ARTICLE IN PRESS

Long Range Planning xxx (xxxx) xxxx

Contents lists available at ScienceDirect

Long Range Planning

journal homepage: www.elsevier.com/locate/lrp

All the bottles in one basket? Evaluating the effect of intra-industry diversification on risk☆

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ARTICLE INFO

Keywords:
Diversification
Enterprise risk management
Monte Carlo
Product portfolios
Risk-return relation

ABSTRACT

This paper develops a framework using Monte Carlo simulation to examine risk/return properties of intra-industry product portfolio composition and diversification. We use product-level data covering all Swedish sales of alcoholic beverages to describe the risk profiles of wholesalers and how they are affected by actual and hypothetical changes to product portfolios. Using a large number of counterfactual portfolios we quantify the diversification benefits of different product portfolio compositions. In this market the most important reductions in variability come from focusing on domestic products and from focusing on product categories that have low variability. The number of products also has a large effect in the simulations, moving from a portfolio of 10 products to one of 20 products cuts standard deviation of cash flows in relation to mean cash flows by more than half. The concentration of import origins plays a minor quantitative role on risk/return profiles in this market.

Introduction

Understanding the costs and benefits of diversification is central to strategic management and a large literature examines the trade-offs between economies of scope and coordination costs (see e.g. Rumelt (1982) and Chatterjee and Wernerfelt (1991) for seminal references). A related line of reasoning stresses the role of a diversified portfolio in limiting the effect of adverse shocks. Such logic emphasizes that insurance companies seek customers with uncorrelated shocks, banks limit exposure to a single borrower or that movie producers have sufficient number of films that at least one success can make up for the inevitable flops. This article examines links between such intra-industry portfolio diversification and risk profiles for firms using Monte Carlo simulation. While the motivation is general we choose to apply the methods to a case with rich product-level data for an entire national market: brewers and wholesalers of alcoholic beverages in Sweden 2006–2011. In this setting, diversification may for instance refer to adding a sparkling wine to a portfolio of red wines, adding a new source country or replacing one dominant product with a set of lesser products that together add up to a similar market share. Counterfactual cash flows that reflect both cost and demand shocks are used to explore the risk/return consequences of actual and hypothetical changes in product portfolios.

Figuratively speaking the present article develops tools to examine the risk consequences of putting all your eggs in one basket. To

☆ I'm grateful to Niklas Amberg, Marcus Asplund, Philippe Bacchetta, the editor Koen Heimeriks, two anonymous referees and seminar participants at the Norwegian School of Economics in Bergen for valuable comments. Thank you to Systembolaget for providing the key data and to the Jan Wallander and Tom Hedelius Foundation for economic support.

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https://doi.org/10.1016/j.lrp.2020.101973
Received 1 August 2018; Received in revised form 5 March 2020; Accepted 9 March 2020
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Please cite this article as: Richard Friberg, Long Range Planning, https://doi.org/10.1016/j.lrp.2020.101973

understand its contribution note that it aims to create tools that can be used by a firm in a specific situation to evaluate portfolios in a forward looking manner. It seeks to provide guidance to the ex ante question "what are the likely risk/return consequences of me replacing product *A* with product *B* in my portfolio."[1]

To introduce some of the key issues consider the portfolios of two wholesalers in the Swedish market that have similar turnover but whose portfolios differ in their composition: Bornicon&Salming and Johan Lidby. Both are relatively small, stand-alone firms owned by the founders. As seen in Table 1 five products each account for more than 10% of revenue for Bornicon&Salming and an important role for Australian wines is complemented by a Thai beer, Singha. There is a mix of package sizes and a predominance of products in the lower two terciles of the price distribution in the respective category.

The other wholesaler, Johan Lidby, has one dominant product which accounts for some 40% of sales. Furthermore, its product portfolio almost exclusively consists of wines in the top tercile of the price distribution and almost exclusively from the euro area. One would therefore expect that the two firms would be affected quite differently by many types of shocks. A reliance on euro area imports should make Johan Lidby sensitive to changes in the euro exchange rate and a focus on high end products are likely to be associated with a greater sensitivity to the business cycle. Indeed, in Fig. 1 we plot the cash flows of the two firms in the period surrounding the financial crisis. It is clear that the cash flows of Johan Lidby took a greater hit from the 2008 recession than what Bornicon&Salming's did. The example illustrates that otherwise similar firms may have quite different product portfolios and this matters for their response to shocks.

Fig. 1 also shows hypothetical cash flows if Johan Lidby's top selling product, the Italian red wine Monte Garbi Ripasso were to be replaced by a spirit imported from the U.K., Gordon's Dry Gin. In the first year these two products have very similar cash flows but the developments prior to and during the crisis (year 0) suggest that by lowering reliance on euro area wines Lidby would have smoothed cash flow developments. Developments in year 1 and 2 post crisis further reflect that product specific cost and demand shocks drive portfolio level cash flows.

The present article makes two contributions to the literature on firm performance and diversification. A first contribution is to leverage rich data (with product level observations of cash flows) to provide a case study of links between *within-industry product differentiation* and diversification. As discussed in the literature section below there is a rich literature on across-industry differentiation but the empirical within-industry literature on diversification is sparse. We use the variability of cash flows in relation to the mean cash flows as a measure of riskiness of portfolios and systematically explore how this measure of risk is affected by product portfolio composition in a number of dimensions.[2] Having more products in the portfolio, avoiding high risk segments, having a higher share of domestic products and a more dispersed pattern of source countries are all ways of lowering risk. As discussed below it has previously been found that diversification to other industries lowers variability of returns and increases the probability of survival in adverse conditions. The present article indicates that diversification benefits are available also at a very fine-grained level, for instance lowering risk by focusing on white wine in bottles rather than white wine sold in the more volatile bag-in-box segment.

Wholesalers in the sample have exclusive control over a given product but in the sample there are a large number of cases where a product changes wholesaler. An evaluation of these acquisitions and divestitures shows that none of the wholesalers acquired or divested products in a way that raised risk while lowering profitability. The results indicate that the mean-variance framework provides a useful prism through which to understand restructuring of product portfolios and evaluate strategic choices by firms.

A second contribution is to develop tools that can be used to evaluate the links between product portfolios and risk in a forward looking manner. As highlighted by the example above which replaced a red wine with a gin one may *ex post* point to alternative product portfolios that will have done better than the actual portfolio. For strategic decision making however we are interested in tools that can be used to consider the risk profile of alternative portfolios ex ante. We combine regression analysis with Monte Carlo simulations using a large number of random draws on product-, category- and origin-level shocks to generate distributions of counterfactual cash flows at the product level. By summing over the actual portfolios that firms in the sample control we generate portfolio level distributions of cash flows and the framework is easily adapted to evaluating different portfolios.

Our use of Monte Carlo simulations to model risk builds on a tradition that goes back to at least Hertz (1964). Many commercial applications exist but published academic work is scarce and typically there is no link between the Monte Carlo simulations and econometric analysis. Rather some cases are taken as base cases and then various distributional assumptions are made. We are not aware of any previous published work that has combined regression analysis and Monte Carlo simulations to examine different product portfolios in the way done in the present paper.[3]

[1] Applications include evaluations of risk consequences of acquisitions or divestitures, bench-marking against competitors, gauging sensitivity to business cycle shocks (see e.g. Bromiley et al. (2008) for a discussion of the relative paucity of research in this area) or for determining the extent of risk management tools needed - for instance the use of financial hedges or the amount of cash to hold.

[2] Inspired by the Fisher separation theorem (see e.g. Stein (2003)) a critical reader might wonder why a firm should be concerned about risk at all. Many of the firms in the data set are privately owned and risk aversion would be a clear motivation for managing risk. Furthermore, risk aversion is only one reason for why the value of the firm can be a concave function of shocks, which implies that variability lowers the expected value; convex tax schedules and a need to maintain sufficient funds to be able to access capital markets when there are credit constraints are but two examples that have been explored in the literature (Smith and Stulz (1985); Froot et al. (1993)). A second question then becomes, why not use derivatives to insure against variability? First note that in order to determine how much to hedge a firm needs to understand its exposure, something which the tools in the present article are useful for. Second, for reasons that are not quite understood many firms seem reluctant to use derivatives to manage exposure. Many do not use derivatives, especially smaller firms and in addition, even in the cases where firms hedge exposures, the amounts covered are frequently too small to have a material impact on the value of the firm (Guay and Kothari (2003), Bartram et al. (2009); for an overview see Friberg (2015)).

Table 1
Product portfolios of two firms during the financial crisis 2008–2009.

Name	Origin	Category	Package	Rev. Share	High price
Bornicon & Salming					
De Bortoli Semillon-Chardonnay	Australia	White wine	3 L BiB	0.28	0
Singha	Thailand	Beer	33 cl bottle	0.21	1
De Bortoli dB Selection Rosé	Australia	Rosé wine	3 L BiB	0.2	0
De Bortoli Shiraz	Australia	Red wine	75 cl bottle	0.11	0
De Bortoli Gewürztraminer	Australia	White wine	75 cl bottle	0.11	0
Claude Val Rouge	France	Red wine	75 cl bottle	0.03	0
De Bortoli Semillon-Chardonnay	Australia	White wine	75 cl bottle	0.02	0
Menetou	France	White wine	75 cl bottle	0.01	1
LS Chardonnay	Bulgaria	White wine	75 cl bottle	0.01	0
Schuchmann Saperavi	Georgia	Red wine	75 cl bottle	0.01	0
Windy Peak Riesling	Australia	White wine	75 cl bottle	0.01	0
Gekkeikan Sake	USA	Sake	75 cl bottle	0	0
Bliss Zinfandel	USA	Red wine	75 cl bottle	0	0
Johan Lidby					
Monti Garbi Ripasso	Italy	Red wine	75 cl bottle	0.41	1
Petit Chablis Brocard St Claire	France	White wine	75 cl bottle	0.24	1
Jurassique Chardonnay	France	White wine	75 cl bottle	0.06	1
Chablis Beauroy Brocard	France	White wine	75 cl bottle	0.05	1
Bourgogne Les Sétilles	France	White wine	75 cl bottle	0.05	1
Seghesio Sonoma Zinfandel	USA	Red wine	75 cl bottle	0.05	1
Bourgogne Cuvée Margot	France	Red wine	75 cl bottle	0.05	1
Fonterutoli	Italy	Red wine	75 cl bottle	0.04	1
Chablis Brocard Dom St Claire	France	White wine	75 cl bottle	0.03	1
Delamotte Brut	France	Sparkling wine	75 cl bottle	0.02	0
Dom Santa Duc Tradition	France	Red wine	75 cl bottle	0	1

The table reports the portfolios for two suppliers to Systembolaget September 1, 2008–August 31, 2009. Rev. share is the respective product's share of revenue for the respective wholesaler in this 12-month period. BiB stands for Bag-in-Box. High price is a dummy that is 1 if a product is in the highest price tercile within its category (16 categories).

