}_{fkt+1})$$

$$= Div_t(\widetilde{N}_{fkt}) + \frac{\lambda_k}{1+r_t}\Big[V_{t+1}(\widetilde{N}_{fkt+1}) - VS_{t+1}(\widetilde{N}_{fkt+1}) + VS_{t+1}(\widetilde{N}_{fkt})\Big]$$

$$+ \frac{(1-\lambda_k)}{1+r_t} V_{t+1}(\widetilde{N}_{fkt+1})$$

$$= Div_t(\widetilde{N}_{fkt}) + \frac{V_{t+1}(\widetilde{N}_{fkt+1})}{1+r_t} + \frac{\lambda_k}{1+r_t}\Big[-VS_{t+1}(\widetilde{N}_{fkt+1}) + VS_{t+1}(\widetilde{N}_{fkt})\Big]$$

Figure 2: Asset Pricing



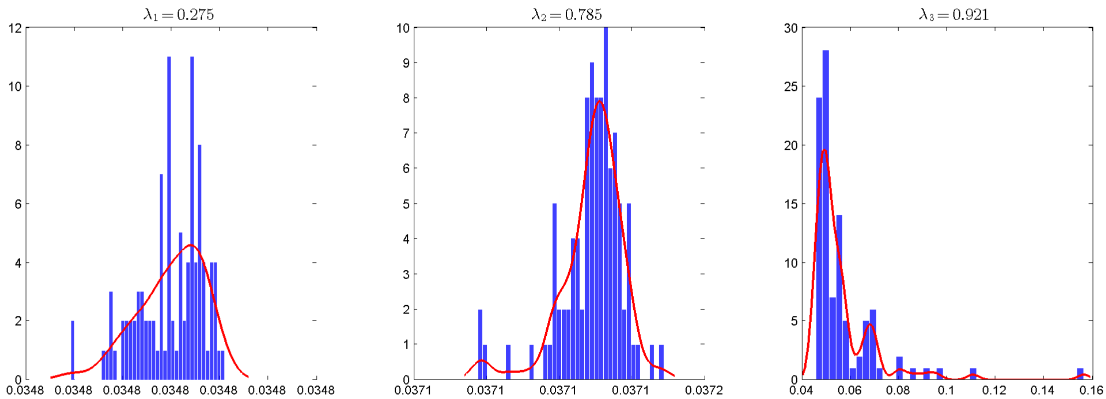
5.7 Parametrization

The parametrization of our model is standard for the most part when compared with other existing pricing models. The only deviations are the three elasticities in the production function to specify the optimal product scopes of firms and the time-dependent parameter defining the frequency of firms' product scope adjustment. For the elasticities, we set the across-group elasticity to be 2, consistent with the literature. We further set the across-firm/-product elasticities to the median of the estimates from Hottman, Redding and Weinstein (forthcoming). For the time-dependent parameters of product scope adjustments, we use the tertiles of product scope adjustments based on our Nielsen scanner data.

5.8 Simulation

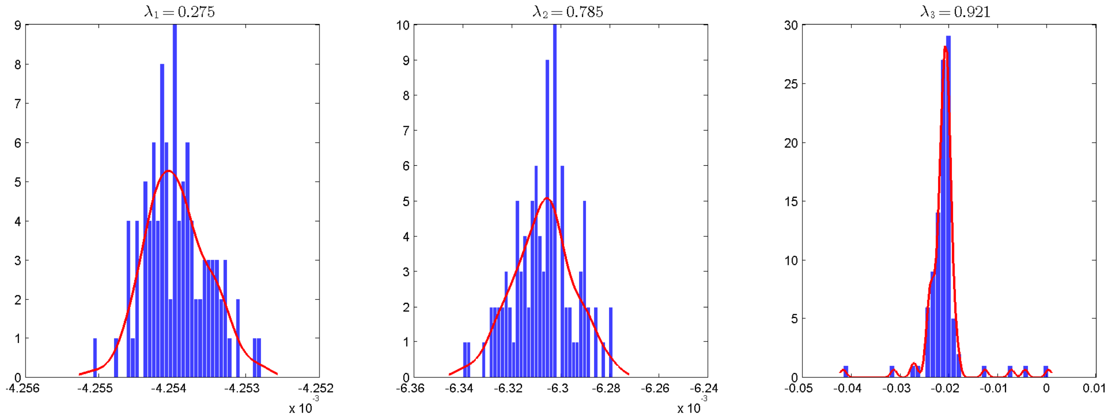
We simulate 100 firms of 3 groups for 1000 periods with the first 800 periods burn-in. [5] First, to measure the return rate, we take the average return rates of the 200 periods; then, for to simulate firms' asset volatility, we take the standard deviations of the return rates throughout the periods. To explore whether firms' flexibility in product scope adjustment plays a role in determining asset return rates and asset volatility, we plot the density of the return rate and volatility of each group. Figure 3 shows the results for the return rates, where we observe a positive correlation between firms' flexibility in product scope adjustment and return rates. That is, as firms become more rigid, the return rate increases. In Figure 4, we show the results for the covariance between inverse consumption growth and return rate. We observe that the density coincides with the negative relationship present in the empirical results. That is, the covariance decreases with the rigidity in product scope adjustment.

