Darmawan, Agus; **Wong, Hartanto**; **Thorstenson, Anders**

Integrated sales and operations planning with multiple products: jointly optimizing the number and timing of promotions and production decisions. (English) Zbl 07193153

Appl. Math. Modelling 80, 792-814 (2020)

Summary: This paper presents a modelling framework for sales and operations planning (S&OP) that considers the integration of price promotion and production planning for multiple products. Such a modelling framework takes into account the potential competition and cannibalization between products, as well as the allocation of shared production resources. The demand model that we adopt combines purchase incidence, consumer choice and purchase quantity in a sequential framework to obtain the dynamics and heterogeneity of consumer response to promotions. Due to large problem sizes, we develop a heuristic approach for solving the resulting joint optimization problem. The results of our numerical study show interesting findings on the optimal number and timing of promotions that take into account the mutual dependence of marketing and production related factors.

MSC:

90-XX Operations research, mathematical programming
91-XX Game theory, economics, finance, and other social and behavioral sciences

Keywords:

demand model; forward buying; product substitution; cannibalization; promotion

Full Text: DOI

References:

[1] Bozarth, C. C.; Handfield, R. B., Introduction to Operations and Supply Chain Management (2016), Pearson Education: Pearson Education New Jersey

[2] K. Bursa, The Challenges of Global S&OP, The European Business Review. (2012). http://www.europeanbusinessreview.com/the-challenges-of-global-sop/(Accessed 28 November 2017).

[3] Hinkel, J.; Merkel, O.; Kwasniok, T., Good sales and operations planning is no longer good enough, Supply Chain Manag. Rev. (2016)

[4] Lund, C. T.; Raun, S., S&OP in Denmark: An Investigation of the S&OP Maturity Level in Danish Companies, Syncronic Manag. Consult. (2017)

[5] Nielsen, Cracking the Trade Promotion Code, (2014). http://www.nielsen.com/us/en/insights/news/2014/cracking-the-trade-promotion-code (Accessed 18 July 2018).

[6] Gomez, M. I.; Rao, V. R.; McLaughlin, E. W., Empirical Analysis of budget and allocation of trade promotions in the U.S. supermarket industry, J. Market. Res., 44, 410-424 (2007)

[7] Gedenk, K.; Neslin, S. A.; Ailawadi, K. L., Sales Promotion, (Krafft, M.; Mantrala, M. K., Retailing in the 21st Century: Current and Future Trends (2010), Springer-Verlag: Springer-Verlag Berlin Heidelberg)

[8] E. Yoon, Sell more with smarter trade promotions, Harvard Business Review. July 19, 2012.

[9] J. Weber, and C. Randall, For better retail promotions, ask these questions, Harvard Business Review. November 16, 2018.

[10] Dawes, J., Sibling rivalry: when companies offer discounts, they too often ignore the impact on other products they sell, Wall Street J. (2009), August 17

[11] Cheng, F.; Sethi., S., A periodic review inventory model with demand influenced by promotional decisions, Manag. Sci., 45, 11, 1510-1523 (1999) · Zbl 0944.90003

[12] Federgruen, A.; Heching, A., Combined Pricing and Inventory Control under Uncertainty, Operat. Res., 47, 3, 454-475 (1999) · Zbl 0979.90004

[13] Kurata, H.; Liu, J. J., Optimal promotion planning – depth and frequency – for a two-stage supply chain under Markov switching demand, Eur. J. Operat. Res., 177, 1026-1043 (2007) · Zbl 1111.90060

[14] Cárdenas-Barrón, L. E.; Smith, N. R.; Goyal, S. K., Optimal order size to take advantage of a one-time discount offer with allowed backorders, Appl. Math. Model., 34, 1642-1652 (2010) · Zbl 1193.90019

[15] Li, C. C.; Wu, Y. C., Combined pricing and supply chain operations under price-dependent stochastic demand, Appl. Math. Model., 38, 1823-1837 (2014) · Zbl 1427.90050

[16] Ahmadi, M.; Shavandi, H., Dynamic pricing in a production system with multiple demand classes, Appl. Math. Model., 39, 2332-2344 (2015) · Zbl 1443.91180

[17] Maiti, T.; Giri, B. C., Two-period pricing and decision strategies in a two-echelon supply chain under price-dependent demand, Appl. Math. Model., 42, 655-674 (2017) · Zbl 1443.90048

[18] Cohen, M. C.; Leung, N. Z.; Panchamgam, K.; Perakis, G.; Smith, A., The Impact of Linear Optimization on Promotion Planning, Operat. Res., 65, 2, 446-468 (2017) · Zbl 1366.90140

[19] Martínez-Costa, C.; Mas-Machuca, M.; Lusa, A., Integration of marketing and production decisions in aggregate planning: a review and prospects, Eur. J. Ind. Eng., 7, 755-776 (2013)

[20] Leitch, R. A., Marketing Strategy and the Optimal Production Schedule, Manag. Sci., 21, 302-312 (1974)

[21] Sogomonian, A. G.; Tang, C. S., A Modeling Framework for Coordinating Promotion and Production Decisions within a Firm, Manag. Sci., 39, 191-203 (1993)

[22] Ulusoy, G.; Yazgac, T., Joint decision making for production and marketing, Int. J. Product. Res., 33, 2277-2293 (1995) · Zbl 0913.90149

[23] Feng, Y.; D'Amours, S.; Beauregard, R., The value of sales and operations planning in oriented strand board industry with make-to-order manufacturing system: Cross functional integration under deterministic demand and spot market recourse, Int. J. Product. Econ., 115, 189-209 (2008)