Fig. 1. Cash flows of two firms surrounding the financial crisis 2008.
The figure reports the cash flows (wholesale price - marginal cost) × quantity as described in the text for two suppliers to Systembolaget. Year −2: September 1, 2006–August 31, 2007, Year −1: September 1, 2007–August 31, 2008 etc. Product assortment kept fixed at year 0 assortment.

The next section provides a thorough review to relate the present article to the previous literature. Section 3 describes the data and the product portfolios of firms in the market. Section 4 presents the empirical approach and then Section 5 examines current portfolios and evaluates the large number of acquisitions and divestitures in the market. The following section considers a large number of counterfactual to document the importance of different margins of diversification for portfolio-level risk and Section 7 concludes.

[3] Monte Carlo simulation combined with regression analysis has also been used as a way to generate probability distributions of cash flows, but without exploring portfolio effects, see e.g. Andrén et al. (2005).

Literature

The links between diversification on the one hand, and firm performance and survival on the other hand, has been of key interest in many research traditions. The set of products that are present in the market can for instance be studied from an institutional perspective - see e.g. Kroezen and Heugens (2018) who examine the re-emergence of craft beers in Netherlands or Wan and Hoskisson (2003) who consider the links between diversification and institutional differences across countries. Behind statements such as "we do what we've usually done" lies a rich and nuanced set of microprocesses that shape the stability and evolution of institutions and practices.[4] Understanding the microfoundations of the routines and capabilities that allow firms to successfully expand their scope and form alliances is an important research theme (see e.g. the introduction to the special issue of the Journal of Management studies in Felin et al. (2012)). Wan et al. (2011) provide a wide ranging survey of different approaches to diversification, taking the resource based view of the firm (see e.g. Penrose (1959); Wernerfelt (1984)) as a starting point but also drawing on organizational economics, institutional economics, industrial organization and finance. The remaining literature review mainly draws on research that is methodoligically close to present article in strategic management, industrial organization and finance.

Diversification occupies a prominent role in the discource on strategic management as manifested by the diversification wave of the 1960s and 1970s and the later trend towards greater focus (see e.g. Shleifer and Vishny (1991); Berger and Ofek (1995); Nippa et al. (2011)). We distinguish two, related, research themes concerning diversification. A first line of research examines how economies of scale and scope determine what industries and product categories that a firm diversifies into. Within strategic management this is the literature that is typically considered when one talks of diversification. A second line of research puts the portfolios and responses to shocks over time center stage. This is frequently billed as corporate portfolio analysis. We discuss them in turn.

Diversification and performance: Economies of scale and scope vs. coordination and other costs

Synergies in the form of economies of scale and scope may lead to a positive relationship between performance and diversification. On the other hand, agency problems and coordination costs as firms expand may lead to worsening performance as firms become more diversified (see e.g Rumelt (1982); Chatterjee and Wernerfelt (1991)). How a firm's resources and capabilities can be extended to new markets and segments are key in this research tradition. Against this backdrop a large empirical literature examines the effects of diversification across different industries and divisions (for seminal contributions see e.g. Bettis (1981); Rumelt (1982)). A typical study relates a measure of performance at the firm level (such as return on assets) to measures of diversification (typically based on the set of industries that the firm is active in) and other controls. In widely cited work Lang and Stulz (1994) and Berger and Ofek (1995) find that the implied value of business segments in diversified firms is substantially lower than their imputed stand-alone value. These works thereby suggest a negative view of diversification. A spate of more recent research has called into question the robustness of this result however, for instance Villalonga (2004) makes the case that, when using a more accurate measure of industry classifications, the diversification discount vanishes and even turns into a premium (see Maksimovic and Phillips (2013) for an overview of related work). More fundamentally, Mackey et al. (2017) argue that the search for an *average* diversification discount or diversification premium may be in vain. If firms are heterogenous the optimal strategy is also likely to be heterogenous and each diversification strategy (focused, diversify to related industires or to unrelated industries) may be rational for the firms that choose it.

Even so Mackey et al. (2017) confirm a frequent finding in the literature that examines the performance effect of diversification: diversification to closely related industries tends to outperform unrelated diversification. This is typically interpreted as support for the theoretical trade-offs mentioned above. Several studies also provide more direct support for the importance of the trade-offs that are at the heart of this literature, that between economies of scope and scale on the one hand, and coordination costs (broadly interpreted) on the other hand (Rawley (2010); Neffke and Henning (2013)).

Overwhelmingly the literature has examined diversification across industries and the set of articles to which this paper belongs, those that examine *within-industry diversification*, is much more limited. Conceptually the trade-offs between benefits and costs of diversification are similar at this more fine-grained level but their relative magnitudes may differ. For instance, the adjustment costs of transferring resources to additional products may be lower within rather than across industries (see e.g. Helfat and Eisenhardt (2004)). The within-industry studies of performance and diversification do not lend themselves to a simple characterization where it is always harmful or always beneficial. Out of prominent studies in this relatively small field Kekre and Srinivasan (1990) find a positive relation between performance measures and the width of product lines across 1400 business units, Li and Greenwood (2004) find no effect of diversification on return on assets in their study of Canadian insurance industry and Tanriverdi and Lee (2008) finds a negative relation between diversification and sales growth in their study of U.S. software firms.

Furthermore the literature on within-industry diversification and performance points to the existence of rich patterns. For instance in their study of intra-industry diversification in the U.S. software industry Zahavi and Lavie (2013) find a U-shaped relation between performance and diversification. The theoretical analysis in Hashai (2015) shows how differential importance of adjustment cost and coordination costs at different levels of diversification can give rise to an S-shaped relationship between performance and within-industry diversification, a prediction which is supported by the empirical results covering a set of Israeli high-technology SMEs.

We distinguish ourselves from the thrust of the previous literature on within-industry diversification both in terms of data and in

[4] For a particularly interesting ethnographic study of such issues see Lok and De Rond (2013).

terms of research question. In terms of *data* most of the previous literature relate firm-level measures of performance in a panel of firms to various measures of diversification in those firms. Rather than rely on firm level accounting measures of performance or sales growth we rely on product-level (defined at the level of stock keeping unit, SKU) cash flows to aggregate up to the firm level. These detailed data give us considerable leeway in performing counterfactual analysis.

In terms of *research question* it has long been realized that diversification affects both performance and risk – it is for instance emphasized in the concluding comments of Bettis (1981)). However the literature discussed above has largely disregarded risk while focusing on average performance. In contrast, the present paper focuses on risk aspects. In the simulations we will assume that the product level profits are independent of which wholesaler that controls a product. We, thus, disregard economies of scope as well as possible market power effects of wider product portfolios. Clearly, this does not mean that these aspects aren't relevant for the optimal product portfolio in the general case - merely that to put the spotlight on the contribution of this paper we disregard these other aspects of product portfolio choice. Institutional details in the Swedish retail market for alcoholic beverages also serve to make the economies of scope and coordination costs of relatively limited importance.[5]

Diversification: Product portfolios and the response to shocks and trends

A second line of reasoning gives center stage to the value of a portfolio as a means to manage shocks. It thus rests on the same logic as the insurance industry or financial portfolios - following the law of large numbers a diversified portfolio will be less risky than a more concentrated portfolio. This line of reasoning has received much less attention by researchers than the trade-offs discussed above. In the 1980s several researchers noted that there might appear to exist a simple analogy between product portfolios and portfolios of financial assets where an asset is evaluated by its contribution to the overall risk of the portfolio (rather than just by average returns for that asset) and tried to adapt the capital asset pricing model (CAPM) to product portfolios (see e.g. Naylor and Tapon (1982); Cardozo and Smith Jr (1983); Cardozo and Wind (1985)). However, these articles drew heavy criticism which highlighted the many differences between a portfolio of products and a portfolio of traded, divisible, assets (see e.g. Boardman and Carruthers (1985); Devinney et al. (1985)). Some of the critique was from leading scholars in strategic management like Birger Wernerfelt (1985, p. 510) who for instance argues that "[the authors] further suggest that firms should buy or sell divisions based solely on their risk/return properties …. According to CAPM, such businesses will on the average be valued accurately by the market, such that our firm gains nothing in the trade. Instead, the stockholders can diversify individually. Firms can only do better than stockholders if there are operating synergies between the divisions such that returns or systematic risks change."

However, as noted above the empirical support that has emerged since the 1980s does not allow us to conclusively say that "market diversification" is always better than "firm diversification". In addition, research in the last decade has documented positive aspects of firm *across-industry diversification* from a risk management perspective. Hann et al. (2013) for instance show that U.S. listed firms which are active in several business segments have lower costs of capital. Several articles have also shown that diversified firms benefited from having access to internal capital markets in connection with the financial crisis around 2008 and had greater survival probabilities (see e.g. Matvos and Seru (2014) or Kuppuswamy and Villalonga (2015)). Last, but not least, the role of precautionary cash holding has come to the fore as a means of managing risk and several articles highlight that firms which are less diversified hold more cash. Duchin (2010) for instance reports that between 1990 and 2006 diversified firms on average held around 12% of their assets in cash, whereas single-industry firms held some 21% of their assets in cash. As there is likely to be an opportunity cost to holding cash this suggests a substantial upside to diversification from a risk perspective.

Empirical work on risk aspects of *within-industry diversification* is scarce. A few studies of within-industry diversification link measures of diversification to the probability of exit, which can be seen as a sharp manifestation of the impact of volatility. Sorenson (2000) and Stern and Henderson (2004) both find that having a wider product line is associated with a lower exit probability in their studies of US computer manufacturers. The evidence is mixed however and Cottrell and Nault (2004) find that the more products and categories in the portfolios of U.S. software firms, the greater was their probability of exit. We add to the relatively small literature on links between portfolio composition and risk both by aggregating up from product level cash flows and by focusing on the ex-ante perspective.

Finally note that many associate the term corporate portfolio management with various matrices of product portfolios, perhaps most famously the BCG growth-share matrix (see e.g. Hedley (1977)). Such tools have been used mainly to examine product portfolios with respect to trends and long-run developments. For instance, technological change and a product life cycle imply the need to plan for tomorrow's products in markets such as automobiles or pharmaceuticals. Such portfolio approaches have been prominent in consulting and among practitioners. Compared to their important role in practice and in teaching such tools have seen exceptionally little academic research. The title of Untiedt et al. (2012)'s survey is telling: "Corporate portfolio analysis tools revisited: Assessing

[5] A wider portfolio might for instance allow a firm to raise markups but for moderate changes in portfolios such effects are likely to be of minor quantitative importance in this market: Friberg and Romahn (2015) evaluate a major merger on the Swedish beer market in 2001 and find that even the merger between two firms that each controlled about a quarter of the market had very limited price effects. In research-intensive markets economies of scale and scope in product development may play an important role for the optimal product portfolio. In contrast wholesaling of alcoholic has a relatively small role for such potential synergies. In terms of marketing channels we consider different portfolios within a narrowly defined market with the same retailer as outlet in all cases. In terms of dealing with different producers there may be different costs of dealing with and bargaining with additional producers. In the descriptive analysis below however we note that also firms with small portfolios on average deal with several producers which indicates that the costs of dealing with several suppliers are not prohibitive.

causes that may explain their scholarly disdain". The present paper differentiates itself from this literature by focusing on relatively short run demand and cost shocks and quantifying their impact.

