The impact of Out of Stock on laundry sales in a supermarket chain in Latin America using vector autoregressive analysis (VAR)

Santiago J. Calderón-Cortés
FES ARAGON, UNAM, Mexico

Miguel A. Morales-Arroyo
IIMAS, UNAM,Mexico

Keywords
Stock outs, In stock, Out of stock (OOS), Consumer Behavior, Sales Behavior.

Abstract
In this paper analyze the sales behavior of the items in the laundry category in a Latin American Supermarket Stores, as well as the stock out level presented in a period of more than 100 weeks to determinate if there is any relation between stock outs level and the sales behavior. Historical data is from the second semester in 2012 to the first semester in 2014, which was analyzed using vector autoregressive analysis (VAR). The results show that the OOS situations observed are lower to breakeven, this imply that the retailer in this study have a high cost of unproductive inventory since the fact of having more inventory has not effect on sales behavior.

Introduction

The purpose of this paper is to analyze the sales behavior in a retail setting and the stock outs level presented on laundry products in a period of more than 100 weeks in a supermarket chain in Latin America; to determinate the relationship, if any, between stock outs level and the sales behavior; and to identify the of stock outs degree of influence on total sales.

The retail industry in Latin America has gained great momentum. Consumer spending has increase in consumer spending due to the middle class growth in the region. Despite the economic volatility experienced Latin American markets for social and political problems, the retailers, especially supermarkets are placed as leaders in the region. The retailers in America Latina reported strong financial results in 2013 even when the devaluation of currencies continues (Brujó & Matias, 2014).

The most relevant countries in this area are Brazil, Mexico, Colombia and Chile. According to Interbrand, these are the most valuable retailers in Latin America (million dollars): OXXO ($2,615) a convenience store in Mexico, Extra ($263) another convenience store in Brazil, Bodega Aurrera ($1,016), Falabella ($547), Superama ($319), Tottus ($160), Pão de Açúcar ($147) most of them supermarkets. These chains work on countries like Chile, Brazil, and Mexico. The most important supermarket chains operating in Latin America are Carrefour, Casino, Cencosud, Coto, Falabella, Pao de Acucar, Tottus, and Wal-Mart, and a typical store surface in these chains are 4900 square meters (Brujó & Matias, 2014); (Capizzani, Ramirez, & Rocha, 2012).

A Brief Survey of Literature

Previous research about OOS have given a numerous definitions (Che, Chen, & Chen, 2012); (Helm & Hegenbart, 2011). According to Gruen et al, a stock out situation happens when an item is not available for sale, at least one piece must be in existence in a specific time on the store, independently of the reasons that originated the stock out circumstance such as store operations, supply chain inefficient or supplier service level (Gruen, Corsten, & Bharadwaj, 2002b). The OOS situation is the intersection between consumer behavior and the distribution channel (Kucuk, 2004).

In that sense the OOS situation most be one of the most relevant key performance indicator in retail logistics since this situation is better understood when it is analyzed from a holistic perspective that includes all the elements in the retail supply chain from the provider to the store shelf as the ending point in the retail supply chain (Aastrup & Kotzab, 2010). Previous studies have examined the OOS situation from two perspectives generating two research streams (Progressive Grocer study a&b, 1968);(Aastrup & Kotzab, 2009). On the first hand, a stream represents the demand side of OOS situations where the consumer reactions facing an OOS are examined. On the second hand, stream analyzes the supply side and the root causes that originated an OOS situation.

The OOS can be seen as the complement of another key retailing performance indicator of customer service, which is On Shelf Availability. This last indicator is defined as the probability of having a product on shelved in the expected location when the customer wants to buy it (Chopra & Van Mieghem, 2000). It does not matter whether the product is available on the store´s backroom since the product is not available to the consumer.