Figure 3: Return Rates of Firms with Different Flexibility in Product Scope Adjustment



[5]Steps: 1) store $RS, CS, VS(\widetilde{N}), V(\widetilde{N}), \widetilde{N}$ for each group k from the solution of Dynare (second-order perturbation); 2) generate path of $\{N\}$ from $\{\widetilde{N}\}$ following the binomial distribution of λ_k and each sequence $\{N\}$ represents a firm; 3) calculate RS, CS, Div, V for each firm at each period and then calculate return rate.

Figure 4: Covariance with Subjective Discount Factor of Firms with Different Extensive Margin Flexibility



6 Conclusion

Existing literature, both theoretical and empirical, has primarily focused on firm's price-setting behavior or "intensive margin adjustment" to understand firm dynamics and their implications on aggregate fluctuations. Here, we highlight the extensive margin adjustment by multi-product firms via products creation and destruction as a potentially important channel through which firms improve their resource allocation and enhance their performance.

We show that flexibility in firms' extensive margin adjustment improves firms' financial risk diversification, an ingredient that is essential to their performance. Benefiting from a rich data set with detailed information about the products consumed at retail stores operating in the U.S., we document several characteristics of firms' product scope adjustment - first, there is a great variation in product turnover rates across firms; second, a firm's product turnover rates is "sticky," in that firms with high (low) product turnover rate show high (low) turnover rates throughout the sample. More importantly, firms with higher flexibility in their product scope adjustments exhibit less financial risks measured by lower excess stock returns and asset volatility. And our simple model of multi-product firms with product turnover rates rationalize these findings.

While the economic benefits of financial risk diversification for firms are self-evident, aggregate implications of these firm-level economic benefits can be further examined. In this regard, connecting firms' financial risk diversification to their labor adjustment behaviors or investment decisions (particularly, R&D investment) would be promising avenues for future research. Also, how policies could be implemented to enhance firms' production flexibility and encourage R&D investment for product creations would be a meaningful extension of this study.

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Appendix

Proposition 1. *The optimal price is* $P_{ufkt} = \frac{\sigma_f}{\sigma_f - 1}\frac{W_t}{Z_t}$

Proof. Given demand $C_{fkt} = \left[\int_0^{N_{fkt}} C_{ufkt}^{\frac{\sigma_u - 1}{\sigma_u}} du\right]^{\frac{\sigma_u}{\sigma_u - 1}}$, $C_{ufkt} = C_t P_t^{\sigma_k} P_{kt}^{\sigma_f - \sigma_k} P_{fkt}^{\sigma_u - \sigma_f} P_{ufkt}^{-\sigma_u}$ and price $P_{fkt} = \left[\int_0^{N_{fkt}} P_{ufkt}^{1-\sigma_u} du\right]^{\frac{1}{1-\sigma_u}}$

$$\frac{\mathrm{d}C_{ufkt}}{\mathrm{d}P_{ufkt}} = C_{ufkt}\Big[\frac{\sigma_u - \sigma_f}{P_{fkt}}\frac{\mathrm{d}P_{fkt}}{\mathrm{d}P_{ufkt}} - \frac{\sigma_u}{P_{ufkt}}\Big]$$
$$\frac{\mathrm{d}C_{\tilde{u}fkt}}{\mathrm{d}P_{ufkt}} = \frac{(\sigma_u - \sigma_f)C_{kfkt}}{P_{fkt}}\frac{\mathrm{d}P_{fkt}}{\mathrm{d}P_{ufkt}}$$
$$\frac{\mathrm{d}P_{fkt}}{\mathrm{d}P_{ufkt}} = \frac{P_{fkt}P_{fkt}^{\sigma_u - 1}}{1 - \sigma_u}(1 - \sigma_u)P_{ufkt}^{-\sigma_u}\mathrm{d}u$$

Assume that $\frac{\mathrm{d}P_{\tilde{u}fkt}}{\mathrm{d}P_{ufkt}} = 0$, and we will verify that after solving for the optimal P_{ufkt}

$$\text{profit:} \quad D_{fkt} = \int_0^{N_{fkt}} C_{\tilde{u}fkt}(P_{\tilde{u}fkt} - MC_t)\mathrm{d}\tilde{u}$$
$$\frac{\mathrm{d}D_{fkt}}{\mathrm{d}P_{ufkt}} = \int_0^{N_{fkt}} \frac{(\sigma_u - \sigma_f)C_{\tilde{u}fkt}}{P_{fkt}}\frac{\mathrm{d}P_{fkt}}{\mathrm{d}P_{ufkt}}(P_{\tilde{u}fkt} - MC_t)\mathrm{d}\tilde{u} - \frac{\sigma_u C_{ufkt}}{P_{ufkt}}(P_{ufkt} - MC_t)\mathrm{d}u + C_{ufkt}\mathrm{d}u$$