Data and market

The setting and data sources

The main data set contains monthly observations on quantities, prices and product characteristics for all alcoholic beverages sold at the retail level in Sweden during January 2006–November 2011 inclusive. Data are at the level of stock-keeping unit (SKU). We limit attention to beer, spirits and wine. The source for the data is the state-owned monopoly retailer for alcoholic beverages in Sweden, Systembolaget. We also use average monthly exchange rates and (quarterly) consumer price indices from IMF to calculate real exchange rates.[6] All nominal variables are expressed in real terms in Swedish kronor (SEK) with November 2008 as a base period. Average nominal SEK price of a U.S. dollar over sample period is 7.02 and average SEK price of a euro is 9.56.

Fig. 2 presents a stylized overview of this market and of the decision variables at different levels in the value chain. A set of domestic brewers produce various kinds of beer and some spirits (notably vodka). Overwhelmingly alcoholic beverages are imported to Sweden however and producers are foreign wineries, distillers and brewers. Producers determine product characteristics and may engage in advertising. Wholesalers then have the exclusive right to distribute a set of products via Systembolaget. The wholesalers are private profit-maximizing firms and the focus in this article is on the product portfolios of these wholesalers. A handful of these firms are domestic brewers who act as wholesalers of their own beers and also as wholesalers of some imported products. However, the market is dominated by firms that have wholesaling of alcoholic beverages as their main business, a few of these are foreign owned but all are domestically registered firms. These wholesalers set the wholesale price which can be adjusted twice per year, choose the products to include in their product portfolios and may engage in advertising.The price that they pay to producers can clearly be subject to bargaining and is not directly observable at the product level but is observable at a slightly more aggregated level as discussed below.

Retailing of alcoholic beverages is exclusively through Systembolaget which provides a simple and transparent retail setting with the aim to provide a level playing field for products from different origins, something which is important for the retail monopoly to be compatible with the common market in the EU. Its goal is to support responsible drinking habits rather than maximize profits. Prices are the same across the country, there are no temporary sales and no in-store promotion of specific products (for instance there are no tastings, all products are sold at room temperature and there are no end-of aisle displays). The retail price is a deterministic function of the wholesale price and we use data on alcohol excise taxes, value added tax and Systembolaget's markup (the same percentage markup is applied across all products and set by Swedish parliament, it is around 20%) to back out wholesale prices.

The process to get onto the shelves in Systembolaget stores follows a highly structured process[7] and during the period of study Systembolaget categorized products into one of four levels of retail distribution. Distribution could change twice per year, in April and October based on a set of observable criteria. The same data set has been used in Friberg and Sanctuary (2017) to estimate the causal effect of changes in retail distribution on sales. Retail distribution is tied to the product, rather than to the wholesaler, such that a wholesaler can acquire the right to distribute a product from another wholesaler. A wholesaler is free to withdraw a product from the assortment and may try to enter new products into the assortment, subject to Systembolaget's rules. While the setting is more regulated than many other markets it features profit maximizing firms that make decisions on assortment, price and advertising and strategy as is common. The upside of the highly structured market is that we observe, and can make public, data that in many other cases would only be available to market participants.

To calculate cash flows at the product level we use wholesale price and quantity from Systembolaget. Data on marginal costs for the wholesalers are also needed to examine their cash flows, something which is typically hard to come by (see for instance Bresnahan (1989) for a classic discussion). The present study makes use of detailed data from trade statistics to gauge marginal costs of wholesalers and producers. All wines, and important shares of beer and spirits, are imported to Sweden. We use monthly unit values from trade statistics to generate a proxy for import prices. These trade data are from Eurostat and report total quantity and value by source country and product at the CN8 level of disaggregation. An example of a data point is that in January 2010 2877 L of Bourbon Whiskey were imported from the U.S. at a total value of 671,000 SEK, which gives a unit value of 233 SEK per liter.

For imported products the import price is the vastly dominant part of wholesalers' marginal cost. The trade data are reported "CIF", which means that transport and insurance is included. Systembolaget takes care of all costs associated with delivery to stores and there are no stocking fees or other major volume-related costs. Other cost are related to administration and are better described as fixed rather than marginal costs. We use the import prices as proxies for marginal costs but make some adjustments. The trade data cover all products from a particular source country and category. This means that they are likely to somewhat overestimate the import price for cheaper products and underestimate it for more expensive products. To take an example, imports of beer from Belgium combine both Stella Artois, a mid-level light lager, with upmarket Trappist beers. The import price of beer from Belgium is a weighted average across all the products but the weights are not known as all products are not delivered in all months, which also

[6] Two further sets of data have been collected but are not used in the main analysis: Advertising expenditure (from TNS SIFO) and accounting and ownership data from the Serrano data base.

[7] The Swedish competition authority monitors Systembolaget on behalf of the European commission and produces a bi-annual report to ensure that it functions in a non-discriminatory fashion.

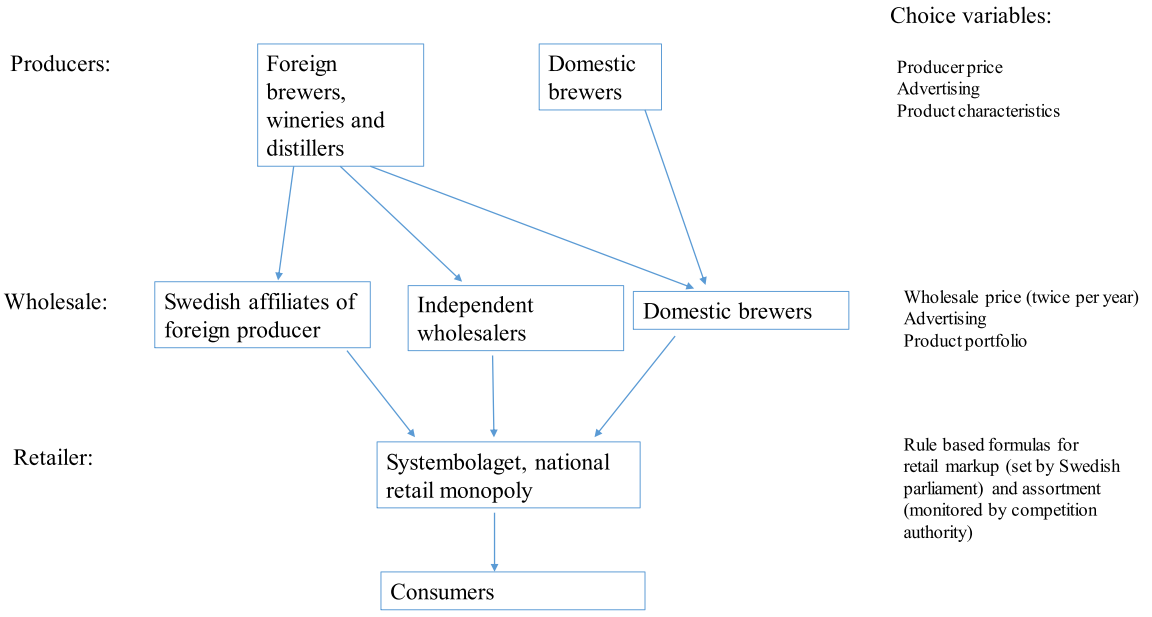

Fig. 2. A schematic view of the vertical structure of the Swedish retail market for alcholic bevarages

raises the time series variability of the series. We use a backward looking four-month moving average of import prices in the respective country/CN8 category to proxy for marginal costs. For some products this estimate of marginal costs imply negative markups in some months, this is particularly the case for low priced bag-in-box wines from high-price source countries such as France. In such cases we re-scale marginal costs so that the percentage markup between marginal cost and the wholesale price is never lower than 2%.

Following the same logic the mean Swedish export prices of beer and different types of spirits to bordering Denmark, Finland and Norway are used as a proxy for Swedish costs of production of these products. The logic for doing so is essentially the same as the logic for using so called "Hausman" instruments in structural demand estimation - they rely on the idea that shocks to the cost of production are reflected in all markets.

Table 2 presents some descriptive statistics on the data where the wholesale markup is simply the wholesale price for a product

Table 2
Prices, costs and markups.

Category	Wholesale markup	Price (wholesale)	MC	Nr of products in category
Beer				
Ale	0.58	31.83	12.82	40.73
Dark beer	0.49	25.84	12.32	20.39
Light lager in bottle	0.42	20.14	11.10	77.45
Light lager in can (Domestic)	0.27	15.28	11.00	41.25
Light lager in can (Foreign)	0.51	19.31	9.01	19.90
Special beer	0.54	32.50	13.29	4.21
Weissbeer	0.62	25.73	9.92	8.82
Wine				
Box red wine	0.28	30.11	20.22	69.99
Box white wine	0.28	22.29	15.63	53.44
Red wine	0.40	59.73	31.26	400.89
Rosé wine	0.30	33.38	22.88	27.61
Sparkling wine	0.31	158.33	103.98	99.25
White wine	0.39	55.19	30.40	266.62
Spirits				
Vodka & Schnaps	0.33	66.84	41.01	62.31
Whisky	0.37	150.65	78.36	115.32
Other spirits	0.45	105.38	52.95	144.49

The table shows, for the respective category, the average wholesale markup in percent, wholesale price and marginal cost in SEK (based on unit values from trade statistics as described in main text) as well as average number of products for the Swedish market for alcoholic beverages 2006–2011 inclusive.

Table 3
A description of the product portfolios and firms in the market.