The demand side research stream analyzes the costumer behavior reaction facing an OOS situation. The results vary from study to study, and they show different behaviors, which depend on the region under study. Campo et al detect that 2% of customer facing and OOS situation switch to another store, the 49% delay the purchase and the 44% choose an item form within different alternatives (Campo, Gijsbrechts, Nisol, & Modelling, 2000). Gruen et al find out that 19% switch to other item, 26% buy an item from another brand, 31% buy the item to another store, 15% delay the purchase and 9% don't purchase the item (Gruen, Corsten, & Bharadwaj, 2002). In addition is needed to consider the purchase customer decision tree of each category product what is a test that denote the purchase considerations in order of importance for the customers, each node is the result of the product attribute hierarchy (Cho, Kim, & Kim, 2002). Depending on the product analyzed the stock out reactions chance significantly:

Category	**Autor**	**Article switch**	**Brand switch**	**Store switch**	**Delay purchase**	**Not buy**
Bread	*Woensel et al (2007)*	84.0% *		10.0%	6.0%	-
Cereals	*Campo et al (2000)*	44.0% *		3.3%	49.0%	3.7%
Groceries	*Schary et al (1979)*	4.8%	17.4%	47.9%	11.2%	18.7%
	Emmelhainz et al (1991)	41.0%	32.0%	14.0%	13.0%	-
	Sloot et al(2005)	18.0%	36.0%	20.0%	23.0%	3.0%
Margarine	*Campo et al (2000)*	66.0%*		2.0%	30.0%	2.0%
Meta-Analysis	*Gruen et al (2002)*	19.0%	26.0%	31.0%	15.0%	9.0%
Wine, Spirits	*Walter et al(1975)*	19.3%	64.1%	14.1%	2.5%	-
White Goods	*Zinn et al (2001)*	62.0% *		22.9%	15.1%	-

Brand and article switch are represent by subtitution

Customer stock out reaction from existing research studies based on (Helm & Hegenbart, 2011)

These studies show a strong influence between situational factors and the consumer response to an OOS situation. The literature on consumer reactions to OOS situation finds out that consumer's responses could vary strongly depending on situational and psychographic variables and based on product and store characteristics (Bayle, Laurent, & Macé, 2006).

The supply side stream research has been studied since the 1960´s (Peckham, 1963; Progressive Grocer study a&b, 1968), these types of studies focus on the impact of OOS situation, how to measure it, the root causes in supply chain that originated this situation (Aastrup & Kotzab, 2010). The first study found an average level of OOS of 12% in relation to the operative issues in a store, finding as root causes: space allocation, ordering routines, inexperienced personnel on the stores (Progressive Grocer study a&b, 1968). Other studies have shown that the world level of OOS is between 10% and 30% (Hess & Gerstner, 1987; Progressive Grocer study a&b, 1968; (Schary & Christopher, 1979), more recently research shows that the OOS level is around 8.2% in a typical day and 15% in items with promotional activity or advertising (Gruen & Corsten, 2008).

The studies from 2000's have analyzed the reasons of the Stock out situations such as logistics problems, deficient distribution and retail store inefficiencies, and other logistics variables that have an impact on OOS situations (Gruen et al., 2002a). The average service level from suppliers to warehouses and from warehouses to stores ranges from 97% to 99%. The On shelf availability (OSA) is around 92-93% (ECR Europe, 2003). This indicates that one of the main OOS situation causes are the in-store operations (ECR Europe, 2003); (McKinnon, Mendes, & Nabateh 2007); (Aastrup & Kotzab, 2010).

The level of OOS depends on the demand of each product and its features: OOS rates vary significantly between different product categories, such as laundry, air fresheners, dishes, processed food, and drinks. The worst OOS performing rates is around 15 to 16% depending on the items, and the best OOS performing rates are less than 1% (ECR Europe, 2003); (Gruen et al., 2002b); (McKinnon, Mendes, & Nabateh 2007). This OOS performing rates vary depending on seasonality, service, demand (Aastrup & Kotzab, 2010). Promoted items have more probability of OOS than items without promotion. According to Gruen et al, the items with promotion have a 75-100% more OOS than the non-promoted items. However, if an item with promotion is handled with special attention, it could present lower OOS levels (Gruen & Corsten, 2008).

The OOS level varies depending the store size and format. In the hypermarkets, the OOS level is lower than the supermarkets (Aastrup & Kotzab, 2009); (ECR Europe 2003). Also, some studies had reported a lower OOS level in supermarkets than convenience stores (Aastrup & Kotzab, 2010); (Fernie & Grant, 2008). OOS level is not constant, it varies depending the day of the week and the hour (Gruen & Corsten, 2008); (Van Woensel et al, 2007). Over stock could create backroom full with some items, and lower OOS performing rates for other items since increase the management of the store operations, and low stock increase efficiency and productivity through the supply chain (ECR Europe, 2003); (Aastrup & Kotzab, 2010); (Scott, 2006). The channel distribution has not effect in the OOS level, either delivered directly from supplier to stores or cross-docking delivered via warehouse (ECR Europe, 2003).