[24] Affonso, R.; Marcotte, F.; Grabot, B., Sales and operations planning: the supply chain pillar, Product. Plann. Control, 19, 132-141 (2008)

[25] González-Ramírez, R. G.; Smith, N. R.; Askin, R. G., A heuristic approach for a multi-product capacitated lot-sizing problem with pricing, Int. J. Product. Res., 49, 1173-1196 (2011)

[26] Lusa, A.; Martínez-Costa, C.; Mas-Machuca, M., An integral planning model that includes production, selling price, cash flow management and flexible capacity, Int. J. Product. Res., 50, 1568-1581 (2012)

[27] Bajwa, N.; Sox, C. R.; Ishfaq, R., Coordinating pricing and production decisions for multiple products, Omega, 64, 86-101 (2016)

[28] Sodhi, M. S.; Tang, C. S., Determining supply requirement in the sales-and-operations-planning (S&OP) process under demand uncertainty: a stochastic programming formulation and a spreadsheet implementation, J. Operat. Res. Soc., 62, 526-536 (2011)

[29] Feng, Y.; D'Amours, S.; Beauregard, R., Simulation and performance evaluation of partially and fully integrated sales and operations planning, Int. J. Product. Res., 48, 5859-5883 (2010) · Zbl 1197.90136

[30] Darmawan, A.; Wong, H.; Thorstenson, A., Integration of promotion and production decisions in sales and operations planning, Int. J. Product. Res., 56, 12, 4186-4206 (2018)

[31] Taskın, Z. C.; Ağralı, S.; Ünal, A. T.; Belada, V.; Gökten-Yılmaz, F., Mathematical programming-based sales and operations planning at Vestel electronics, Interfaces, 45, 325-340 (2015)

[32] Lim, L. L.; Alpan, G.; Penz, B., A simulation-optimization approach for sales and operations planning in build-to-order industries with distant sourcing: Focus on the automotive industry, Comput. Ind. Eng., 112, 469-482 (2017)

[33] Ghasemy Yaghin, R.; Torabi, S. A.; Fatemi Ghomi, S. M.T., Integrated markdown pricing and aggregate production planning in a two echelon supply chain: A hybrid fuzzy multiple objective approach, Appl. Math. Model., 36, 6011-6030 (2012) · Zbl 1349.90295

[34] Ghasemy Yaghin, R., Integrated multi-site aggregate production-pricing planning in a two-echelon supply chain with multiple demand classes, Appl. Math. Model., 53, 276-295 (2018)

[35] Steenkamp, J.-B. E.M.; Nijs, V. R.; Hanssens, D. M.; Dekimpe, M. G., Competitive Reactions to Advertising and Promotion Attacks, Market. Sci., 24, 35-54 (2005)

[36] Kotler, P. T.; Armstrong, G., Principles of Marketing (2013), Pearson: Pearson London

[37] Silva-Risso, J. M.; Bucklin, R. E.; Morrison, D. G., A Decision support system for planning manufacturers' sales promotion calendars, Market. Sci., 18, 274-300 (1999)

[38] Ailawadi, K. L.; Gedenk, K.; Lutzky, C.; Neslin, S. A., Decomposition of the sales impact of promotion-induced stockpiling, J. Market. Res., 44, 450-467 (2007)

[39] Fok, D.; Paap, R.; Franses, P. H., Modeling dynamic effects of promotion on interpurchase times, Comput. Stat. Data Anal., 56, 3055-3069 (2012) · Zbl 1254.91585

[40] Simester, D., Optimal Promotion Strategies: A Demand-Sided Characterization, Manag. Sci., 43, 251-256 (1997) · Zbl 0888.90098

[41] Srinivasan, S. R.; Ramakrishnan, S.; Grasman, S. E., Identifying the effects of cannibalization on the product portfolio, Market. Intell. Plann. Bradford, 23, 359-371 (2005)

[42] Gumus, M.; Kaminsky, P.; Mathur, S., The impact of product substitution and retail capacity on the timing and depth of price promotions: theory and evidence, Int. J. Product. Res., 54, 2108-2135 (2016)

[43] Guadagni, P. M.; Little, J. D.C., A Logit Model of Brand Choice Calibrated on Scanner Data, Market. Sci., 2, 203-238 (1983)

[44] Bucklin, R. E.; Lattin, J. M., A Two-State Model of Purchase Incidence and Brand Choice, Market. Sci., 10, 24-39 (1992)

[45] Seetharaman, P. B., Modeling multiple sources of state dependence in random utility models: a distributed lag approach, Market. Sci., 23, 263-271 (2004)

[46] S. Chopra, and P. Meindl, Supply Chain Management: Strategy, Planning, and Operation. 6th Edition. Pearson Education, New Jersey2016

[47] Chaudhry, S. S.; Luo, W., Application of genetic algorithms in production and operations management: a review, Int. J. Product. Res., 43, 4083-4101 (2005) · Zbl 1080.90514

[48] Fahimnia, B.; Luong, L.; Marian, R., Genetic algorithm optimisation of an integrated aggregate production-distribution plan in supply chains, Int. J. Product. Res., 50, 81-96 (2012)

[49] Wari, E.; Zhu, W., A survey on metaheuristics for optimization in food manufacturing industry, Appl. Soft Comput., 46, 328-343 (2016)

[50] Pandey, H. M.; Chaudhary, A.; Mehrotra, D., A comparative review of approaches to prevent premature convergence in GA, Appl. Soft Comput., 24, 1047-1077 (2014)

[51] Pham, D.; Karaboga, D., Intelligent Optimisation Techniques: Genetic Algorithms, Tabu Search, Simulated Annealing and Neural Networks (2000), Springer-Verlag: Springer-Verlag London · Zbl 0986.90001