Nr products	Nr. wholes.	Rev (mi.)	HHI (rev.)	Beer (share)	Wine (sha<re)	Spirits (share)
< 2	65	0.24	0.81	0.15	0.71	0.14
2–5	39	0.68	0.24	0.25	0.55	0.20
6–10	15	4.10	0.06	0.39	0.53	0.09
11–30	32	9.46	0.02	0.14	0.74	0.12
>30	17	33.05	0.00	0.18	0.60	0.22
Total	168	5.76	0.38	0.19	0.65	0.15
Nr products	**Domest. (share)**	**Euro (share)**	**USD (share)**	**Nr. suppliers**	**High price**	**Low price**
<2	0.06	0.60	0.09	0.77	0.48	0.09
2–5	0.18	0.47	0.06	1.80	0.39	0.08
6–10	0.07	0.46	0.14	3.97	0.24	0.17
11–30	0.08	0.53	0.07	7.24	0.30	0.21
>30	0.13	0.42	0.07	20.30	0.23	0.21
Total	0.10	0.52	0.08	4.50	0.38	0.15
Nr products	**Cash/assets**	**Assets (mi.)**	**Stand-alone**	**Beverage wholes.**	**Brewer**	**Nr. industries**
<2	0.17	17.54	0.78	0.65	0.05	1.27
2–5	0.18	16.84	0.54	0.59	0.23	1.30
6–10	0.16	29.10	0.43	0.87	0.07	1.11
11–30	0.14	88.93	0.38	0.81	0.06	1.20
>30	0.08	1406.77	0.29	0.71	0.18	1.43
Total	0.15	187.28	0.58	0.69	0.11	1.27

The table shows average characteristics of portfolios of products and wholesalers on the Swedish market for alcoholic beverages 2006–2011, broken down by the average number of products in the portfolio of the respective wholesaler or producer. In the upper panel Nr. wholes. is the number of wholesalers with the respective number of products, rev (mi.) is the average revenue per month in million SEK, HHI is the Herfindahl-Hirschmann index of concentration of a wholesaler's cash flows, Beer, Wine and Spirits are the average share of revenue stemming from the respective category. In the middle panel Domestic refers to the revenue share of domestic products, Euro and USD are the corresponding shares for euro and US (including Chile) origin, Nr suppliers is the average number of suppliers and the last two columns are the share of products whose prices are in the highest and lowest terciles within the category respectively. In the lowest panel cash/assets is cash and other liquid assets as a share of total assets, assets is in million SEK, standalone takes the value 1 if the firm is not a subsidiary, and 0 otherwise. Analogously indicators for Beverage wholes. and brewer take the value 1 if it's the firms main business. Nr of industries is the number of industries that the firm is active in, measured at 5-digit level of Swedish industry classification SNI 2007 (equivalent to NACE Rev. 2 at 4-digit level, 821 industries in total).

minus its marginal cost divided by the wholesale price. The reported categories follow Systembolaget's classification apart from the case of spirits, where we have aggregated several smaller categories. These 16 categories will be used to consider category-level demand shocks in the later counterfactual analysis. As seen there are a large number of products: for instance some 40 ales, 400 red wines and 115 whiskeys. The wholesale markup ranges from some 27% for domestic light lager in cans to 62% for weissbeer.

A description of product portfolios

We now turn to a description of portfolios and the wholesalers. Table 3 reports some average characteristics for wholesalers, reported by the average number of products for each wholesaler. For instance 17 wholesalers have on average at least 30 products in their portfolio and their average revenue is around 33 million SEK per month. A further 32 wholesalers have 11–30 products in their portfolio but many of the more than 150 wholesalers have on average only a handful of products in their portfolio. The third column presents the equivalent of the Herfindahl-Hirschmann index (HHI), the sum of squared revenue shares at the wholesale level. This value ranges from 0 to 1 and a value of 1 is the equivalent of all revenue coming from one single product and as we approach 0 no one single product has a discernible effect. Revenue for the smallest (in terms of products) wholesalers is very concentrated, but for the largest no single product dominates. Turning to the revenue share of beer, wine and spirits there are few marked differences across size classes. Across all size classes wine is the most important source of revenue, with beer and spirits accounting for approximately equal shares.[8]

The middle panel of Table 3 first reports the share of revenue for different currency areas. Across all size classes the euro area dominates and accounts for, very roughly, around half of revenue. The share of domestic revenue is highest for wholesalers with 2–5

[8] Since the goal is to present wholesalers we report unweighted averages across wholesalers, thus a large share of revenue from beer for the large brewers is to some extent masked when smaller importers of spirits and wine are given the same weight.

products - in this category we find several Swedish micro breweries. The data set also contains the name of the producer (such as E.J Gallo Wineries or the Boston Beer Company). On average each wholesaler distributes products from many producers, a rough ballpark estimate is that the number of producers is around half of the number of products. Finally, we split the products by terciles in the price distribution in the respective category (16 categories as reported in Table 2). We count a product as high priced if it is in the top third of prices in its category and as low priced if it is in the bottom third. As seen smaller wholesalers tend to have a higher revenue share of higher priced products and larger producers a higher share of low priced products.

The descriptive statistics show that many wholesalers are quite diversified. One implication of this is that it appears empirically relevant to consider different diversification strategies also for smaller firms. In contrast, if all wholesalers had tended to focus only on one segment, and importing from one supplier, it would be natural to hypothesize that there were strong benefits to focusing, even within this narrowly defined market.

The lowest panel of Table 3 reports some further characteristics of the wholesalers. The first column shows that on average cash as a share of assets fall by almost 10 percentage points as we move from the smallest to the largest portfolios. This is suggestive of some of the benefits of a diversified portfolio - a lower perceived need for precautionary cash holding, something which has previously been established for across-industry diversification (see e.g. Duchin (2010)). Average assets are remarkably stable across the size classes, apart from the firms with the largest portfolios. Three quarters of the smallest wholesalers are standalone firms but the share falls as the portfolio widens and only around a third of the firms in the largest size class are standalone. This implies that risk management is likely to be relevant also for many of the small firms - if small firms were all fully owned subsidiaries many of the reasons for managing risk discussed in footnote 2 might be mute. Most of the firms have beverage wholesale as their main business and domestic brewers make up some 5–20% of firms across all size classes. On average firms are not active in any other business segments apart from their main business, the average number of (5-digit) segments that a firm is active in is close to 1 across all size classes. In the across-industry dimension we thus see substantial focus in this market which again indicates that the issue of within-industry portfolio diversification is potentially important.

At a fundamental level we expect that a more diversified portfolio exhibits less variability in cash flows for a given level of cash flows. One way to examine this relation in the data is to consider the “coefficient of variation”: the historical standard deviation of cash flows for each portfolio divided by the mean cash flow for that portfolio and let us for simplicity refer to this as a risk/return measure.[9] Fig. 3 sets this risk/return measure in relation to the average number of products in the respective portfolio. We see that there appears to be a downward sloping relation (as indicated by the fitted quadratic relation which is estimated for all portfolios up to 50 products, thus excluding the outliers) but we also observe substantial noise. Of course, not only the number of products but also other dimensions of portfolio diversification are likely to matter for observed patterns and we may use regression analysis to control for such other factors. Column (1) of Table 5 presents the estimated coefficients for such a regression but we postpone the discussion of results until Section 6 where we also discuss regressions based on simulated data. Appendix A provides some further analysis of sources of variation in cash flows in the data.

Empirical strategy - A framework for simulating of the effects of portfolio composition on variability

We now turn to a description of the empirical strategy that we use. Let us first however highlight the value of a forward looking analysis.

Motivations for a forward looking analysis

Fig. 3 and regression analysis based on these observations can provide useful insights on links between portfolio characteristics and risk/return properties of portfolios. Backward looking analysis is therefore an important motivation for the paper's interest in diversification. However, if we want to offer tools that can be used by managers to examine the implications of different strategic choices with respect to portfolio composition there are at least two limitations associated with such backward looking regressions.

One limitation is that, unless we have very long time-series data from a stable market, we will only observe a limited set of outcomes. For instance, with the benefit of hindsight we noted in the introduction that it would have been beneficial for Johan Lidby to swap the cash flows associated with a its largest selling wine (Italian Monti Garbi Ripasso), with a spirit imported from the U.K. (Gordon's dry gin). However, the outcome might have been very different under a different set of plausible cost and demand shocks. In choosing strategy and letting the past guide the future we want to examine not only what happened, but also take account of alternative scenarios that had important probabilities of materializing. In a simple analogy consider an individual that considers betting on a roulette wheel and that has observed the outcome of 10 spins of the wheel. In formulating a betting strategy such an individual would like to take account of the full set of probabilities, not just the 10 realizations that she has observed. Our simulations allow for the modeling of a full range of cost and demand shocks.

A second related limitation of a backward looking analysis is that in a typical market there are relatively few firms - in this market there is a total of 168 firms are active in at least one period but many of those have very limited portfolios. At the portfolio level there are thus rather few observations that can be used to disentangle the relative importance of different means of diversification. In addition various measures of diversification are highly correlated in the cross-section. A firm that has few products sourced in a few

[9] “Simplicity” here refers to that in a backward looking analysis not all the variability need be “risk” in the more narrow sense, some of the variation might have been entirely predictable and we typically want to reserve the term risk for effects that are not perfectly foreseen.

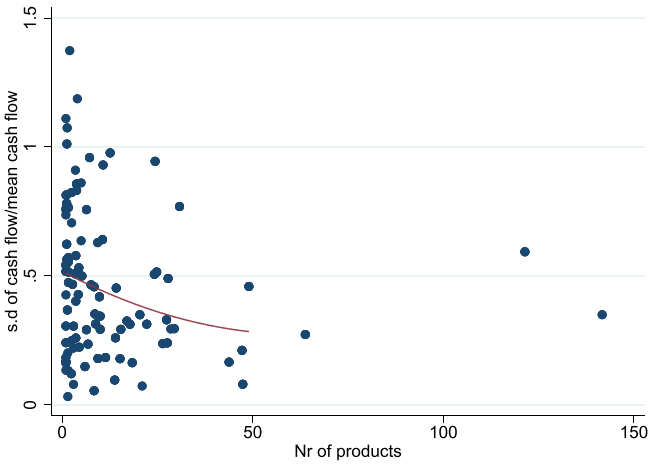

Fig. 3. Standard deviation cash flows divided by mean cash flows at wholesale level.
The figure reports the standard deviation of yearly wholesale level cash flows divided by the mean wholesale level cash flow against the mean number of products for that wholesaler. Swedish market for alcoholic beverages 2006–2010. The curved line plots prediced values from a regression with a constant and number of products and number of products squared as explanatory variables fitted for portfolios with less than 50 products on average, thus excluding the three largest outliers.

Table 4
Demand regressions, yearly data.

VARIABLES	(1)	(2)	(3)
	liters	liters	liters
ln (liters)$_{t-1}$	1.001	1.004	1.004
	(0.00300)	(0.00277)	(0.00442)
Change in relative price		−0.631	−0.631
		(0.0763)	(0.0555)
Widening retail distribution		0.213	0.213
		(0.0131)	(0.0183)
Shrinking retail distribution		−0.207	−0.207
		(0.0113)	(0.0112)
Constant	−0.0472	−0.0948	−0.0948
	(0.0343)	(0.0325)	(0.0487)
Observations	4102	4102	4102
R-squared	0.965	0.970	0.970

The table reports regressions of product level quantities sold in Systembolaget 2006–2010 on yearly data. Relative price is defined as price of a product divided by the average price of products in the respective category (16 categories in all) and change is relative price as the ln(relative price)$_{t-1}$ - ln(relative price)$_t$. Wider retail distribution is a dummy which takes the value 1 if a product moves to a wider level of retail distribution (four levels in all). Narrowing retail distribution defined analogously. Standard errors in parentheses, in column (3) they are clustered by category.

locations is also likely to have sales concentrated in a few segments. The resulting multicollinearity tends to make the magnitude and statistical significance of individual coefficients sensitive to the exact specification. Monte Carlo methods that allow for the construction of different counterfactual portfolios largely circumvent this problem.

Counterfactual cash flow distributions

We now describe the empirical strategy that we use and how regression analysis is combined with Monte Carlo simulations to generate counterfactual cash flows.[10] The simulations are easily programmed in standard programs for statistical analysis such as Stata or SPSS, and indeed the Stata files that generate the current simulations are available at www.richardfriberg.se.