It is important to define the OOS level since it should be a balance between benefits and investment in unproductive inventory. Besides, an analysis of the costs of lost sales and the costs of unproductive inventory is needed (Fitzsimons, 2001), which are some of the most relevant issues that retailers must considerer.

The majority of the studies are focused on Consumer Behavior facing an OOS situation, and there are a few studies that investigate the frequency of the OOS situations, and how this phenomenon could affect the sales, generate losses to the suppliers and retailers (Bayle et al., 2006). Also these studies have more limitations. Some of the results do not allow showing generalized rules to explain or predict an OOS reaction behavior (Diels & Wiebach, 2011).

Moreover, these studies do not analyze the effect of the OOS situation in the sales behavior from of the retailers and suppliers, which is a valuable avenue for research, and it will be the perspective used in this paper.

Data and Methodology

In this study, Time series are used. Specifically, Vector Autoregressive Model to explaining the OOS phenomenon in a supermarket chain in Latin America, the generic product analyzed was liquid laundry with more than 200 different items in more than 400 stores; the data contains more than 100 weekly sales since July 2012.

The Vector Autoregressive models (VAR) are used to analysis of multivariate time series; to describe a dynamic behavior between two or more variables. This method is used mainly for forecasting and econometric studies. Also the VAR model could be used to analyze for structural inference and policy analysis (Zivot & Wang, Modeling Financial Time Series with S-PLUS® 2006, pp 385-429, Chapter 11). This model was proposed in 1980 by Sims. In 1987, Engle and Granger wrote about non-stationary of variables (Martins, 2010). A VAR model could handle responses for a dependent variable generated within the model, which could be utilized to understand a structural relationship among variables of the system under study (Sa-ngasoongsong & Bukkapatnam, 2012).

The unrestricted VAR model contains one equation for each variable and are considered endogenous, the variable most be treated symmetrically with the same set of regressors (Martins, 2010).

If we consider this form with k order VAR with p variables VAR (p):

$$y_t = A_1 y_{t-1} + \dots + A_p y_{t-p} + u_t$$

Where

- Yt is a set of endogenous variable with t = 1, 2, …, K
- Ai are matrices of parameters K x K with i = 1,2,…., p
- Ut as the vector of deterministic components with the vector of coefficients with E(Ut)=0 and the covariance matrix E(UtUt)=∑u (white noise).

The VAR (p) models assume that the parameters are constant over the time and linear.

The errors independent and normally distributed with correlation equal to 0.

The residual covariance matrix Ω with dimensions K x K

We need to asses if the model satisfies these properties to ensure a reliable statistical inference (Martins, 2010).

The matrix form can be represented by:

$$\xi_t = \begin{bmatrix} y_t \\ \vdots \\ y_{t-p+1} \end{bmatrix}, \quad A = \begin{bmatrix} A_1 & A_2 & \cdots & A_{p-1} & A_p \\ I & 0 & \cdots & 0 & 0 \\ 0 & I & \cdots & 0 & 0 \\ \vdots & \vdots & \ddots & \vdots & \vdots \\ 0 & 0 & \cdots & I & 0 \end{bmatrix}, \quad v_t = \begin{bmatrix} u_t \\ 0 \\ \vdots \\ 0 \end{bmatrix}$$

Where:

The stacked vector dimensions Єt and the Ut is (KPx1).

The dimension of matrix A is (Kp x Kp) considering the moduli of eigenvalues of A less than 1 to a VAR (p) stable.

When roots of the characteristic polynomial are less than 1 in absolute value, then the solutions converge when the time trends to infinity.

(|ρj| < 1)

To analyze the data VAR model was used R software; also identify the relationship between both variables: sales and out of stocks, this model determinates the degree of influence of out of stocks in sales behavior and identify the breakeven where the out of stocks has no influence on sales behavior for this study. The estimated sales are consequence of past sales and the out of stock observations presented over several weeks, where the sales is the dependent variable and the out of stocks are the independent variables.

Results

The analysis detected the number of lags for SC(n) is 2, the estimated sales as can be observed in Chart 1 the minimum value is in 2, this means the number of regressions that need to estimate the model, t = -2.

