

Multivariate Analysis of the Determinants of Retail Infant Formula Prices

Although the event study analysis described earlier strongly suggests that being the WIC contract brand leads to higher retail prices relative to the noncontract brands, the analysis has several limitations. First, it examines changes in price over a relatively short period—from shortly before to shortly after a change in the holder of the WIC contract. The analysis does not indicate if the positive effect that being the WIC contract holder has on the price of infant formula holds up over longer periods: a more thorough analysis requires that differences in infant formula retail prices by WIC contract status be examined over a longer period. Second, the event study analysis looks only at market areas in which the WIC contract brand changed over the 1994-2000 study period. Thirteen of the 54 market areas in which a WIC brand was designated did not experience a change in the milk-based contract brand during the study period while 17 market areas did not experience a change in the soy-based contract brand. A methodology that can also examine market areas with no changes in the WIC contract holder would support broader conclusions. Third, the event study analysis does not control for other factors that may have influenced changes in infant formula prices by brand. The possible confounding effects of these various factors must be disentangled in order to definitively determine the relationship between WIC contract brand status and retail price.

In order to assess the quantitative relationship between the WIC infant formula rebate program and retail infant formula prices within individual market areas over the entire 1994-2000 study period, a multivariate regression analyses was used. Multivariate regression analysis is a statistical tool used to study the statistical dependence of a variable, called the dependent variable, on two or more other variables, called explanatory or independent variables. It measures the net effect of an independent variable on the dependent variable, given that other independent variables are in the model. It has the benefit of simultaneously controlling for multiple factors that may influence the retail price of infant formula, such as the wholesale price of infant formula, consumer income, and the presence of discount stores. (See appendix C for a discussion of the theoretical basis of the regression model.)

The Regression Model

The dependent variable in the model was the average real (i.e., inflation-adjusted) retail price of infant formula in supermarkets in a particular market area. Since retail prices may be influenced by a number of factors, it is important to control for as many of these confounding factors as possible when assessing the quantitative relationship between WIC's infant formula rebate system and the retail price of formula. Therefore, the model included a number of independent variables to represent economic, demographic, and WIC program factors thought to influence the retail price of infant formula (table 9-1). These independent variables included the median household income in the area, the poverty rate, the wholesale price of infant formula, the presence of Wyeth and PBM infant formula products, and a measure of number of discount stores (see appendix E for detailed information on the construction of the variables used in the model).¹ One potential complicating factor to modeling factors influencing the retail price of infant formula is

¹ While a market area's median household income and its poverty rate may be (negatively) correlated, both variables are included in the regression model. The former measures the income level at which a market area's income distribution is centered while the latter reflects the shape of the income distribution; in principle, either variable can change separately from the other and both variables can affect infant formula retail prices.

Table 9-1—The independent variables included in the regression analyses

Variable	Hypothesized effect on retail infant formula prices
Wholesale price	The greater the wholesale price of infant formula, the greater the costs to the retail store, and the greater the expected retail price.
Discount stores	The greater the number of discount stores (who also sell infant formula) per 100,000 residents, the greater the competition for the infant formula market and the lower the expected retail price.
Supermarket concentration	Higher supermarket concentration (i.e. the greater the degree to which a few supermarket chains dominate the market in an area), means less competition and higher retail prices.
Household income	The greater the household income in the market area, the greater the expected retail price of formula.
Poverty rate	The greater the poverty rate in the market area, the lower the expected retail price.
Presence of Wyeth	The presence of Wyeth brand formulas in the market area is expected to increase competition and lower retail prices.
Presence of private label	The presence of lower priced private label formula is expected to increase competition and lower retail prices.
Relative size of WIC if contract brand	The larger the size of the WIC program, the greater its influence on the infant formula market, and the higher the retail price of the contract brand.
Relative size of WIC if noncontract brand	The larger the size of the WIC program, the higher the retail price of the noncontract brand.
Change in contract brand	The more times the WIC contract brand has changed, the greater the retail price of formula.