Firm level cash flow is the sum of product level cash flows over the n products in the portfolio of the respective firm. We generate 1000 random draws on two set of demand shocks and costs shocks which yield 1000 counterfactual cash flows for each product i. Cash flow per product in each of these iterations c is in turn given by price p_i minus counterfactual marginal cost $\widetilde{mc}_{ic}$ times

[10] We use the term cash flows rather than profits to highlight that there is no modeling of fixed cost. Including them is a matter of finding good estimates of fixed costs, as one would do in any investment budget. In the present setting they are likely to be low.

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Table 5
Sources of variation across actual and simulated random portfolios.

VARIABLES	Data	Simul.	Simul.	Simul.	Simul.
	(1)	(2)	(3)	(4)	(5)
	s.d./mean	s.d./mean	s.d./mean	s.d./mean	standardized c.
Nr of products	−0.00891	−0.00877	−0.00774	−0.00757	−1.021
	(0.00323)	(0.000809)	(0.000963)	(0.00103)	
Nr of products squared	6.11e-05	0.000185	0.000163	0.000154	0.690
	(2.72e-05)	(2.44e-05)	(2.51e-05)	(2.62e-05)	
Share in high var. categ.			0.0967	0.0806	0.176
			(0.0111)	(0.0116)	
Share in low var. categ.			−0.0449	−0.0439	−0.0831
			(0.0133)	(0.0132)	
Nr of categories			0.000157	0.00124	0.0530
			(0.00109)	(0.00110)	
Share domestic	−0.232			−0.0738	−0.112
	(0.0967)			(0.0162)	
HHI (imports)				0.0252	0.0592
				(0.0119)	
Constant	0.571	0.203	0.161	0.164	
	(0.0397)	(0.00577)	(0.00812)	(0.00943)	
Observations	101	1500	1500	1500	1500
R-squared	0.119	0.173	0.235	0.247	0.247

Dependent variable in all columns standard deviation of cash flows/mean cash flow across different portfolios. Column (1) estimated on actual data, Swedish market for alcoholic beverages 2006–2010. Columns (2)–(4) estimated on 1500 counterfactual portfolios as described in text. To aid interpretation, column (5) reports estimates of standardized coefficients of the same specification as in column (4).

counterfactual quantity $\tilde{q}_{ic}$ for that product. We assume that the marginal cost for each product is independent of quantity. To avoid seasonality and to focus on time periods that are long enough to be economically important we aggregate data to the yearly level.

Portfolio cash flows in iteration c are thus given by:

$$\tilde{\Pi}_c = \sum_{i=1}^{n} (p_i - \widetilde{mc}_{ic})\tilde{q}_{ic}. \tag{1}$$

The set of cash flows associated with the different draws of c give a frequency distribution for cash flows at the portfolio level that can be thought of as probability distributions. These may be examined graphically or be described by different moments. Means and standard deviations analyzed below refer to the respective moments across the 1000 counterfactual cash flow distributions. For instance, the expected value of cash flows associated with a given portfolio is simply the average across the random draws:

$$E(\tilde{\Pi}_c) = \frac{1}{1000} \sum_{c=1}^{1000} \sum_{i=1}^{n} (p_i - \widetilde{mc}_{ic})\tilde{q}_{ic}. \tag{2}$$

By changing the set of products that a firm controls, changing n, it is then straight forward to consider different counterfactual portfolios and different counterfactual cash flow distributions.

Demand regression

To have empirically based estimates of the importance of demand shocks we first estimate demand on observed data (in this case 2006–2010) using an autoregressive process as specified in Equation (3). We assume that quantity for each product i in period t can be explained by its quantity in the previous period, a vector of other explanatory variables X_{it} and an econometric error term υ_{it}. X_{it} includes price and demand shifters that are important in the respective setting. Price is measured as the real price of product i divided by the average real price of products in the respective category.

$$ln(q_{it}) = \alpha ln(q_{it-1}) + \beta X_{it} + \upsilon_{it}. \tag{3}$$

Estimates of the demand Equation (3) are presented in Table 4. Column (1) reports a specification where only a constant and the previous year's quantity are used as explanatory variables. The point estimate on the (natural logarithm of) liters sold in the previous year is precisely estimated and very close to 1, which indicates that volumes for a product are close to a random walk. We also note that R-squared is around 0.96 which indicates that volumes can be quite well explained simply by observing past volume.

In column (2) of Table 4 additional explanatory variables are included. Changes in the (natural logarithm) of relative price has a negative effect and the point estimate suggests an own-price elasticity that is on average close to −0.6. If a product achieves wider distribution this is associated with higher quantities and more narrow distribution is associated with lower quantities. The effects are rather precisely estimated and imply that moving a step up or down in the width of retail distribution is associated with a change in

quantity sold of around 20%.[11] The standard errors in column (2) are calculated following the standard assumption of ordinary least squares that the error term is independently and identically distributed (i.i.d.). However there is likely to be a correlation of shocks to products in the same category and the error term is therefore likely to show some clustering. Column (3) therefore reports the standard errors from a specification where standard errors are clustered on category. A comparison of columns (2) and (3) indicates that the correlation of shocks at the category level matters even if the effect is not especially large and all coefficients are statistically significant at the 1% level under both specifications.

Counterfactual draws on product- and category-level demand shocks and marginal cost shocks

To generate counterfactual cash flows we rely on three sets of shocks. Two sets of demand shocks - a category-level shock $\tilde{\eta}_{jc}$ that affect all products in each of 16 categories, a product-level demand shock $\tilde{\varepsilon}_{jc}$ and a set of exchange rate shocks $\tilde{\gamma}_{ic}$ that affect the cost of imported products for the respective wholesaler. We perform the counterfactual simulations for a given year (2010) and with q_{it} being the actual quantity in 2010 the counterfactual quantity q_{ic} under each of 1000 draws c is given by:

$$ln(\tilde{q}_{ic}) = ln(q_{it}) + \tilde{\eta}_{jc} + \tilde{\varepsilon}_{ic}. \quad (4)$$

$\tilde{\eta}_{jc}$ and $\tilde{\varepsilon}_{ic}$ are each i.i.d. draws from normal distributions with mean 0. The standard deviation of the distribution from which the category level shocks $\tilde{\eta}_j$ are drawn are set to 20% of the overall standard deviation of the error term for the respective product category in Table 4 column (2). This implies that different categories will have different levels of risk. While we generate 1000 i.i.d. shocks for each category and each product it deserves to be noted that all products i in category j are affected by the same $\tilde{\eta}_j$ in iteration c.[12]

Also generate 1000 product level shocks for each product i that are drawn from a normal distribution with mean 0 and where the standard distribution has been set to 80% of the overall standard deviation of the error term in Table 4 column (2).[13] Note that the logarithmic formulation implies that we may think of the shocks as reflecting percentage shocks rather than level shocks which is attractive in markets where volumes differ widely across products. The counterfactual distributions from which the random draws are generated are chosen to fit the facts of the market but there is room for judgment and robustness in this dimension. Drawing from a t-distribution instead of a normal distribution would for instance generate thicker tails and one might use some multivariate distribution or copula to model correlation between category level shocks.

On the cost side generate a set of 1000 counterfactual draws on costs such that the marginal cost for product i under each draw mc is given by

$$\widetilde{mc}_{ic} = mc_{it} + \tilde{\gamma}_{ic}. \quad (5)$$

In the present setting currency movements are crucial for marginal costs and we assume that import prices are fixed in the currency of the producer. An examination of the relation between import prices from the trade statistics and exchange rates indicates that this assumption matches the situation well.[14] Counterfactual import prices faced by wholesalers will be governed by exchange rates and we generate 1000 counterfactual shocks $\tilde{\gamma}_{ic}$ for each of the five most important exchange rates (the SEK exchange rate against euros, US dollars, British pounds, Australian dollars and South African rand). These five currencies cover the 13 most important source countries by value (Argentina is the largest source country not covered). For other source countries assume that price is fixed in US dollars. Exchange rates partly move in tandem and we let the draws follow a multi-variate normal distribution where the variance-covariance matrix of counterfactual shocks match yearly movements from 2006 to 2010.

For simplicity keep prices and other explanatory variables fixed across simulations. In general adding randomness via additional shocks to exogenous variables (for instance income shocks) is straightforward whereas the response of endogenous variables such as prices requires the analyst to take a stand on the assumed mechanisms governing them and potentially make trade-offs between compatibility with economic theory and ease of use. In the current application prices are indeed quite stable: the average price lasts 11 months and, conditional on a price changing, the average absolute percentage price change is a rather limited 3.04%. See Appendix C for an overview of how endogenous price responses can be incorporated.

Location of firms in mean-variance space: Baseline and observed acquisitions and divestitures

Before proceeding to a systematic examination of portfolio changes it is useful to present the simulations for the existing wholesale portfolios - an important motivation is to see if this way of analyzing portfolios passes the “smell test”, are results plausible and does this way of examining portfolio composition potentially add to our understanding of the market?

[11] Friberg and Sanctuary (2017) use monthly data to provide separate estimates for each category and each change between the four distribution levels. The results presented here are well in line with the estimates in Friberg and Sanctuary (2017). For instance they find that the last two steps up in widening retail distribution for wines are associated with an increased quantity of around 18%.

[12] Thus for a firm that wholesales two French red wines in bottles both wines are hit by the same category level shock in iteration 1 but by separate product level shocks. Iteration 2 will have a new set of category level shocks that again affect both wines in the same way in addition to a new set of product-specific shocks and so forth.

[13] To limit the effect of outliers on counterfactuals we match the winsorized (at the 1 and 99 percentiles) standard deviation.

[14] An illustrative example is provided in Appendix A in Fig. 7 which plots the import prices for wine from the euro area and the euro exchange rate.

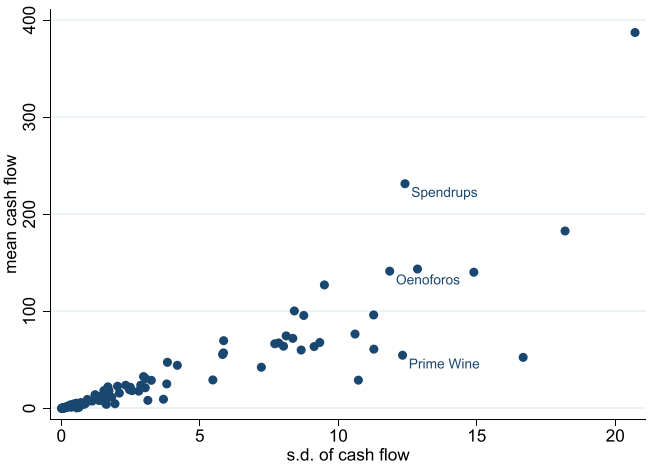

Fig. 4. Mean and standard deviations of cash flows for wholesalers on the Swedish market for alcoholic beverages 2010, based on 1000 Monte Carlo draws.
The figure illustrates risk/return characteristics of product portfolios across 1000 counterfactuals with product-level, category level and origin-level shocks as described in text.