Because of symmetry, the FOC of D_{fkt} can be rewritten as

$$\int_0^{N_{fkt}} (\sigma_u - \sigma_f)\Big(\frac{P_{fkt}}{P_{ufkt}}\Big)^{\sigma_u - 1}\frac{P_{ufkt} - MC_t}{P_{ufkt}}\mathrm{d}u - \frac{\sigma_u}{P_{ufkt}}(P_{ufkt} - MC_t) + 1 = 0$$
$$\implies \quad P_{ufkt} = \frac{\sigma_f}{\sigma_f - 1}\frac{W_t}{Z_t}$$

□

Proposition 2. *Cannibalization effect*

- *product level:* $-\frac{\mathrm{d}C_{ufkt}}{\mathrm{d}N_{fkt}}\frac{N_{fkt}}{C_{ufkt}} = \frac{\sigma_u - \sigma_f}{\sigma_u - 1}$
- *firm level:* $\frac{\mathrm{d}C_{fkt}}{\mathrm{d}N_{fkt}}\frac{N_{fkt}}{C_{fkt}} = \frac{\sigma_f}{\sigma_u - 1}$

Proof.

$$\frac{\mathrm{d}C_{ufkt}}{\mathrm{d}N_{fkt}} = C_{ufkt}\Big[(\sigma_u - \sigma_f)\cdot\frac{1}{P_{fkt}}\frac{\mathrm{d}P_{fkt}}{\mathrm{d}N_{fkt}} - \sigma_u\cdot\frac{1}{P_{ufkt}}\frac{\mathrm{d}P_{ufkt}}{\mathrm{d}N_{fkt}}\Big]$$
$$= C_{ufkt}\Big[(\sigma_u - \sigma_f)\cdot\frac{1}{P_{fkt}}\frac{P_{fkt}P_{fkt}^{\sigma_u - 1}}{1 - \sigma_u}\cdot P_{Nfkt}^{1-\sigma_u}\Big]$$
$$= -\frac{C_{ufkt}}{N_{fkt}}\frac{\sigma_u - \sigma_f}{\sigma_u - 1} < 0$$

$$
\begin{aligned}
\frac{\mathrm{d}C_{fkt}}{\mathrm{d}N_{fkt}} &= C_{fkt} C_{fkt}^{\frac{1-\sigma_u}{\sigma_u}} \frac{\sigma_u}{\sigma_u - 1} \Big[\int_0^{N_{fkt}} \frac{\sigma_u - 1}{\sigma_u} \frac{C_{ufkt}^{\frac{\sigma_u - 1}{\sigma_u}}}{C_{ufkt}} \frac{\mathrm{d}C_{ufkt}}{\mathrm{d}N_{fkt}} \mathrm{d}u + C_{Nfkt}^{\frac{\sigma_u-1}{\sigma_u}} \Big] \\
&= \frac{C_{fkt}}{N_{fkt}} \frac{\sigma_f}{\sigma_u - 1} > 0
\end{aligned}
$$

□

Proposition 3. *Optimal product scope without friction:*

Proof.

$$
\begin{aligned}
\frac{\mathrm{d}D_{fkt}}{\mathrm{d}N_{fkt}} &= \frac{MC_t}{\sigma_f - 1} \Big[C_{Nfkt} + \int_0^{N_{fkt}} -\frac{C_{ufkt}}{N_{fkt}} \frac{\sigma_u - \sigma_f}{\sigma_u - 1} \mathrm{d}u \Big] - F \cdot MC_t \\
&= \frac{MC_t}{\sigma_u - 1} \cdot C_{ufkt} - F \cdot MC_t \\
&= \frac{MC_t}{\sigma_u - 1} \frac{C_{fkt}}{N_{fkt}^{\frac{\sigma_u}{\sigma_u - 1}}} - F \cdot MC_t \\
\implies \quad N_{fkt} &= \Big[\frac{C_{fkt}}{F(\sigma_u - 1)} \Big]^{\frac{\sigma_u - 1}{\sigma_u}} \\
& \frac{\partial N_{fkt}}{\partial F} < 0, \ \frac{\partial N_{fkt}}{\partial C_{fkt}} > 0
\end{aligned}
$$

□

Proposition 4. *Optimal product scope with friction:*

$$
(\sigma_u - 1) \widetilde{N}_{fkt}^{\frac{\sigma_u - \sigma_f}{\sigma_u - 1}} = \frac{\sum_{j=0}^{\infty} \lambda_k^j \mathbb{E}_t \Big[\Lambda_{t+j} MC_{t+j} C_{t+j} P_{t+j}^{\sigma_k} P_{kt+j}^{\sigma_f - \sigma_k} MC_{t+j}^{-\sigma_f} \Big]}{\sum_{j=0}^{\infty} \lambda_k^j \mathbb{E}_t \Big[\Lambda_{t+j} MC_{t+j} F \Big]}
$$

Proof.

