The World's Largest Open Access Agricultural & Applied Economics Digital Library

This document is discoverable and free to researchers across the globe due to the work of AgEcon Search.

Help ensure our sustainability.

Give to AgEcon Search

AgEcon Search
http://ageconsearch.umn.edu
aesearch@umn.edu

*Papers downloaded from **AgEcon Search** may be used for non-commercial purposes and personal study only. No other use, including posting to another Internet site, is permitted without permission from the copyright owner (not AgEcon Search), or as allowed under the provisions of Fair Use, U.S. Copyright Act, Title 17 U.S.C.*

No endorsement of AgEcon Search or its fundraising activities by the author(s) of the following work or their employer(s) is intended or implied.

Competitive Package Size Decisions

Koichi Yonezawa* and Timothy J. Richards**
*Department of Marketing and Consumer Research, Technische Universität München
**Morrison School of Agribusiness, Arizona State University

Selected Poster prepared for presentation at the 2015 Agricultural & Applied Economics Association and Western Agricultural Economics Association Joint Annual Meeting, San Francisco, CA, July 26-28.

Copyright 2015 by Koichi Yonezawa and Timothy J. Richards. All rights reserved. Readers may make verbatim copies of this document for non-commercial purposes by any means, provided this copyright notice appears on all such copies.

* Contact author: Yonezawa (koichi.yonezawa@tum.de)

Competitive Package Size Decisions

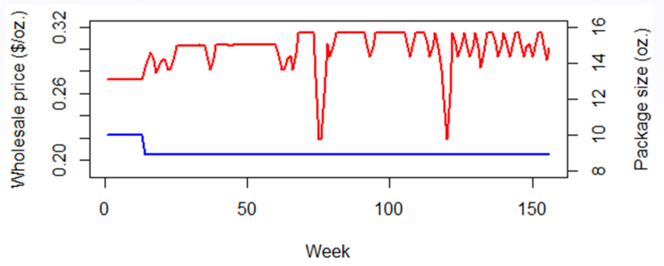
Koichi Yonezawa* and Timothy J. Richards**
*Technische Universität München **Arizona State University
Contact author: Yonezawa (koichi.yonezawa@tum.de)

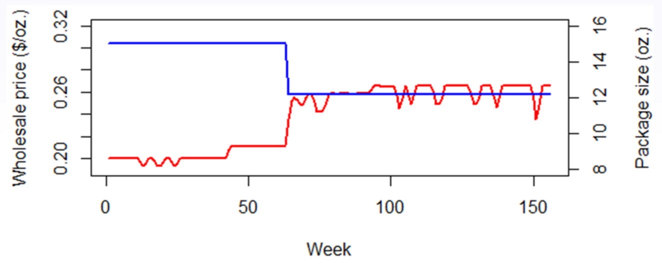
Introduction

Back Ground
- Why do manufacturers offer different package sizes?
- Why do manufacturers reduce the size of some products?
- Manufacturers are seeking ways to soften price competition. Does reducing package size fly in the face of those broader efforts?

Current Orthodoxy
- Consumers do not have precise information about package size (e.g. Binkley and Bejnarowicz 2003).
- Consumers are not responsive to unit price changes (e.g. Cakira and Balagtas 2014).
- Package downsizing makes the comparison of unit price difficult (e.g. Ellison and Ellison 2009).
- Manufacturers reduce package size to pass along price increase.
- Manufacturers are able to extract surplus from package downsizing.

Real-World Observation
- Why do manufacturers change package sizes less frequently? Can the current orthodoxy explain it?





Research Objective

- Investigate how manufacturers choose package size and price in a competitive environment

Hypotheses

- Consumers base their purchase decisions on package size.
- Manufacturers incur the costs of making different packages.
- Manufacturers compete in price and package size.

Contributions

- Consider role of package size as a competitive tool
- Show interdependence of price and package size
- Provide evidence of semi-collusion in package size
- Explain package downsizing in terms of cost and competition
  - Change in package size is costly.
  - Raising unit prices by package downsizing is not easy due to competition

Model

Consumer
- Consumers are assumed to be heterogeneous, make a discrete and hierarchical choice among differentiated products.
- Utility within the random coefficient generalized extreme value (GEV) framework:

$$U_{hijt} = \alpha_{hb} + \beta_{ht} p_{ijt} + f(q_{it}) + \psi d_{ijt} + \omega\left(p_{ijt} \times d_{ijt}\right) + \xi_{ijt} + \tau_{hijt} + (1-\sigma)\varepsilon_{hijt}$$

  p_{ijt}: Retail price
  q_{it}: Package size
  $f(\cdot)$: Contribution to utility by purchase quantity (Draganska and Jain 2005), $f(q_{it}) = f(0) + f'(0)q_{it} + \frac{f''(0)}{2} {q_{it}}^2 = \gamma_{1ht} q_{it} + \gamma_{2t} {q_{it}}^2$
  d_{ijt}: Price discount (dummy variable)
  ξ_{ijt}: iid error term that reflects product attributes that are relevant, but unobserved to the econometrician
  $\tau_{hijt} + (1-\sigma)\varepsilon_{hijt}$: GEV extreme-value distributed term (Cardell 1997)
- Market share

$$s_{ijt} = \iiint \frac{exp\left(\delta_{ijt}+\phi_{hijt}\right)/(1-\sigma)}{D_J^{\sigma}\left(\sum_{j\in J} D_J^{1-\sigma}\right)} g_1(\iota) g_2(\kappa) g_3(\lambda) d\iota d\kappa d\lambda$$

Vertical Relationship
- We assume the Stackelberg competition (e.g. Besanko, Dubé and Gupta 2003; Villas-Boas and Zhao 2005; Villas-Boas 2007).