that infant formula, unlike most products, is often used as a loss leader by retailers in order to bring customers into the store (see discussion of loss leaders in Chapter 7—Infant Formula Prices and Availability by Market Area). The model for this study specifically included an independent variable believed to be an important factor in explaining the use of loss leaders—the degree of supermarket concentration in an area.²

Three independent variables were included to help assess the influence of the WIC program or its infant formula rebate program on the retail price of formula. Two of these variables are intended to reflect the influence of the WIC program in an area, as measured by the relative size of the WIC program, where:

relative size of WIC = the number of WIC formula-fed infants in the State containing the market area / the number of non-WIC formula-fed infants in the State containing the market area.

Note that *relative size of WIC* reflects the size of the WIC formula-fed infant population relative to the size of the non-WIC formula-fed infant population and not the absolute number of WIC formula-fed infants in an area. For example, a value of 0.50 indicates that the number of WIC formula-fed infants in a State is half the number of non-WIC formula-fed infants, a value of 1 indicates that the number of WIC formula-fed infants equals the number of non-WIC formula-fed infants, and a value of 2 indicates that the number of WIC formula-fed infants is twice the number

² See appendix C for further information on the rationale behind the inclusion of this variable in the model.

of non-WIC formula-fed infants.³ The mean value of *relative size of WIC* for the market areas included in the regression analysis over the 1994-2000 period was 1.14 (fig. 9-1). The mean value for the *relative size of WIC* variable by individual market areas during the study period ranged from 0.59 (Denver) to 2.36 (Knoxville and Nashville).⁴ The lowest value for the relative size of WIC variable across all market areas in any one quarter was 0.42, while its highest value was 4.2. These values are used below to depict graphically the minimum and maximum effects of the *relative size of WIC* variable.

The first WIC-related variable included in the model—*relative size of WIC if contract brand*—represents the relative size of the WIC program interacted with the contract brand status (where contract brand status = 1 if contract brand and contract brand status = 0 if noncontract brand). The coefficient for *relative size of WIC if contract brand* derived from the regression analysis is expected to be positive. The rationale for this hypothesis is that winning the WIC contract will increase the demand for the contract brand of formula since WIC recipients must obtain the WIC brand of formula with their vouchers. Furthermore, since these WIC recipients receive the formula for free with their vouchers, they are price insensitive—i.e. they do not respond to changes in price.⁵ The greater the number of these price-insensitive WIC formula-fed infants relative to non-WIC formula-fed infants, the greater the likelihood that retailers (i.e., authorized WIC vendors) will respond by increasing the retail price of the contract brand.⁶ Retailers cannot increase the price of the contract brand too much, however, or else non-WIC consumers who prefer the contract brand of formula will switch to some other lower priced brand or possibly shop for formula in a lower price store.⁷ However, the greater the ratio of WIC to non-WIC infants in an area, the less the vendor needs to be concerned about these non-WIC consumers.⁸

Changes in *relative size of WIC* may also affect the price of the noncontract brands of formula. If the price of the contract brand of formula increases as *relative size of WIC* increases, economic theory would suggest that the price of the noncontract brand of formula may increase as well. This is because the contract brand of formula is a substitute for the noncontract brand of formula for non-WIC households, and the higher the price of a commodity's substitutes, the more that retailers can increase the commodity's price.⁹ That is, a high price associated with the contract brand of formula could induce some non-WIC consumers who were purchasing the contract brand of formula to switch to a lower price substitute formula—i.e., a noncontract brand. This increase in demand for the noncontract brand may lead to retailers increasing its price. The extent to which

³ The *relative size of WIC* variable is a ratio of formula-fed WIC infants to formula-fed non-WIC infants. An alternative measure of the prevalence of formula-fed WIC infants in a market area is the share of those infants in comparison to all formula-fed infants. The former specification was adopted in part to incorporate a hypothesized nonlinear price responsiveness. Preliminary analysis suggested that the two specifications yielded similar qualitative results for the range of data under study.