$$
\begin{aligned}
\max_{\widetilde{N}_{fkt}} \quad & \sum_{j=0}^{\infty} \beta^j \lambda_k^j \mathbb{E}_t \Big\{ \frac{\Lambda_{t+j}}{\Lambda_t} \Big[\int_0^{\widetilde{N}_{fkt}} \Big(P_{ufkt+j} - MC_{t+j} \Big) C_{ufkt+j} du \\
& \qquad - F \widetilde{N}_{fkt} MC_{t+j} \Big] \Big\} \\
s.t. \quad & C_{ufkt+j} = C_{t+j} P_{t+j}^{\sigma_k} P_{kt+j}^{\sigma_f - \sigma_k} P_{fkt+j}^{\sigma_u - \sigma_f} P_{ufkt+j}^{-\sigma_u}
\end{aligned}
$$

$$
\begin{aligned}
\frac{\partial \sum_{j=0}^{\infty} \beta^j \lambda_k^j \mathbb{E}_t \Big[\frac{\Lambda_{t+j}}{\Lambda_t} F \cdot N_{fkt} MC_{t+j} \Big]}{\partial \widetilde{N}_{fkt}} &= \frac{1}{\Lambda_t} \sum_{j=0}^{\infty} \beta^j \lambda_k^j \mathbb{E}_t \Big[\Lambda_{t+j} F \cdot MC_{t+j} \Big] \\
\frac{\partial \sum_{k=0}^{\infty} \beta^j \lambda_k^j \mathbb{E}_t \Big[\frac{\Lambda_{t+j}}{\Lambda_t} \int_0^{N_{fkt}} \frac{MC_{t+j}}{\sigma_f - 1} \cdot C_{ufkt+j} \mathrm{d}u \Big]}{\partial \widetilde{N}_{fkt}} &= \sum_{j=0}^{\infty} \beta^j \lambda_k^j \mathbb{E}_t \Big[\frac{\Lambda_{t+j}}{\Lambda_t} \frac{MC_{t+j}}{\sigma_f - 1} \Big(C_{\widetilde{N}fkt+j} + \int_0^{\widetilde{N}_{fkt}} \frac{\partial C_{ufkt+j}}{\partial \widetilde{N}_{fkt}} \mathrm{d}u \Big) \Big] \\
&= \frac{1}{\Lambda_t} \sum_{j=0}^{\infty} \beta^j \lambda_k^j \mathbb{E}_t \Big[\Lambda_{t+j} \frac{MC_{t+j}}{\sigma_f - 1} C_{ufkt+j} \frac{\sigma_f - 1}{\sigma_u - 1} \Big]
\end{aligned}
$$

$$
\begin{aligned}
\text{where } C_u &= C\Big(\frac{P_k}{P}\Big)^{-\sigma_k}\Big(\frac{P_f}{P_k}\Big)^{-\sigma_f}\Big(\frac{1}{N^{\frac{1}{1-\sigma_u}}}\Big)^{-\sigma_u} \\
&= CP^{\sigma_k}P_k^{\sigma_f-\sigma_k}N^{\frac{\sigma_u-\sigma_f}{1-\sigma_u}}\Big(\frac{\sigma_f MC}{\sigma_f-1}\Big)^{-\sigma_f}
\end{aligned}
$$

$$
\implies \quad (\sigma_u-1)\widetilde{N}_{fkt}^{\frac{\sigma_u-\sigma_f}{\sigma_u-1}} = \frac{\Big(\frac{\sigma_f}{\sigma_f-1}\Big)^{-\sigma_f}\sum_{j=0}^{\infty}\beta^j\lambda_k^j\mathbb{E}_t\Big[\frac{\Lambda_{t+j}}{\Lambda_t}MC_{t+j}C_{t+j}P_{t+j}^{\sigma_k}P_{kt+j}^{\sigma_f-\sigma_k}MC_{t+j}^{-\sigma_f}\Big]}{\sum_{j=0}^{\infty}\beta^j\lambda_k^j\mathbb{E}_t\Big[\frac{\Lambda_{t+j}}{\Lambda_t}MC_{t+j}F\Big]}
$$

$$
\iff \widetilde{N}_{fkt}^{\frac{\sigma_u-\sigma_f}{\sigma_u-1}} \equiv \frac{\sigma_f^{-\sigma_f}}{(\sigma_f-1)^{-\sigma_f}(\sigma_u-1)}\frac{PVR_{kt}}{PVC_{kt}}
$$