Retailers
- Retailers are assumed to pass through manufacturers' package size decisions, and set prices and act as local monopolist.
- Retailer j's profit maximization problem:

$$\pi_t^j = \max_{p_{it}} Q_t \sum_{i=1}^{I} (p_{it} - r_{it})\, s_{it} - F_{jt}$$

  I: Index of product
  Q_t: Market size
  p_{it}: Retail price
  r_{it}: Retailing cost
  s_{it}: Market share
  F_{jt}: Fixed retailing cost
- First order condition with conduct a parameter, ρ (in matrix notation):
- $p - r = -\left(\left(\frac{1}{\rho}\right)\Omega\right)^{-1} s$
- Ω : $I \times I$ matrix where the (i,j) element is given by $\frac{\partial s_j}{\partial p_i}$

Manufacturers
- Manufacturers are assumed to set package sizes and wholesale prices simultaneously and compete in both of them.
- Manufacturer m's profit maximization problem:

$$\pi_t^m = \max_{w_{it}, q_{it}} Q_t \sum_{i=1}^{I_{mt}} (w_{it} - c_{it})\, s_{it} - F_{mt} - \sum_{i=1}^{I_{mt}} h(q_{it})$$

  I_{mt}: Index of product that manufacturer m offers
  Q_t: Market size
  w_{it}: Wholesale price
  c_{it}: Marginal cost
  s_{it}: Market share
  F_{mt}: Fixed cost
  $h(q_{it})$: Package-size cost function e.g. set-up, inventory, and distribution costs, $h(q_{it}) = \theta_0 + \theta_1 q_{it} + \theta_2 q_{it}^2$
- First order condition with respect to wholesale prices with a conduct parameter, φ (in matrix notation):

$$w - c = -\varphi\left((G^{-1}\Omega)\Omega * I_N\right)^{-1} s$$

- First order condition with respect to package sizes with a conduct parameter, η_1 (in matrix notation):

$$q = \eta_0 + \eta_1 Q \Gamma (w - c)$$

Estimation
- Two-stage estimation method (Yang, Chen, and Allenby 2003)
- Demand-side model: Simulated maximum likelihood (SML) method with a control function (Pertin and Train 2010; Park and Gupta 2009)
- Supply-side model: Seemingly unrelated regressions (SUR) model with a control function

Data

- Store-level scanner data (IRI Infoscan) provided by 2 major retail chains in a US metropolitan market
  - Ready-to-eat breakfast cereal category for 3 years (April 2007-March 2010)
  - 35 major SKUs (15 out of 35 products changed package size.)
- Manufacturer pricing data by Promodata, Inc.

Results

Table 1: Estimation Result of Demand-Side Model

Variable	Parameter	Estimate	t-value
Package size	Mean coefficient	-0.157*	-2.746
	Std. dev. of coefficient	0.019*	213.126
Log likelihood at convergence		4,258	

- Consumers prefer smaller packages.
- Preference for package size is heterogeneous.

Table 2: Conduct Parameters of Supply-Side Model

Model	Estimate	t-value
Retail price equation	0.00065*	4.93713
Manufacturer price equation	0.00003*	6.68000
Manufacturer package-size equation	3.25769*	3.37530

- Market is more competitive than the maintained assumptions.
- Prices are less responsive to changes in demand induced by competitors' price changes.

- The positive conduct parameter in the package-size equation means wholesale prices and package sizes are strategic complements.

$$q_1 = \eta_0 + \boxed{\eta_1}\left[(w_1 - c_1)\boxed{\frac{\partial s_1}{\partial q_1}} + (w_2 - c_2)\boxed{\frac{\partial s_2}{\partial q_1}}\right] \quad \text{(product 1)}$$

$$q_2 = \eta_0 + \boxed{\eta_1}\left[(w_1 - c_1)\boxed{\frac{\partial s_1}{\partial q_2}} + (w_2 - c_2)\boxed{\frac{\partial s_2}{\partial q_2}}\right] \quad \text{(product 2)}$$

- $w_1 \uparrow \Rightarrow q_1 \downarrow$: Manufacturers use changes in package size to mitigate the effects of price increase.
- $q_1 \downarrow \Rightarrow w_1 \uparrow \Rightarrow q_2 \uparrow \Rightarrow w_2 \downarrow$: A package downsizing intensifies price competition.

- What happen if the size of Cheerios 15/14 oz. is reduced by 10%?
  - Price competition is sharpened and manufacturers lose, but retailers gain.

Table 3: Response of manufacturers and retailers

Product	Wholesale price (%)	Package size (%)	Manufacturer margin (%)	Retail price (%)	Retail margin (%)
Cheerios 15/14 oz.	-0.951	-1.015	-6522.209	0.084	0.263
Frosted Flakes 17 oz.	-0.029	0.007	-9.784	0.003	0.008
Rice Krispies 12 oz.	-0.078	0.018	-16.212	0.002	0.006

Conclusions and Implications

- Consumers prefer smaller packages. ⇒ Manufacturers should launch at least one small-pack product.
- Preference for package size is heterogeneous. ⇒ Manufacturers should offer multiple packages.
- Package-size decisions depend on demand, cost, and competition.
- Package downsizing mitigates the effects of price increase.
  - Reason why manufacturers simultaneously lower the package and raise the unit price of a product
- Package size and price are strategic complements.
- Package downsizing intensifies price competition.
  - Ability to raise unit prices through changes in package sizes is constrained by competition.
  - Reason why manufacturers seldom lower package sizes
- Package upsizing softens price competition.
  - Reason why manufacturers launch larger packages
- Retailers gain more from package downsizing than manufacturers.
- Package size and price are interdependent.
- Manufacturers cannot easily pass-through cost increases through package downsizing.
  - Retail prices increase slower than once thought.