⁴ These figures represent the values of the *relative size of WIC* variable by market areas averaged over the 1994-2000 study period. However, in the regression analyses, *relative size of WIC* was calculated separately by market area for each of the 27 quarters.

⁵ In economic terms, the effect of winning the WIC contract is to shift the demand curve for the contract brand of formula to the right and make it steeper (i.e., more price inelastic).

⁶ This cause-effect relationship—that the relative size of WIC affects retail infant formula prices—is the basis of the report's statistical analysis. The analysis supposes that, in the range of infant formula prices observed for 1994-2000, price changes do not affect WIC participation. See appendix C for more detail.

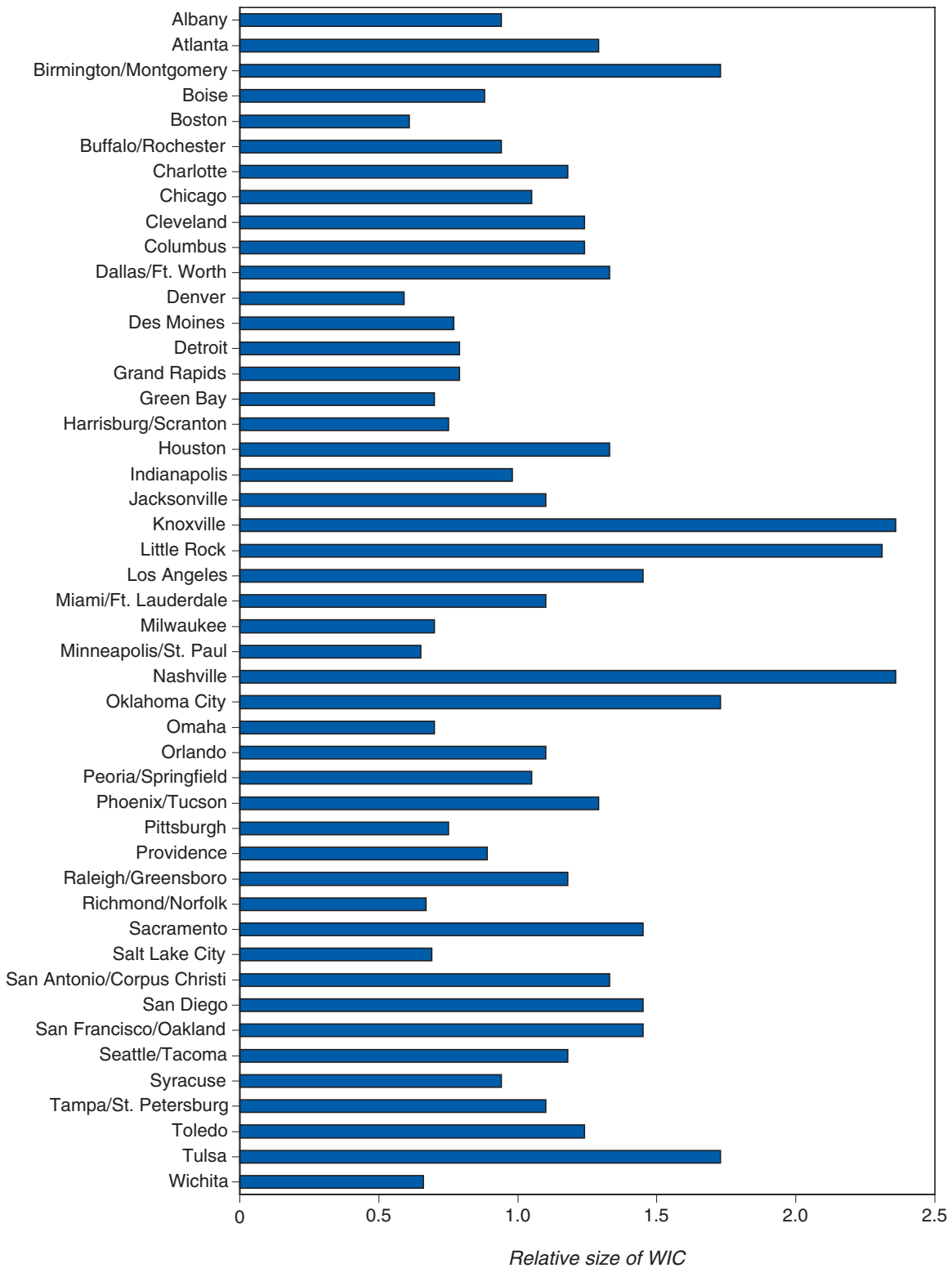
⁷ WIC may also place restrictions on how much WIC vendors can charge for the contract brand of infant formula. See the following chapter for further discussion.