$$
\begin{aligned}
PVR_{kt} &= \frac{1}{P_t}\sum_{j=0}^{\infty}\beta^j\lambda_k^j\mathbb{E}_t\Big[\frac{\Lambda_{t+j}}{\Lambda_t}MC_{t+j}C_{t+j}P_{t+j}^{\sigma_k}P_{kt+j}^{\sigma_f-\sigma_k}MC_{t+j}^{-\sigma_f}\Big] \\
&= \sum_{j=0}^{\infty}\beta^j\lambda_k^j\mathbb{E}_t\Big[\frac{\Lambda_{t+j}}{\Lambda_t}\Big(\frac{W_{t+j}}{Z_{t+j}P_{t+j}}\Big)^{1-\sigma_f}\Big(\frac{P_{kt+j}}{P_{t+j}}\Big)^{\sigma_f-\sigma_k}\frac{P_{t+j}}{P_t}C_{t+j}\Big] \\
&= \Big(\frac{W_t}{Z_tP_t}\Big)^{1-\sigma_f}\Big(\frac{P_{kt}}{P_t}\Big)^{\sigma_f-\sigma_k}C_t \\
&\quad + \beta\lambda_k\sum_{j=1}^{\infty}(\beta\lambda_k)^{j-1}\mathbb{E}_t\Big[\frac{\Lambda_{t+1}}{\Lambda_t}\frac{\Lambda_{t+j}}{\Lambda_{t+1}}\Big(\frac{W_{t+j}}{Z_{t+j}P_{t+j}}\Big)^{1-\sigma_f}\Big(\frac{P_{kt+j}}{P_{t+j}}\Big)^{\sigma_f-\sigma_k}\frac{P_{t+j}C_{t+j}}{P_t}\Big] \\
&= \Big(\frac{W_t}{Z_tP_t}\Big)^{1-\sigma_f}\Big(\frac{P_{kt}}{P_t}\Big)^{\sigma_f-\sigma_k}C_t + \beta\lambda_k\mathbb{E}_t\Big[\frac{\Lambda_{t+1}}{\Lambda_t}\frac{P_{t+1}}{P_t}PVR_{kt+1}\Big] \\
PVC_{kt} &= \frac{1}{P_t}\sum_{j=0}^{\infty}\beta^j\lambda_k^j\mathbb{E}_t\Big[\frac{\Lambda_{t+j}}{\Lambda_t}MC_{t+j}F\Big] \\
&= \frac{W_tF}{Z_tP_t} + \sum_{j=1}^{\infty}\beta^j\lambda_k^j\mathbb{E}_t\Big[\frac{\Lambda_{t+j}}{\Lambda_t}\frac{W_{t+j}F}{Z_{t+j}P_{t+j}}\frac{P_{t+j}}{P_t}\Big] \\
&= \frac{W_tF}{Z_tP_t} + \beta\lambda_k\sum_{j=1}^{\infty}(\beta\lambda_k)^{j-1}\mathbb{E}_t\Big[\frac{\Lambda_{t+1}}{\Lambda_t}\frac{\Lambda_{t+j}}{\Lambda_{t+1}}\frac{W_{t+j}F}{Z_{t+j}P_{t+j}}\frac{P_{t+j}}{P_{t+1}}\frac{P_{t+1}}{P_t}\Big] \\
&= \frac{W_tF}{Z_tP_t} + \beta\lambda_k\mathbb{E}_t\Big[\frac{\Lambda_{t+1}}{\Lambda_t}\frac{P_{t+1}}{P_t}PVC_{kt+1}\Big]
\end{aligned}
$$

NB: $M_{t,t+k}$ only depends on aggregate C_t which is independent with N since there is no firm entry. □

Table 1: Transition Matrix

	Introduction Rate		Destruction Rate		Turnover Rate	
	Bottom	Top	Bottom	Top	Bottom	Top
Bottom	0.66	0.34	0.71	0.29	0.68	0.32
Top	0.09	0.91	0.08	0.92	0.09	0.91

Table 2: High Turnover Firms vs. Low Turnover Firms

	Introduction Rate			Destruction Rate		
	Bottom	Top	pvalue	Bottom	Top	pvalue
firm characteristics						
size (in m$)	0.02	0.02	0.61	0.01	0.02	0.40
book-to-market ratio	3.78	5.43	0.09	4.83	4.39	0.65
beta	1.98	1.65	0.56	1.95	1.68	0.64
leverage	0.64	1.15	0.14	0.78	1.01	0.51
cash flow	1.23	0.98	0.63	0.84	1.37	0.32
turnover (in m$)	37.01	23.61	0.41	21.41	39.05	0.28
spread	0.33	0.34	0.90	0.34	0.33	0.84
	Bottom	Top	pvalue	Bottom	Top	pvalue
purchaser characteristics						
income<median	0.52	0.52	0.90	0.52	0.51	0.72
household size	2.40	2.39	0.80	2.40	2.39	0.73
has child	0.23	0.23	0.98	0.23	0.22	0.79
male household head						
employed	0.67	0.66	0.33	0.68	0.66	0.29
edu>high school	0.63	0.61	0.38	0.62	0.62	0.83
age<50	0.18	0.16	0.27	0.18	0.16	0.11
female household head						
employed	0.55	0.54	0.51	0.56	0.53	0.12
edu>high school	0.58	0.59	0.71	0.59	0.58	0.49
age<50	0.19	0.18	0.30	0.20	0.17	0.11
	Bottom	Top	pvalue	Bottom	Top	pvalue
retailer characteristics						
sales (in m$)	5.80	5.75	0.95	5.77	5.78	0.99

Table 3: Parameterization

σ_k	group elasticity of substitution	2	
σ_f	firm elasticity of substitution	3.9	Hottman et al. (2016)
σ_u	product elasticity of substitution	6.9	Hottman et al. (2016)
β	time preference	0.99	
ϕ	Frisch elasticity	0.5	
χ		1	
F	fixed cost of product scope (per variety)	1	
ρ_z	productivity AR(1) coef.	0.9	
σ_z	productivity std	0.01	
ρ_ν	monetary policy shock AR(1) coef.	0.9	
σ_ν	monetary policy std	0.02	
ϕ_π	Taylor rule	1.5	
ϕ_y	Taylor rule	0.5	
λ_1	Probability of not able to change product scope (1st tertile)	0.275	Nielsen
λ_2	Probability of not able to change product scope (2nd tertile)	0.785	Nielsen
λ_3	Probability of not able to change product scope (3rd tertile)	0.921	Nielsen