A standard visualization from the field of finance is to plot mean returns against standard deviations of returns. Fig. 4 plots the mean-variance position of each wholesaler's portfolio across the 1000 simulations. As expected the relation is upward sloping but substantial dispersion is observed. To expand our analysis let us consider three different wholesalers that differ substantially in their mean cash flows despite having similar standard deviations: Spendrups, Oeneforos and Prime Wine as indicated in Fig. 4.

All three are privately owned Swedish firms without direct ties to international firms and focused on beverages. Spendrups is a major domestic brewer that is also the importer of some beers and wines. Its product portfolio is dominated by the beers that it itself brews and a relatively low risk relative to returns reflects that production costs are largely born in the same currency as sales. Oenoforos and Prime Wine are pure importers and exclusively act as wholesalers for wine. They each import a large number of wines in 2010, (45 in the case of Oenoforos and 60 in the case of Prime Wine). Their portfolios have similar concentration patterns with the largest two selling products accounting for 21% and 12% respectively for Oenoforos and 26% and 15% for Prime Wine. The explanation for the marked difference in risk is instead linked to the regional origin of the imported wines. Oenoforos is mainly importing from the euro area whereas Prime Wine's imports during 2010 are concentrated in the new world: from US, South America and South Africa with higher exchange rate variability than the euro area.

In stock markets any investor can in principle replicate a portfolio of traded assets and an “efficient frontier” maps out the highest expected return for a given level of risk. The analogy between financial portfolios and product portfolios should however not be pushed too far. The position of Spendrups as a major domestic brewer has been built up over some 100 years. The resources and capabilities that it controls are not easily copied by a relatively new importer of wines. The interpretation that Spendrups represents a point on an “efficient frontier” is therefore not one that we want to make. However, if risk considerations are of relevance for these firms Fig. 4 and the numbers that it represent may be useful. It may for instance shed light on differences between firms in the use of financial derivatives or cash holding.

Illustrating the effect of one change in the product portfolio

Another use of the framework is to evaluate how changes in the portfolio of an individual firm would be expected to impact its risk profile. To illustrate such use consider again wine importer Johan Lidby and examine a policy of replacing its dominant red wine (Monte Garbi) with a high end Scottish whisky instead, Lagavulin, which has approximately the same cash flow in 2010. The correlation with the other products in the portfolio are lowered both by replacing some of the euro exposure with exposure to the British pound and by replacing some exposure to red wine with exposure to whisky. Fig. 5 plots the counterfactual cash flow distributions for these two cases. As seen the means are roughly equal but the policy that includes the more disparate whisky in the portfolio is associated with a tighter distribution. Replacing one product that is subject to the same exchange rate shocks and same category level shocks as all the other products in the portfolio with one that is subject to different category level shocks and a different exchange rate shock can sharply decrease standard deviation for a given level of cash flow.

Evaluating acquisitions and divestitures from a mean-variance perspective

The cash-flow distributions can not only be used to examine hypothetical changes but also be used to evaluate the actual changes in control over products that appear in-sample. There are in total 819 occasions in the sample when a product changes from belonging to the portfolio of one wholesaler to that of another. Often several products change hands at the same time, there are in total 249 selling occasions in 292 deals. The number of deals is higher since at one occasion wholesaler A might divest some products to

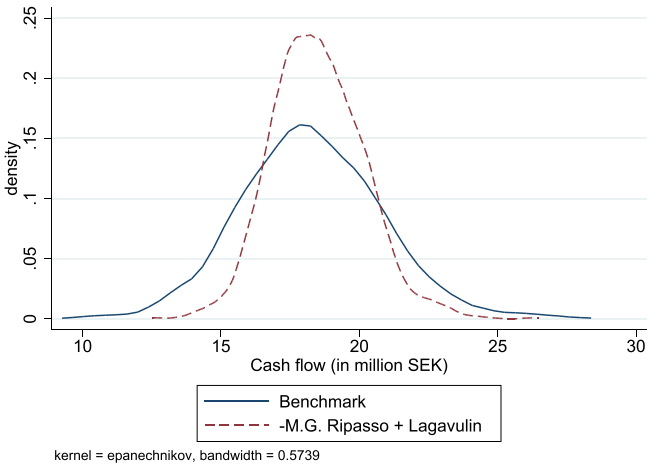

Fig. 5. Cash flow distributions for Johan Lidby 2010 for actual portfolio and for a counterfactual where a high-end Italian wine is replaced by a Scottish whisky.
The figure shows the density of cash flows for one Swedish wholesaler across 1000 counterfactuals with product-level, category level and origin-level shocks as described in text. Two cases are plottted, one for the actual product portfolio and one for the case where an Italian red wine has been dropped and counterfactually replaced by a Scottish whisky.

wholesaler B and some to wholesaler C. What are the implications of these changes in ownership in a mean-variance framework? To examine this question first examine the location in mean-variance space for initial portfolios. Then compare this to the location in mean-variance space at the end of the sample. For the year 2010 we thus compare two counterfactual portfolios; one with all the products that were initially controlled by the wholesaler in question (either at the start of the sample or when first introduced) and a second portfolio that for each wholesaler consists of the products that were in its portfolio at the end of the sample period, or that were controlled by the firm in question when the product exited. Each arrow in Fig. 6 represents the movement for a particular wholesaler: the base of the arrow indicates the original position and the head of the arrow represents the final position in mean variance space.

If mean-variance considerations are important we do not expect movements to the southeast in the figure: we do not expect firms to engage in trades that are associated with a lower mean cash flow and higher standard deviations. Indeed there are no such moves in the sample.[15] Movements to the northwest are attractive from a mean-variance standpoint, higher expected cash flows and lower expected standard deviation but we would also expect to see few such "free lunches" in equilibrium and we only see one major move in this direction. This is the local Swedish wholesaler Prime Wine which was examined in connection with Fig. 4. During the period it engaged in a succession of smaller deals which added a number of euro area wines to its original portfolio that was dominated by new world wines. This suggests that the framework is useful not only for describing cross-sectional patterns, but also for understanding

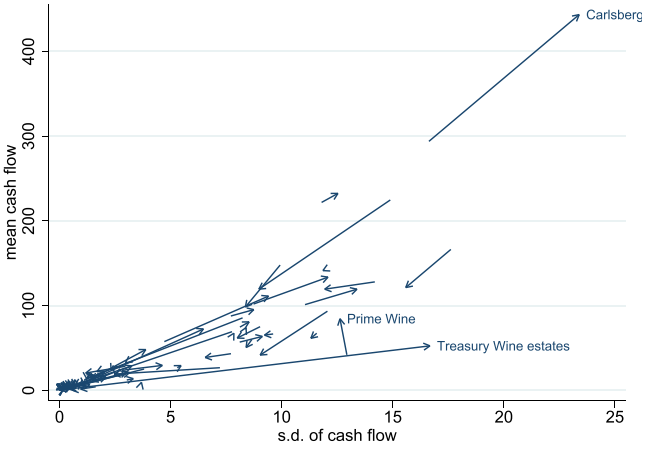

Fig. 6. Cash flows (mean and s.d.) at wholesale level; before and after changes in control.
The figure illustrates risk/return characteristics of product portfolios across 1000 counterfactuals with product-level, category level and origin-level shocks as described in text. Only portfolios that change betwee 2006 and 2011 included. Base of arrow marks original portfolio and top of arrow marks portfolio after actual change (in total 819 products change wholesaler in sample.

changes to portfolios.

The remaining trades are in the northeasterly or southwesterly direction: higher expected cash flow coupled with higher standard deviations or vice versa. The uppermost long arrow is associated with the InBev brands of beer (for instance the Stella Artois and Staropramen brands) switching distribution from local wholesaler Galatea to the local branch of Danish brewer Carlsberg in December 2006. In terms of the number of products many transfers are related to the sale of the Swedish state-owned spirits producer and wholesaler V&S. In July 2008 the local affiliate of French spirits firm Pernod Ricard acquired the portfolio of V&S. This was part of a global deal where Pernod Ricard gained control over Absolut Vodka, which was produced by V&S. In a second stage Pernod Ricard divested many of the acquired brands. Many of the spirits were divested to the local beverage wholesaler Altia and many wines were divested to the Swedish branch of Australian wine producer Treasury Wine Estates in March 2009. The long arrow at the bottom represents Treasury Wine Estates which went from a recent startup with a minuscule portfolio to being a large importer with a portfolio almost exclusively consisting of Australian wines after the change in control. While such a move might have been surprising for a privately owned domestic wholesaler it is less surprising for a local branch of a large Australian wine producer. Again, the point of the Monte Carlo analysis is that it provides a means by which mean-variance patterns at the firm level can be examined and alternative courses of action investigated.

Portfolio composition and the determinants of variability

We now examine different counterfactual portfolios in a more systematic fashion with the aim to understand what dimensions of portfolio choice that are most important for the risk profile of portfolios in this particular market. Answers are clearly dependent on the nature of this particular market but the tools would be useful for other applications as well. To consider broader evidence of portfolio effects we consider a large number of different portfolios. Across the 168 wholesalers that are active in at least one period the average number of products is 11 and the bulk of the wholesalers have between 1 and 30 products. To consider the risk/return profiles of portfolio composition we therefore generate 1500 random portfolios where the number of products ranges from 3 to 30. For each of these portfolios we calculate the portfolio level profit for each of the 1000 set of random draws that we generated and reported in the previous section. We then calculate mean cash flows and standard deviation of cash flows for each of these new counterfactual portfolios.

To provide some intuition for the results we note that the variance of a portfolio of products is equal to the sum of individual product variances (*var*) and two times the covariance terms (*cov*). In the case of two products the variance of portfolio cash flows would thus be given by

$$var(\Pi) = var(\pi_1) + var(\pi_2) + 2cov(\pi_1, \pi_2). \tag{6}$$

Thus the variance of overall cash flows will be higher as individual products are more variable (in our case due to product, category level and import origin shocks) and the higher the covariance between shocks. Having products that are in the same category or have the same import origin clearly are associated with higher covariances.

The number of products will also matter for the overall variability of portfolio cash flows. As a measure of risk/return ratio we use standard deviations of cash flows for a portfolio divided by the mean cash flow of that portfolio. This “coefficient of variation” is a common measure of the risk/return ratio of different portfolios. To consider the intuition for the link between this measure and the number of products consider a case where shocks to cash flow are independent across products and the cash flow of each product *i*, out of a total of *n* products in the portfolio, has the same expected value (denoted by $E(\pi)$). The standard deviation of the portfolio cash flow, set in relation to the mean cash flow, would then be given by

$$\frac{s.\,d(\Pi_k)}{E(\Pi_k)} = \frac{\sqrt{var(\pi_1 + \pi_2 + ... + \pi_n)}}{nE(\pi)}. \tag{7}$$

To generate intuition for the dependence of this ratio on the number of products assume that all product level cash flows have a common standard deviation, denoted by σ_i. We can then rewrite Equation (7) to find

$$\frac{s.\,d.\,(\Pi_k)}{E(\Pi_k)} = \frac{\sigma_i}{\sqrt{n}E(\pi)}, \tag{8}$$

which implies a downward sloping and convex relation between risk/return ratio for cash flows and the number of products in the portfolio.