⁸ That is, the increase in revenue from increasing the price to WIC consumers will outweigh the loss in revenue from non-WIC consumers switching to another alternative.

⁹ In economic terms, the higher the price of substitutes, the steeper (i.e., more price inelastic) the demand curve for a particular brand of infant formula.

Figure 9-1

Relative size of WIC by market area, 1994-2000 averages



Note: *Relative size of WIC* reflects the size of the WIC formula-fed infant population relative to the size of the non-WIC formula-fed infant population. Values reported represent the mean value of the *relative size of WIC* variable during 1994-2000 reference period.

retailers can increase the price of the noncontract brand of formula depends on the price of the contract brand of formula and consumers' willingness to switch forms, brands, outlets, and/or breastfeed.¹⁰ Therefore, the coefficient for the second WIC-related variable—*relative size of WIC if noncontract brand*—derived from the regression analysis is also expected to be positive.¹¹ Both the *relative size of WIC if contract brand* variable and the *relative size of WIC if noncontract brand* variable were included in the regression model because the price effects of *relative size of WIC* are expected to be larger for the contract brand than the noncontract brand.

The third WIC-related variable—*change in contract brand*—measured for a given quarter the number of times the WIC contract had changed in a market area over the 1994-2000 period.¹² This variable was included in the model to determine if a change in the WIC contract holder acts as a “trigger event” that results in retailers reassessing and possibly increasing the price of the all infant formula brands, contract and noncontract brands alike. That is, a change in the WIC contract brand may signal to retailers of an opportune time to increase the retail price of infant formula. The reason retailers do not raise prices during other times of the year (or at least not to the same degree as when the WIC contract brand changes) is that if one retailer increases its prices and the others do not, the first retailer may lose some of the market to the others. That is, no “trigger event” signals to all retailers simultaneously that this is the time to increase prices. If the major super-market retailers in an area increase their prices of formula similarly, revenue for all the retailers will increase (as long as they don't increase prices excessively and lose customers to lower priced mass merchandisers).

Separate regression models were run for real prices of infant formula made by each of the three manufacturers currently holding WIC contracts—Mead Johnson, Ross, and Carnation—by each of the four product base/physical form categories—milk-based powder, milk-based liquid concentrate, soy-based powder, and soy-based liquid concentrate—for a total of 12 separate regressions. The retail price of formula was based on InfoScan supermarket data from the first quarter of 1994 to the third quarter of 2000. Within each market area, each quarter represents a separate observation. The data were restricted to the 47 market areas in which a WIC contract brand was designated and at least 90 percent of the area's population resided in one State.¹³

Regression Results

This section focuses on the statistical results of the regression analysis that deal specifically with the WIC-related variables. See appendix D for descriptive statistics on all the variables included in the model as well as complete results of the regression analyses. Regression coefficients were considered to be statistically significantly different from zero at the 5 percent level of significance.