Table 4: Summary statistics

VARIABLES	N	mean	sd
# destroyed UPC	1413	81.35	266.7
# created UPC	1413	63.62	252.0
destruction rate (%)	1413	17.1	15.3
creation rate (%)	1413	13.9	16.3
turnover rate (%)	1413	26.5	18.2
destruction rate (weighted, %)	1413	8.97	17.6
creation rate (weighted, %)	1413	10.2	18.7
turnover rate (weighted, %)	1413	17.0	22.6
return rate (%)	1413	15.8	47.11
sd(return rate)	1413	4.884	3.093
market size (in m$)	1413	0.0193	0.0519
beta	1413	1.374	8.439
turnover (in m$)	1413	30.42	85.65
book-to-market ratio	1413	4.271	8.175
cash flow (in m$)	1413	1.246	3.940
price-to-cost margin	1413	35.27	18.03
spread	1413	0.237	0.908
leverage	1413	0.968	5.014
R&D expenditure (in k$)	1413	-9.114	96.20
industry book-to-mkt ratio	1413	0.411	0.156
industry return rate	1413	11.96	20.78
No. Firms	203		

Table 5: The Portfolio Analysis

	Bottom	Top	Difference	(p-value)
CreationRate				
ReturnRate	2.06	1.08	0.98	0.07
R(3factor)	1.28	0.48	0.80	0.02
R(5factor)	1.08	0.39	0.69	0.03
DestructionRate				
ReturnRate	2.29	1.13	1.17	0.95
R(3factor)	1.46	0.53	0.93	0.98
R(5factor)	1.27	0.46	0.81	0.98

Note: This table reports the (unexplained) return rate among firm groups with different turnover rates. The top panel uses the creation rate to rank firms, while the bottom panel uses the destruction rate to re-rank them. Within each panel, the first column presents the mean return rate of the bottom one third firms, and the second shows that of the top one third. The third column is the gap between the two, and the last is the p-value of the t-test on whether the gap is significantly greater than zero or not.

Table 6: Return Rate and Extensive Margin Adjustments

	(1)	(2)	(3)	(4)	(5)	(6)
	YearFE	+industryPortfolio	+R&D	+#upc	turnoverRate	+#UPC
	b/se	b/se	b/se	b/se	b/se	b/se
CreationRate	-0.104*	-0.106*	-0.106*	-0.109*		
	(0.06)	(0.06)	(0.06)	(0.06)		
DestructionRate	0.014	0.002	0.002	0.004		
	(0.06)	(0.06)	(0.06)	(0.06)		
TurnoverRate					-0.107*	-0.107*
					(0.06)	(0.06)
# of UPC				-0.031***		-0.030***
				(0.01)		(0.01)
mktSize	-2.615**	-2.256*	-2.233*	-2.356*	-2.218*	-2.314*
	(1.28)	(1.29)	(1.29)	(1.31)	(1.32)	(1.35)
Book-to-Mkt	0.018**	0.017**	0.017**	0.017**	0.017**	0.017**
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
beta	-0.008**	-0.008**	-0.008**	-0.008**	-0.008**	-0.008**
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
leverage	-0.012**	-0.011**	-0.011**	-0.011**	-0.011**	-0.011**
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
Cash Flow	0.025***	0.020***	0.020***	0.020***	0.020***	0.020***
	(0.01)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Stock Turnover	0.000	0.000	0.000	0.000	0.000	0.000
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
spread	0.017*	0.018*	0.018*	0.018*	0.018*	0.018*
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
Price-Cost Margin	0.020***	0.020***	0.020***	0.021***	0.020***	0.021***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
IndustryHHI	-0.338	-0.401	-0.403	-0.351	-0.463	-0.416
	(0.72)	(0.67)	(0.67)	(0.67)	(0.67)	(0.67)
IndustryReturn		0.004***	0.004***	0.004***	0.004***	0.004***
		(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
IndustryBook-to-Mkt		0.003	0.005	0.003	0.003	0.003
		(0.08)	(0.08)	(0.08)	(0.08)	(0.08)
R&Dexpenditure			-0.000*			
			(0.00)			
N	1413	1413	1413	1413	1413	1413
r2	.2868	.2976	.2977	.2982	.2977	.2983

Note: This table reports the relationship between stock return rate and different measures of extensive margin adjustments (creation rates, destruction rates and turnover rates). Column (1) is the baseline result with year and firm fixed effects. Column (2) adds industry-specific portfolio characteristics. Column (3) includes R&D expenditure to control for the factor influencing product turnover yet not through the risk channel. Column (4) controls for the number of products to test whether the original product scope affects the result or not. Column (5) replaces creation rate and destruction rate with turnover rate as dependent variable. The last column expands Column (5) by adding product scope as an additional control. ***, **, * represent significance of 1%, 5% and 10%, respectively.