To systematically explore the links between portfolio composition and risk/return characteristics we estimate the following relation on the 1500 counterfactual portfolios *k*:

$$\frac{s.\,d.\,(\Pi_k)}{E(\Pi_k)} = \alpha_1 Nrproducts_k + \alpha_2 Nrproducts_k^2 + \beta Categ_k + \delta Orig_k + \varepsilon_k. \tag{9}$$

where *Nrproducts* is the number of products in the portfolio (ranging from 3 to 30) and *Categ* is a set of variables that capture the

[15] As noted the discussion is based on mean and variance as in a CAPM application. Alternatively one might consider the ration s.d.(cash flows)/mean(cash flows) and see how that is affected by mergers and acquisitions. there are some instances where that ratio increases as a result of trades - an indication that minimization of this ratio is not an overriding objective for all firms.

category composition of the portfolio (across the 16 categories): the number of categories represented in the portfolio, the share of products that are in the third of categories with the highest variability of cash flows compared to their mean and the share of products that are in the third of categories with the lowest variability of cash flows compared to their mean.[16] $Orig_k$ is a set of variables that capture the origin composition of the portfolio: the share of domestic products in the portfolio and a Herfindahl-Hirschmann index (HHI) of import origins, defined as the sum of squared shares of different import origins. A measure of *HHI* (*imports*) of 1 means that all imports come from one currency area and the more dispersed the origins, the closer to 0 is the index.

Column (1) of Table 5 reports the results from a regression on actual historical data as discussed in Section 3.3. Different measures of portfolio diversification are correlated in the real data and including a large number of coefficients risks that multicollinearity clouds the relative contribution of different measures of portfolio composition. Only the share of domestic products is therefore included and as expected this tends to lower standard deviations, as does adding additional products. Columns (2)–(5) report results using regression analysis on the 1500 randomly generated portfolios. Column (2) establishes that just the number of products and its square explain a substantial share of the variation in the risk/return measure of these portfolios with an R-squared of 0.173. The sign of coefficients indicate a downward sloping and convex relation as predicted. Adding measures of category composition and orgins further adds explanatory power. Let us discuss the different coefficients in turn, focusing on the specification in column (4). The effect of the number of products is quantitatively strong. Evaluated at the means of the other variables the standard deviation of cash flows over mean cash flows decrease from 0.13 to 0.06 if we move from 10 to 20 products in the portfolio.

Variability is higher if there is a higher share of products in high variability segments and decreases if the portfolio is more concentrated in low variability segments. Evaluated at the means of the other variables a portfolio with only high variability segments is predicted to have a standard deviation to profit ratio of 0.18, compared to a ratio of 0.05 if it only were in low variability segments and 0.10 if all products were in the middle tercile segments.

The point estimate on the number of categories is positive, suggesting that being present in more categories is associated with higher variability which at first seems counterintuitive. Even in the simulated data there is multicollinearity however and the number of categories is correlated with the number of products (a correlation coefficient of 0.84). When products are drawn at random into portfolios as in the current exercise there are on average 7 categories and 16 products in portfolios. In regressions (not reported) that exclude the number of products the measure of number of categories enters negatively.

A larger share of domestic products decreases risk whereas more concentrated import origins increase risk. Moving from the average share of domestic products (0.08) to only domestic products is associated with a decrease in the standard deviation to profit ratio of from 0.12 to 0.05. Insulating profits from the direct effect of exchange rate changes thus has a large effect on the risk profile. Finally, having imports concentrated to few origins is associated with higher risk. The mean (HHI) of import origins in the simulated data is 0.09 and moving to the case where all the imports are from one currency area is predicted to increase the standard deviation to profit ratio of from 0.12 to 0.15. This effect may appear to be surprisingly low given the variability of exchange rates but we note that the changes in the different exchange rates are positively correlated.

Another common way to interpret the magnitude of coefficients when they are in different units is to standardize both dependent and explanatory variables so that their variances are 1. The interpretation is therefore how many standard deviations the dependent variable will change for a change of one standard deviation in an explanatory variable. Column (5) reports the standardized coefficients from the estimation reported in column (4). These again indicate that the most important from a risk management perspective in this market is the number of products, the share of domestic products and the variability of segment cash flows.

The regression results above are generated for random portfolios, this is one way to understand links between portfolio composition and risk but it should be noted that quantitative impacts for individual firms can differ substantially from this. By examining portfolios drawn at random from all the products in the market we create a benchmark that consists of quite diversified portfolios. Starting from more concentrated portfolios would result in greater effects of diversification.

Discussion

In the concluding comments let us focus on three points: relating our contribution to the previous literature on within- and across-industry diversification, tying our findings to the wider strategy field and finally offering some thoughts on open areas of research that are implied by the current study.

We contribute both in terms of both methodology and findings. The perhaps main contribution is to develop a way through which regression analysis is combined with a large number of counterfactual draws of cash flows that can then be used to evaluate a large number of counterfactual portfolios. The variability of cash flows from product portfolios is created in a bottom-up fashion that is well suited to explore different “what if” scenarios for a firm in a forward looking way. In contrast the academic literature has almost exclusively relied on backward looking analysis at the firm level - for instance relating returns on assets at the firm level to measures of the number of industries that the firm is active in or to the number of products sold. Such studies can be highly useful in establishing patterns but lend themselves less directly to an evaluation of different counterfactual portfolios for a particular firm.[17]

[16] The top tercile in terms of segment variability are: Red wine in Bag-in-Box, white wine in Bag-in-Box, rosé© wine, Whisky and red wine in bottles. The lowest tercile in terms of variability containts: Ale, light lager in bottles, foreign light lager in cans, special beer and weissbeer.

[17] The idea to use Monte Carlo simulations to generate input for corporate decision making is however not novel. Several excel-based commercial products are available, for instance Palisade's @RISK and Oracle's Chrystal Ball. A tight link to regression analysis, as in the current application, is likely to be useful in generating empirically relevant assumptions.

In terms of findings our conclusions largely echo results from both the within- and across-industry studies of diversification: A wider portfolio tends to be associated with less variability and results tend to be quantitatively important. One novelty is that the detailed data allow us to explore not only diversification in terms of the number of products or segments but also to explore different dimensions such as the number of source countries represented in a portfolio. Another contribution is the evaluation of product transfers between firms in the risk-return dimension - more than 800 products change wholesaler during the sample period and our evaluation shows that none of the wholesalers acquired or divested products in a way that raised risk while lowering profitability.

Let us now relate our findings to the wider strategy field. Arguably, the ultimate goal of research in strategic management is to help make firms “better” decisions. A firm that wants to evaluate its product portfolio and weigh potential changes needs to understand its capabilites and how they interplay with institutions and have been shaped by past developments. To examine the consequences of future actions the quantitative framework will hopefully be seen as useful. It provides a sandbox where different alternatives can be evaluated. A common finding in the literature that examines between-industry diversification is that diversification to related industries outperforms unrelated diversification (see e.g. Mackey et al. (2017)). Diversification within the same market can clearly be seen as an example of highly related diversification and thereby be more attractive for a firm than between-industry diversification.

Let us finally point to some open areas that follow from our findings. One application would be to use the framework developed here to further evaluate the importance of risk considerations as a motivation for within-industry mergers. While the literature focuses on market power and costs savings as motivations for mergers (see e.g. Björnerstedt and Verboven (2016)) the evidence presented here is consistent with the idea that the risk profile of the product portfolio is a factor in mergers and acquisitions. A relatively large literature examines risk management as a motive for conglomerate mergers (tantamount to between-industry diversification), with Amihud and Lev (1981) as an early seminal reference. Extending such study for within-industry concentrations should be of interest.

Another application is related to Enterprise Risk Managament (ERM), which emphasizes a company wide view of risk rather than piecemeal management of individual risks. While there is broad agreement about this goal there is still a marked lack of tools that are well suited to provide such an analysis, see e.g. Bromiley et al. (2015) for a discussion. The methods examined here provide one way to generate and summarize information that can be useful for enterprise wide risk management.

The present work also suggests a renewed interest in the relation between risk and return. A positive relation between risk and return is intuitive if investors dislike risk and need to be compensated for it. From a strategic management perspective influential results in Bowman (1980) instead indicated that higher risk, measured by variability of accounting returns, was associated with lower returns. The current set of tools may be of use in further examinations of the relation; not only mean-variance patterns but also richer patterns of skewed or fat-tailed distributions.

The motivation for a study of the current market was good access to data in a well understood setting. In future work it will be interesting to apply the tools to other markets and also to larger firms. One might argue that as firms become larger and have hundreds of products and are present on many different (national) markets the effects examined in the present article are less relevant. Partly that is precisely the point of this article: the more diversified a business, the less do we need to model and understand portfolio considerations. Second, to the extent that many products are subject to the same shocks (an auto manufacturer concentrated in low mileage cars for instance or a smart phone manufacturer highly reliant on one product), the less diversification benefit does the portfolio offer and the more might the tools and considerations of the present article be of use for strategic decision making.

Declaration of competing interest

No conflict of interest.

Appendix A. Product level determinants of cash flows

As a further indication of the sources of shocks to product-level cash flows Table 6 reports regression output where observed product-level cash flow at the yearly level 2006–2010 is the dependent variable. Column (1) only contains price and a constant as explanatory variables and as seen by the R-squared almost none of the variation in cash flow is explained. Column (2) adds fixed effects at the year × origin level and we see that, as measured by R-squared, these fixed effects explain around 6% of the variation in the data. A test for the joint significance of these fixed effects yields an F-statistic of 10.8 and the data thus support that exchange rate shocks have important effects on cash flows. Column (3) adds year × category fixed effects and the regressions again support that these fixed effects are an important source of variation in cash flows. Adding product fixed effects in column (4) brings the R-squared up to 0.89. This indicates that the sources of variation that we consider in the counterfactual analysis; origin, category and product level shocks account for much of the variation in the data. Different wholesalers may have different pricing policies and a product's cash flows may in other ways depend on the wholesaler. Column (5) therefore also includes wholesale fixed effects but here the evidence for important effects is weaker. On the other hand it must be acknowledged that with product fixed effects the wholesaler effects are only econometrically identified out off the cases where a product changes wholesaler. The coefficient on price is imprecisely estimated in all regressions which is not surprising. In demand regressions we expect a negative relation between price and demand whereas in cash flow regressions we expect price to be close to an optimum and to a first approximation the effect of price on cash flow should be zero.