SC(n)	2

	1	2	3	4	5
SC(n)	4.383883e+01	4.325929e+01	4.332519e+01	4.330683e+01	4.338177e+01
	6	7	8	9	10
SC(n)	4.343980e+01	4.351055e+01	4.359201e+01	4.359821e+01	4.367333e+01

Chart 1.
SC(n) values

The estimated coefficients for the equation "RUN.SALES" are listed on Chart 2 and each variable indicates a two variables for the lag.

The equation for sales is:

V= aVt-1+bFt-1+cVt-2+dFt-2+e

Where V= SALES; F= OOS;

With the values found, we have:

V=(2.403e-01)Vt-1+(8.989)Ft-1+(6.985e-01)Vt-2-(2.881)Ft-2+6.455e+04

As can observe in Chart 2 the coefficients for SALESt-1 and SALESt-2 are significant this reflect that the sales are not lineal and behavior with one week high and one low. The coefficient of OOS is high but the significance is 0.05 for t-1 and no significance for t-2.

Estimation results for equation RUN.SALES:

	Estimate	Std. Error	t value	Pr(>|t|)
RUN.SALES.l1	2.403e-01	7.200e-02	3.337	0.0012 **
RUN.OOS.l1	8.989e+00	5.311e+00	1.693	0.0937 .
RUN.SALES.l2	6.985e-01	7.046e-02	9.913	<2e-16 ***
RUN.OOS.l2	-2.881e+00	5.397e+00	-0.534	0.5947
const	6.455e+04	1.518e+05	0.425	0.6717

*Signif codes: 0 '***'; 0.001 '**' ; 0.01 '*' ; 0.05 '.' ; 0.1 ' '; 1*

Residual standard error: 333700 on 97 degrees of freedom	
Multiple R-Squared: 0.8753,	**Adjusted R-squared: 0.8702**

Chart 2.
Estimation results for equation RUN.SALES

The R-squared for equation SALES shows that the model explains the 87% of the variance.

The estimated coefficients for the equation RUN.OOS are given by:
The equation for OOS is:

$$F= rVt-1+sFt-1+uVt-2+vFt-2+q$$

With the values found, we have: F=(-6.020e-04)Vt-1+(8.552e-01)Ft-1+(1.354e-04)Vt-2-(-6.401e-02)Ft-2+7.448e+03

The higher significance for coefficient OOSt-1 implicit a positive correlation, this means when the OOS in t-1 increase, the OOS in t increase too. When the OOS for t-2 increase, then the OOS for t decrease, however this shows no significance for the equation OOS.

Estimation results for equation RUN.OOS:

	Estimate	Std. Error	t value	Pr(>|t|)
RUN.SALES.l1	-6.020e-04	1.375e-03	-0.438	0.6624
RUN.OOS.l1	8.552e-01	1.014e-01	8.435	3.17e-13 ***
RUN.SALES.l2	1.354e-04	1.345e-03	0.101	0.9200
RUN.OOS.l2	-6.401e-02	1.030e-01	-0.621	0.5359
const	7.448e+03	2.899e+03	2.570	0.0117 *

*Signif codes: 0 '***'; 0.001 '**'; 0.01 '*'; 0.05 '.'; 0.1 ' '; 1*

Residual standard error: 6731 on 97 degrees of freedom
Multiple R-Squared: 0.6348, Adjusted R-squared: 0.6197
F-statistic: 42.15 on 4 and 97 DF, p-value: < 2.2e-16

Chart 3.
Estimation results for equation RUN.FALTANES

In this case for equation OOS, the model explain the 62% of the variance.

VAR Estimation Results:
========================
Endogenous variables: RUN.SALES, RUN.OOS
Deterministic variables: const
Sample size: 102
Log Likelihood: -2475.009
Roots of the characteristic polynomial:
0.9551 0.7794 0.7216 0.08252

Chart 4.
VAR Estimation Results

Given the roots of the characteristic polynomial less than 1, then assume that the solutions converge when time trends to infinity. Otherwise, the analysis found the breakeven on: SALES: 64,550; OOS: 7,448.

This represent the normal value of sales when the values of the variables on the equation sales are 0 and the maximum level of out of stocks that not influence on sales behavior.