Table 7: Asset Volatility and Extensive Margin Adjustments

	(1)	(2)	(3)	(4)	(5)	(6)
	YearFE	+industryPortfolio	+R&D	+#UPC	turnoverRate	+#UPC
	b/se	b/se	b/se	b/se	b/se	b/se
CreationRate	-1.072**	-1.045**	-1.046**	-1.027*		
	(0.53)	(0.52)	(0.52)	(0.52)		
DestructionRate	-0.268	-0.279	-0.278	-0.281		
	(0.41)	(0.42)	(0.42)	(0.41)		
TurnoverRate					-0.956**	-0.947**
					(0.47)	(0.47)
# of UPC				-0.273*		-0.276*
				(0.15)		(0.15)
mktSize	2.293	1.855	1.882	0.968	1.277	0.394
	(5.74)	(5.63)	(5.65)	(5.59)	(5.50)	(5.45)
Book-to-Mkt	-0.001	0.000	0.000	-0.001	-0.000	-0.001
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
beta	-0.019	-0.019	-0.019	-0.019	-0.019	-0.019
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
leverage	-0.004	-0.006	-0.006	-0.006	-0.006	-0.005
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
Cash Flow	-0.020	-0.013	-0.013	-0.014	-0.015	-0.016
	(0.05)	(0.05)	(0.05)	(0.05)	(0.05)	(0.05)
Stock Turnover	0.001	0.001	0.001	0.001	0.001	0.001
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
spread	-0.115	-0.116	-0.116	-0.114	-0.115	-0.113
	(0.10)	(0.10)	(0.10)	(0.10)	(0.10)	(0.10)
Price-Cost Margin	-0.049**	-0.048**	-0.048**	-0.047**	-0.048**	-0.046**
	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)
IndustryHHI	-13.712*	-13.554*	-13.556*	-13.126	-13.746*	-13.312
	(8.09)	(8.09)	(8.09)	(8.04)	(8.17)	(8.11)
IndustryReturn		-0.007*	-0.007*	-0.008*	-0.008*	-0.008*
		(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
IndustryBook-to-Mkt		0.305	0.306	0.302	0.287	0.284
		(0.52)	(0.52)	(0.52)	(0.53)	(0.53)
R&Dexpenditure			-0.000			
			(0.00)			
N	1413	1413	1413	1413	1413	1413
r2	.2928	.2941	.2942	.296	.2938	.2957

Note: This table reports the relationship between stock return volatility and different measures of extensive margin adjustments (creation rates, destruction rates and turnover rates). Column (1) is the baseline result with year and firm fixed effects. Column (2) adds industry-specific portfolio characteristics. Column (3) includes R&D expenditure to control for the factor influencing product turnover yet not through the risk channel. Column (4) replaces creation rate and destruction rate with turnover rate as dependent variable. Column (5) uses product turnover rates as the dependent variable. The last column further controls the product scope on top of Column (5). ***, **, * represent significance of 1%, 5% and 10%, respectively.

Table 8: CCAPM-Based Excess Return and Extensive Margin Adjustments

	(1) Baseline b/se	(2) +R&D b/se	(3) +#UPC b/se	(4) turnoverRate b/se	(5) +#UPC b/se
CreationRate	0.011*	0.010*	0.010*		
	(0.005)	(0.005)	(0.005)		
DestructionRate	-0.004	-0.003	-0.005		
	(0.006)	(0.006)	(0.006)		
TurnoverRate				0.010**	0.009**
				(0.002)	(0.002)
# of UPC		0.000**			0.000*
		(0.000)			(0.000)
mktSize	0.172***	0.117***	0.171***	0.176***	0.131***
	(0.022)	(0.019)	(0.022)	(0.024)	(0.018)
Book-to-Mkt	0.000*	0.000*	0.000	0.000*	0.000*
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
beta	-0.001	-0.001	-0.001	-0.001*	-0.001
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
leverage	-0.000	-0.000	-0.000	-0.000	-0.000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Cash Flow	-0.002**	-0.001**	-0.002**	-0.002**	-0.001**
	(0.001)	(0.000)	(0.001)	(0.001)	(0.000)
Stock Turnover	0.000	-0.000	0.000	0.000	0.000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
spread	0.001	0.001	0.001	0.001*	0.001**
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Price-Cost Margin	0.000**	0.000**	0.000*	0.000**	0.000**
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
IndustryHHI	-0.007	-0.006	-0.006	-0.007	-0.006
	(0.016)	(0.014)	(0.015)	(0.017)	(0.016)
R&Dexpenditure		-0.000**	-0.000*		
		(0.000)	(0.000)		
N	203	203	203	203	203
r2	.2247	.2328	.2256	.2262	.2316

Note: This table reports the relationship between Cov(return rate, consumption growth) and different measures of extensive margin adjustments (creation rates, destruction rates and turnover rates). Column (1) is the baseline result. Column (2) adds R&D expenditure as an additional control. Column (3) controls for the number of products to test whether the original product scope affects the result or not. Column (4) controls for the number of products to test whether the original product scope affects the result or not. Column (5) replaces creation rate and destruction rate with turnover rate as dependent variable. The last column expands Column (5) by adding product scope as an additional control. ***, **, * represent significance of 1%, 5% and 10%, respectively.