Table 6
Sources of variation in cash flows, product level, actual data

VARIABLES	(1)	(2)	(3)	(4)	(5)
	cash flow	cash flow	cash flow	cash flow	cash flow
Relative price	−212,473	−119,038	39,580	925,745	247,749
	(60,743)	(60,594)	(59,252)	(443,280)	(480,002)
Constant	2.447e+06	2.269e+06	1.571e+06	2.063e+06	4.089e+06
	(83,247)	(465,242)	(968,873)	(850,087)	(2.600e+06)
Observations	6000	6000	6000	6000	6000
R-squared	0.002	0.060	0.304	0.886	0.889
Year x Origin FE	NO	YES	YES	YES	YES
Year x Categ. FE	NO	NO	YES	YES	YES
Article FE	NO	NO	NO	YES	YES
Wholes. FE	NO	NO	NO	NO	YES
F-statistic		10.82	27.53	12.76	1.414
p-value		0.000	0.000	0.000	0.0160

The table reports estimates with yearly product-level cash flows as dependent variable. Swedish market for alocholic beverages 2006–2010. F-statistic is for the joint hypotheses that the "additional" fixed effects are 0. (Year × origin in column (2), year × category in column (3), product fixed effects in column (4) and wholesale fixed effects in column (5)).

Appendix B. Relation between exchange rate and import price

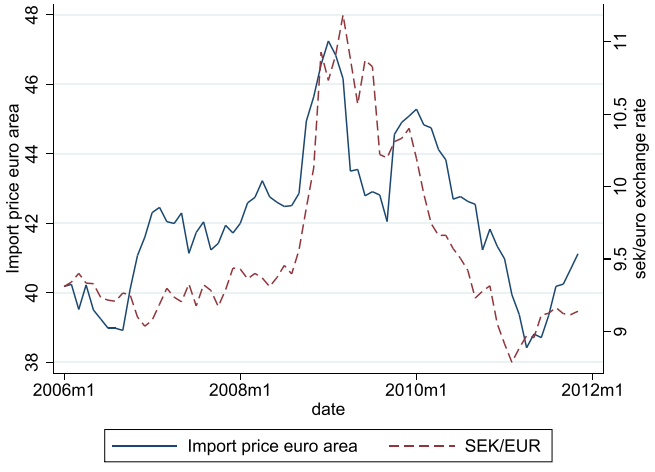

Fig. 7. Import price of wine imported from euro area and sek/eur exchange rate.

Appendix C. Letting prices respond to counterfactual shocks

In the main analysis prices are kept fixed in the counterfactual exercise. This has the benefit of simplicity and given price stability on this (and many other markets) is likely to be a good first approximation in the short-to medium run (see for instance Nakamura and Steinsson (2013)). Clearly stable prices will not be a feature for all markets and counterfactuals and in this appendix we outline how the assumption of stable prices can be relaxed and some of the modeling choices faced. There are essentially two ways to allow for endogenous price changes. One way is to use a known (or estimated) rule to link prices to marginal costs and demand shocks. For instance using a fixed markup or an estimated rate of pass-through to determine a new price associated with marginal cost. This is easy to implement in that the simulations simply incorporate the assumed rule but not necessarily consistent with economic theory.

Another way is to estimate a demand system with Berry et al. (1995) (BLP) as a seminal reference. The results from the demand estimation can then be combined with an assumption on the form of competition (typically static Bertrand) to back out marginal costs. These marginal costs can then be combined with estimated parameters of the demand system and an assumption on the form of competition to solve for counterfactual prices for a large set of draws on cost and demand shocks. Cash flow distributions can then be generated by simply combining counteractual prices, marginal costs and quantities and aggregating to the portfolio level.

Let us outline how an approach that lets prices endogenously respond following the lines above would proceed. We limit attention to wine, to implement it in this market one would combine this with corresponding work for the beer and spirits segments. We focus on the relatively straightforward "nested logit", see Berry (1994) for foundational work or Friberg and Ganslandt (2007), who use a similar framework to examine exchange rate exposure for firms in the bottled water market. Assume that products can be divided into

G mutually exclusive nests (in our case red wine in bag-in-box, red wine in bottle, rosé©, sparkling, white wine in bag-in-box, white wine in bottle). Demand is assumed to be generated by consumers k that each buy one unit (or none) of product i out of all the available products (I) and receive the following utility of consuming product i.:

$$u_{ik} = \delta_i + \zeta_{ig} + (1-\sigma)\varepsilon_{ik}$$

where δ_i is the mean valuation of product i that is common for all consumers, ε_{ik} and $\zeta_{ig} + (1-\sigma)\varepsilon_{ik}$ are distributed iid with a type I extreme value distribution. ζ_{ig} measures the common component in valuation of products within each nest. $0 \leq \sigma < 1$ measures the correlation of tastes within nests. The mean valuation of a product is assumed to depend on observable product characterstics in a vector x, on price p, on market share within the nest ($s_{i|g}$) and a component of mean utility that is unobservable, ξ_i. The model is formulated in terms of a total market M and market shares $s_i = q_i/M$. The literature typically make an assumption on the maximum potential sales M and we here set that to three times the highest montly sales of wine. M minus the total sales of wine is denoted as the market share of the outside good (s_o) and its utility is normalized to zero. With these assumptions Berry (1994) showed that the preference parameters for consumers can be estimated by taking the following equation to the data:

$$\ln(s_i) - \ln(s_o) = \underbrace{x_i\beta - \alpha p_i + \sigma \ln(s_{i|g}) + \xi_i}_{\equiv \delta_i}.$$

With sufficiently rich data it is typically preferable to also include product fixed effects (which would cancel the observable product characteristics in our case, since the latter do not vary over time in this market) and period fixed effects to capture demand shocks. Table 7 presents the results for the wine data in this paper. Column (1) reports results for a "logit" specification that disregards the nesting structure using product characteristics, column (2) the corresponding results for a fixed effects specification, column (3) a nested logit specification and column (4) a nested logit specification where we use instrumental variable estimation to control for the endogeneity of price and market share in the nests. The results are somewhat sensitive to the instruments used and we have not performed the kind of specification search would be preferable if the estimates were to be used as a foundation for simulations (it might for instance be the case that a random coefficients logit following Berry et al. (1995) would be more appropriate for this data set). It should thus be stressed that these results are for illustrative purposes only. An advantage of the nested logit formulation is that it has closed form solutions for elasticities; the own-price elasticity is for instance given by $\alpha p_i(s_i - 1/(1-\sigma) + \sigma/(1-\sigma)s_{i|g})$ and it is a common check on the plausibility of results if this elasticity is in line with expectations. We report the own-price elasticity in this case in row 1 of Table 8 and as seen it broadly conforms to expectations. All elasticities are lower than -1 and the average elasticity is around -4.4.

Table 7
Logit and nested logit regressions for wine, Swedish market 2006–2011.

	(1)	(2)	(3)	(4)
VARIABLES	logit	logit	nested logit	nested logit (IV)
p	−0.00557	−0.00518	0.000855	−0.0128
	(5.03e-05)	(0.000368)	(0.000129)	(0.00513)
ln (ms in nest)			0.988	0.630
			(0.00147)	(0.128)
Constant	−6.351	−8.519	−3.740	−3.945
	(0.0710)	(0.0527)	(0.0198)	(0.4005)
Observations	65,163	65,163	65,163	63,435
R-squared	0.458	0.869	0.984	0.969
Period FE	YES	YES	YES	YES
Product FE	NO	YES	YES	YES
Origin FE	YES	NO	NO	NO
Controls	YES	NO	NO	NO

The regression reports logit and nested logit demand based on discrete choice model of demand following Berry (1994). Dependent variable in all columns standard deviation of ln(market share)-ln(market share of outside good). Total market size set to 3 times the maximum total volume. Column (1) uses observed product characteristics, while columns (2)–(4) use product fixed effects. Nested logit (columns 3–4) uses following nests: red wine in bag-in-box, red wine in bottle, rosé, sparkling, white wine in bag-in-box, white wine in bottle. Column (4) uses instrumental variable regression with exchange rate, marginal cost and a BLP instrument (alcohol) as instruments for price and market share in nest. Note: Estimation only for illustrative purposes.

In these specification ξ_i, the part of mean valuation not dependent on observable characteristics, takes the role of an error term and the natural way to generate counterfactual demand shocks would be to generate a large number of counterfactual draws on ξ_i for each of the products and segments.

Turning now to counterfactual prices the demand estimates would need to be coupled with assumptions about the supply side of the market. A firm that produces n products is assumed to set prices to maximize profits:

$$\max_{p} \sum_{i=1}^{n} (p_i - mc_i) M s_i.$$

If firms set price independently for each product, and mc is constant, a Nash equilibirum in pure strategies yields that the price of each product i will be equal to:

$$p_i = \frac{(1-\sigma)}{\alpha} / \left(1 - \sigma s_{i|g} - \left(1-\sigma\right) s_i\right) + mc_i. \tag{10}$$

In standard applications marginal costs are unknown but all other variables are observed (price and market shares) or estimated (α and σ are the estimated coefficients on price and market share within nests from Table 7, column (4)). Thus, the estimated parameters from the demand system can be used to back out marginal costs. These marginal costs can then be hit with a large number of counterfactual costs shocks. Given these counterfactual cost shocks and counterfactual demand shocks for all products one can then solve for counterfactual prices. Note that market share and market share within nests will depend on all the (counterfactual) prices in the market and it is also in these market share equations that demand shocks will enter (via the mean valuation for each product). Again the nested logit form provides us with an explicit functional form where the first term is the market share within the nest:

$$s_i = \frac{e^{\delta_i/(1-\sigma)}}{D_g} \frac{D_g^{(1-\sigma)}}{1 + \sum_{g=1}^{G} D_g^{(1-\sigma)}} \tag{11}$$

where

$$D_g = \sum_{m \in G_g} e^{\delta_m/(1-\sigma)} \tag{12}$$

Thus the combination of Equations (10)–(12) gives a system of I equations that can be solved for I optimal prices and the solution is repeated for each set of counterfactual draws on cost and demand shocks.

Table 8
Implied own price elasticity and backed-out markups from nested logit demand estimation, Swedish market 2006–2011.

variable	mean	sd	min	max
Own price elasticity	−4.40	3.59	−64.81	−1.30
Markup in data $(p - mc)/p$	0.72	0.09	0.40	0.99
Markup (backed out) $(p - \hat{mc})/p$	0.29	0.11	0.02	0.77

The table reports the own-price elasticity implied by the estimated coefficients in Table 7, column (4) as well as the total markup (retail price - marginal cost)/retail price; using trade data as described in paper (row 2) and using the backed out marginal costs that are implied by static profit maximization in combination with the estimated parameters of Table 7, column (4).

The presentation above indicates that even in the “simple” case of nested logit the application of the above kind of framework to a large number of counterfactual scenarios is rather complex. A more important constraint is that one needs to be alert so that the results are generated by the market rather than by assumptions on functional forms or the nature of (static) competition. Compare markups using actual trade data in row 2 of Table 8 with the markup using backed-out marginal costs in row 3. The marginal costs from the trade data are clearly inconsistent with the combination of observed prices, demand estimates and static Nash competition in prices. Some structural work, for instance Björnerstedt and Verboven (2016) include an additional conduct parameter that can be used to capture deviations from Nash-Bertrand play and thereby provide one way to make the structural model fit both the price and marginal cost data. We believe that this may be one way to proceed in future work but believe that it is useful to first take the step of examining the links between risk/return and portfolio composition in the relatively simple and transparent model that we use in the present paper.

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