Portmanteau Test (asymptotic)		
data: Residuals of VAR object var		
Chi-squared = 29,3758	df = 24	p-value = 0.2063

Chart 5
Portmanteau Test

Correlation matrix of residuals:		
	RUN.SALES	RUN.OOS
RUN.SALES	1.00000	-0.02646
RUN.OOS	-0.02646	1.00000

Chart 6.

Correlation matrix of residuals

Discussion and Summary

In the competitive retail market, customer service is one of the most important and essential principles that any organization requires. In this sense, the Latin American Retailer in this study focus on offering the merchandise at the right moment, in the right place and the correct quantity and quality. The previous situation requires an efficient supply chain that allows the flow of the products from the suppliers to the store shelves when the reality shows a lot of problems start in the supply chain. In order to support intrinsic inefficiencies in any supply chain, the retailers must carry a higher inventory cost to avoid great lost sales caused for OOS situations, which was the focus of this study.

Most of the previous literature provide a perspective of how the customer reacts facing an OOS situation (demand side), this study includes the understanding of retailers perspective (supply side). By including both perspectives, the relationship between sales behavior and OOS situations, it was possible to find the breakeven when the OOS situations has not influence on sales behavior.

The results show that the OOS situations observed are lower to breakeven, this imply that the retailer in the study have a high cost of unproductive inventory since the fact of having more inventory has not effect on sales behavior. Also, the study shows that sales can forecasted by considering two periods back. Otherwise, there is an interesting relationship between OOS and sales because the sales increase the OOS increase too, if the sales decrease, the OOS decrease again.

Direction for Future research

Although the study analyze the OOS situation in a Latin American supermarket chain the item category was laundry, the results can vary from one category to other. In particular laundry category is very sensitive to price. The results can vary depending on the region and the tree decision purchase for the category. The study did not consider more product categories because want to obtain more specifically conclusions. Future research can consider some interesting challenge with more complex model that can define the influence for other variables.

Acknowledgments

The authors want to specially thank to Anel Calderón, Hannalí Silva, Erick Talavera, Roberto Trigueros and Liu Xuedong for the important contributions to this research paper.

References

Aastrup, J., & Kotzab, H. (2009). Analyzing out-of-stock in independent grocery stores: an empirical study. *International Journal of Retail & Distribution Management*, *37*(9), 765–789. doi:10.1108/09590550910975817

Aastrup, J., & Kotzab, H. (2010). Forty years of Out-of-Stock research – and shelves are still empty, *20*(1), 147–164. doi:10.1080/09593960903498284

Angerer, A. (2005). The Impact of Automatic Store Replenishment Systems on Retail, (3123).

Bagliano, F., & Favero, C. A. (1998). Measuring Monetary Policy with VAR Models : an Eevaluation, (December 1997).

Bayle, A., Laurent, G., & Macé, sandrine. (2006). Assessing the Frequency and Causes of Out-of-Stock Events Through Store Scanner Data, 1–47.

Bell, D. R., & Fitzsimons, G. J. (1999). An Experimental and Empirical Analysis of Consumer Response to Stockouts Preliminary Draft : Comments Welcome An Experimental and Empirical Analysis of Key Words : Stockouts ; Choice Models ; Satisfaction ; Retail Competition.

Breugelmans, E., Campo, K., & Gijsbrechts, E. (1981). Investigating consumer behavior in an online grocery context: The impact of the adopted stock-out policy and virtual shelf placement. *Itinerario*. Retrieved from http://journals.cambridge.org/abstract_S0165115300023299

Brujó, G., & Matias, A. (2014). Best Mexican retail brands. *Interbrands*. Retrieved from http://scholar.google.com/scholar?hl=en&btnG=Search&q=intitle:No+Title#0

Campo, K., Gijsbrechts, E., Nisol, P., & Modelling, S. M. (2000). The Impact of Stock-Outs on Whether , How Much and What to Buy The Impact of Stock-Outs on Whether , How Much and What to Buy, 1–50.

Capizzani, M., Ramirez, F., & Rocha, P. (2012). RETAIL IN LATIN AMERICA : TRENDS , CHALLENGES AND OPPORTUNITIES RETAIL IN LATIN AMERICA : TRENDS , CHALLENGES AND OPPORTUNITIES, 3.

Che, H., Chen, J., & Chen, Y. (2012). Investigating Effects of Out-of-Stock on Consumer SKU Choice Investigating Effects of Out-of-Stock on Consumer SKU Choice Introduction.