Table 9: Cointegration-Type Test on Retailer and Household

	Retailer			Household		
	CreationRate	DestructionRate	Turnover	CreationRate	DestructionRate	Turnover
	b/se	b/se	b/se	b/se	b/se	b/se
Mean of the Rest	0.921***	0.921***	0.929***	0.995***	0.995***	0.995***
	(0.01)	(0.01)	(0.01)	(0.00)	(0.00)	(0.00)
N	181168	181168	181168	3589279	3589279	3589279

Note: This table reports the co-integration relationships for different types of extensive margin adjustments (creation rates, destruction rates and turnover rates). The first three columns report the results based on the categorization based on retailers. The last three columns report the results based on the categorization based on households. ***, **, * represent significance of 1%, 5% and 10%, respectively.

Table 10: Robustness Check: Return Rate and Product Creation/Destruction Rates Controlling for Retailers and Households

	(1) +retailer b/se	(2) +demand b/se	(3) +both b/se
Creation Rate	-0.103*	-0.103*	-0.099*
	(0.06)	(0.06)	(0.06)
Destruction Rate	0.001	-0.005	-0.006
	(0.06)	(0.06)	(0.06)
Creation Rate (Retailer)	-0.788		-0.874
	(1.77)		(1.86)
Destruction Rate (Retailer)	-0.290		-0.124
	(1.71)		(1.76)
Creation Rate (Households)		0.044	0.054
		(0.35)	(0.35)
Destruction Rate (Households)		0.091	0.091
		(0.45)	(0.45)
mktSize	-2.280*	-2.267*	-2.292*
	(1.28)	(1.28)	(1.28)
Book-to-Mkt	0.017**	0.017**	0.017**
	(0.01)	(0.01)	(0.01)
beta	-0.008**	-0.008**	-0.008**
	(0.00)	(0.00)	(0.00)
leverage	-0.011**	-0.011**	-0.011**
	(0.01)	(0.01)	(0.01)
Cash Flow	0.020***	0.020***	0.020***
	(0.00)	(0.00)	(0.00)
Stock Turnover	0.000	0.000	0.000
	(0.00)	(0.00)	(0.00)
spread	0.018*	0.018*	0.018*
	(0.01)	(0.01)	(0.01)
Price-Cost Margin	0.020***	0.020***	0.020***
	(0.00)	(0.00)	(0.00)
IndustryHHI	-0.397	-0.368	-0.361
	(0.66)	(0.67)	(0.67)
IndustryReturn	0.004***	0.004***	0.004***
	(0.00)	(0.00)	(0.00)
Industry Book-to-Mkt	-0.001	0.004	-0.001
	(0.08)	(0.08)	(0.08)
N	1413	1413	1413
r2	.2977	.2974	.2975

Note: This table reports the relationship between return rate and various measures of extensive margin adjustments (creation rates, destruction rates and turnover rates) controlling for retailers and households. Column (1) is the baseline result controlling for retailer-specific turnover rates. Column (2) controls for household-specific turnover rates. The last column controls for both. ***, **, * represent significance of 1%, 5% and 10%, respectively.

Table 11: Robustness Check: Return Rate and Turnover Rates Controlling for Retailers and Households

	(1) +retailer b/se	(2) +demand b/se	(3) +both b/se
TurnoverRate	0.008***	0.007**	0.007**
	(0.001)	(0.003)	(0.001)
CreationRateRetailer	0.038		0.048
	(0.026)		(0.030)
DestructionRateRetailer	-0.092**		-0.098**
	(0.021)		(0.020)
CreationRateHH		-0.033	-0.047**
		(0.019)	(0.011)
DestructionRateHH		-0.028	-0.012
		(0.028)	(0.011)
R&Dexpenditure	-0.000**	-0.000**	-0.000**
	(0.000)	(0.000)	(0.000)
# of UPC	0.000**	0.000**	0.000**
	(0.000)	(0.000)	(0.000)
mktSize	0.128***	0.133***	0.140***
	(0.014)	(0.017)	(0.017)
Book-to-Mkt	0.000	0.000	0.000
	(0.000)	(0.000)	(0.000)
beta	-0.001*	-0.001	-0.001*
	(0.000)	(0.000)	(0.000)
leverage	-0.000	-0.000	-0.000
	(0.000)	(0.000)	(0.000)
Cash Flow	-0.001**	-0.001**	-0.002**
	(0.000)	(0.000)	(0.000)
stock Turnover	0.000	0.000	0.000
	(0.000)	(0.000)	(0.000)
spread	0.001	0.001*	0.000
	(0.001)	(0.001)	(0.001)
Price-Cost Margin	0.000	0.000**	0.000*
	(0.000)	(0.000)	(0.000)
IndustryHHI	-0.005	-0.002	-0.001
	(0.013)	(0.009)	(0.008)
N	203	203	203
r2	.2517	.2625	.2821

Note: This table reports the relationship between return rate and product turnover rates controlling for retailer and households. Column (1) is the baseline result controlling for retailer-specific turnover rates. Column (2) controls for household-specific turnover rates. The last column controls for both. ***, **, * represent statistical significance of 1%, 5% and 10%, respectively.