Cho, Y. H., Kim, J. K., & Kim, S. H. (2002). A personalized recommender system based on web usage mining and decision tree induction. *Expert Systems with Applications*, *23*(3), 329–342. doi:10.1016/S0957-4174(02)00052-0

Chopra, S., & Van Mieghem, J. (2000). PERFORMANCE RELATIONSHIP STRATEGY TECHNOLOGY Needed : A Strategic Framework, 32–40.

Connie, K., & Kok, G. de T. (2000). A SAFETY STOCK ADJUSTMENT PROCEDURE TO ENABLE TARGET SERVICE LEVELS IN SIMULATION OF GENERIC INVENTORY SYSTEMS, 1–30.

Diels, J. L., & Wiebach, N. (2011). Customer Reactions in Out-of-Stock Situations – Do promotion-induced phantom positions alleviate the similarity substitution hypothesis?

Dominguez, E., & Zabaleta, I. (2010). Un Modelo Var aplicado al empleo y las horas de trabajo, *52*, 5–29.

Doukidis, G., & Vrechopoulos, A. (2005). *Consumer Driven Electronic Transformation*. Retrieved from http://link.springer.com/content/pdf/10.1007/b138555.pdf

Dubas, K., Hershey, L., Nijhawan, I., & Mehta, R. (2011). Breakeven and profitability analyses in marketing management using R software. *Businessperspectives.org*, *7*(3), 51–61. Retrieved from http://www.businessperspectives.org/journals_free/im/2011/im_en_2011_03_Dubas

Emmelhainz, M., James, S., & Emmelhainz, L. (1991). Consumer Response to Retail Stock-outs.

Europe, E. (2003). ECR-optimal shelf availability: increasing shopper satisfaction at the moment of truth. Retrieved from http://scholar.google.com/scholar?hl=en&btnG=Search&q=intitle:ECR+–+OPTIMAL+SHELF+AVAILABILITY+INCREASING+SHOPPER+SATISFACTION+AT+THE+MOMENT+OF+TRUTH#0

Fitzsimons, G. J. (2001). Consumer Response to Stockouts.

Fernie, J., and D.B. Grant. 2008. On-shelf availability: The case of a UK grocery retailer. The International Journal of Logistics Management 19, no. 3: 293–308.

Gruen, T., & Corsten, D. (2008). *A comprehensive Guide To Retail Reduction In the Fast-Moving Consumer Goods Industry To Retail Out-of-Stock Reduction In the Fast-Moving Consumer Goods Industry*.

Gruen, T., Corsten, D., & Bharadwaj, S. (2002a). Retail Out of Stocks : A Worldwide Examination of Extent , Causes , and Consumer Responses.

Gruen, T., Corsten, D., & Bharadwaj, S. (2002b). Retail Out of Stocks: A Worldwide Examination of Extent, Causes and Consumer Responses.

Helm, R., & Hegenbart, T. (2011). Costumer reactions to real out-of-stocks.

Herpen, E., Nierop, E., & Sloot, L. (2011). The relationship between in-store marketing and observed sales for organic versus fair trade products. *Marketing Letters*, *23*(1), 293–308. doi:10.1007/s11002-011-9154-1

Hess, J & Gerstner E (1987). Loss Leader Pricing and Rain Check Policy Page Range: 358 – 374. http://dx.doi.org/10.1287/mksc.6.4.358

Kucuk, S. U. (2004). Reducing the Out-of-Stock Costs in a Developing Retailing Sector. *Journal of International Consumer Marketing*, *16*(3), 75–104. doi:10.1300/J046v16n03_05

Liberopoulos, G., & Tsikis, I. (2008). Do stockouts undermine immediate and future sales ? Do stockouts undermine immediate and future sales ?, (April).

Luetkepohl, H. (2011). VECTOR AUTOREGRESSIVE MODELS.

Martins, P. M. G. (2010). Fiscal Dynamics in Ethiopia : The Cointegrated VAR Model with Quarterly Data by Fiscal Dynamics in Ethiopia : The Cointegrated VAR Model with Quarterly Data, (10).

McKinnon, A.C., D. Mendes, and M. Nabateh. 2007. In-store logistics: An analysis of on shelf availability and stock out response for three product groups. International Journal of Logistics: Research and Applications 10, no. 3: 251–68.

Liu Sun, X. (n.d.). Tasa de interés y ajuste cambiario bajo el régimen de metas inflacionarias Caso empírico de México, 1998-2012.

Miranda, P. a., & Garrido, R. a. (2009). Inventory service-level optimization within distribution network design problem. *International Journal of Production Economics*, *122*(1), 276–285. doi:10.1016/j.ijpe.2009.06.010

Models, I. C. (2013). Inventory Control Models 12, 1–39.

Peckham, J. (1963). The Consumer speaks. Journal of Marketing, 27(4), 21–26.

Pfaff, B. (2008). VAR, SVAR and SVEC models: Implementation within R package vars. *Journal of Statistical Software*, (2006). Retrieved from http://vps.fmvz.usp.br/CRAN/web/packages/vars/vignettes/vars.pdf

Progressive Grocer. 1968a. The out of stock study, Part 1. October: 1–16. New York: The Nielsen Company.

Progressive Grocer. 1968b. The out of stock study, Part 2. November: 17–32. New York: The Nielsen Company.

Ofenbakh, I. (n.d.). Report on inventory analytics: Reducing lost revenue due to out of stock inventory.

Sa-ngasoongsong, A., & Bukkapatnam, S. T. S. (2012). Automobile Sales Modeling using Granger-Causality Graph with PROC VARMAX in SAS, 1–10.

Schary, P.B., and M. Christopher. 1979. The anatomy of a stock-out. Journal of Retailing 55, no. 2: 59–70.

Scott, L. 2006. Wal-Mart: Living up to new expectations. ECR Journal 6, no. 1: 8–18.

Shivsharan, C. (2012). Optimizing the Safety Stock Inventory Cost Under Target Service Level Constraints, (May). Retrieved from http://scholarworks.umass.edu/theses/822/

Shycon, H., & Sprague, C. (1975). Put a price tag on your customer servicing
Sims, C., & Wold, T. (n.d.). Chapter 4 : VAR Models, 103–152.
Spielmaker, K. J. (2012). On Shelf Availability in Retailing : A Literature Review and Conceptual Framework, 1–20.
Stevenson, W. J. (2005). Operations Management, (3).
Teece, D. J. (2010). Business models, business strategy and innovation. *Long Range Planning*, *43*(2-3), 172–194.
Teece, D. J., Pisano, G., & Shuen, A. (1997). Dynamic capabilities and strategic management. *Strategic Management Journal*, *18*(7), 509–533. doi:10.1002/(SICI)1097-0266(199708)18:7<509::AID-SMJ882>3.0.CO;2-Z
The Vector autoregressive model. (n.d.) (pp. 58–67). Retrieved from *http://books.google.com/books?hl=en&lr=&id=ff4BAQAAQBAJ&oi=fnd&pg=PR1&dq=Handbook+of+Research+Methods+and+Applications+in+Empirical+Macroeconomics&ots=79A0l9z6D8&sig=7KVgiV-76EjODDJADOCLbnXH89k*
Van Woensel, T., K. van Donselaar, R. Broekmeulen, and J. Franso. 2007. Consumer responses to shelf out-of-stocks of perishable products. International Journal of Physical Distribution & Logistics Management 37, no. 9: 704–18.
Verbeke, W., Farris, P., & Thurik, R. (1998). Consumer response to the preferred brand out-of-stock situation. *European Journal of Marketing*. Retrieved from http://www.emeraldinsight.com/journals.htm?issn=0309 0566&volume=32&issue=11/12&articleid=853575&articletitle=Consumer+response+to+the+preferred+brand+out-of-stock+situation
Walter, Z., & Liu, P. C. (2001). Consumer Response To retail Stockouts, *22*(1), 49–72.
Yin, R. K. (2009). *Case Study Research: Design and Methods*. (L. Bickman & D. J. Rog, Eds.)*Essential guide to qualitative methods in organizational research* (Vol. 5, p. 219). Sage Publications. doi:10.1097/FCH.0b013e31822dda9e
Zivot, E., & Wang, J. (2006). Vector Autoregressive Models for Multivariate Time Series. *Modeling Financial Time Series with S-PLUS®*, 383–427. Retrieved from http://link.springer.com/chapter/10.1007/978-0-387-32348-0_11