Effect of *relative size of WIC if contract brand* on retail prices. The results of the regression analyses show that, after controlling for other factors, *relative size of WIC if contract brand* had a statistically significant positive effect on the retail price of the contract brand of formula. Specifi-

¹⁰ Given the small number of infant formula manufacturers, consumers have only a limited (although increasing) number of alternatives available.

¹¹ The variable *relative size of WIC if noncontract brand* represents the *relative size of WIC* interacted with the *contract brand status* where *contract brand status* = 0 if contract brand and *contract brand status* = 1 if noncontract brand.

¹² The milk-based contract brand changed in 42 market areas during the study period, including 9 market areas in which the WIC contract brand changed twice. The soy-based contract brand changed in 38 market areas during the study period, including 9 market areas in which the WIC contract brand changed twice.

¹³ Since some of the independent variables included in the model represent the characteristics of an individual State (such as relative size of WIC), those market areas in which more than 10 percent of the population lived in a different State were excluded from the regression analysis.

cally, an increase in the percentage of a State's infant formula-fed population participating in WIC was statistically associated with an increase in the retail price of the contract brands of formula. Figures 9-2 to 9-13 present this result graphically by product base, product form, and brand and show the estimated prices of formula at the minimum, mean, and maximum values of *relative size of WIC*. Using Mead Johnson's contract brand of milk-based powdered formula as an example, having a *relative size of WIC* of 0.42 (the minimum value among all market areas and periods) results in a retail price of \$2.37 (26 ounces reconstituted) compared with a price of \$2.45 for an area that had a *relative size of WIC* value of 1.14 (the mean across market areas and periods), and a price of \$2.82 for an area with *relative size of WIC* of 4.20 (the maximum value among all markets areas and periods), while controlling for all other factors (fig. 9-2).

Stated another way, increasing the *relative size of WIC* from 1.0 (where the number of WIC formula-fed infants equals the number of non-WIC formula-fed infants in an area) to 2.0 (where the number of WIC formula-fed infants is twice the number of non-WIC formula-fed infants in an area) results in a 11.9-cent increase in the retail price of the Mead Johnson milk-based formula (per 26 reconstituted ounces) in a market area in which it has the WIC contract. The finding that the retail price of the WIC contract brand of formula increases as relative size of WIC increases held for each of the 12 different types and brands of the contract brand of formula.¹⁴

Effect of *relative size of WIC* if noncontract brand on retail prices. The regression results show that the greater the *relative size of WIC*, the greater the price of noncontract formula (figs. 9-2 to 9-13). Once again using Mead Johnson's milk-based powdered formula as an example, having a *relative size of WIC* of 0.42 results in a retail price of \$2.36 (26 ounces reconstituted) compared with a price of \$2.43 for an area that had a *relative size of WIC* value at the mean of 1.14, and a price of \$2.74 for an area with *relative size of WIC* of 4.20, while controlling for all other factors (fig. 9-2). In other words, increasing the *relative size of WIC* from 1.0 (where the number of WIC formula-fed infants equals the number of non-WIC formula-fed infants in an area) to 2.0 (where the number of WIC formula-fed infants is twice the number of non-WIC formula-fed infants in an area) results in a 10.04-cent increase in the retail price of Mead Johnson formula (per 26 reconstituted ounces) in a market area in which it does not have the WIC contract. This finding of a positive, statistically significant coefficient was consistent across all brands, product bases, and forms, with the exception of the two Carnation soy-based formulas.¹⁵

Contract brand status effect on retail prices. As discussed above, an increase in the *relative size of WIC* variable on the noncontract brand usually resulted in increased prices for both the contract and noncontract brands of formula. However, in general, the effect of *relative size of WIC* on the noncontract brand was less than its effect on the contract-brands. That is, holding all other factors constant, being the contract brand of formula results in higher retail prices compared with the noncontract brand of formula for most of the different types/brands of formula. An implication of this result is that, holding other factors constant, at any given level of *relative size of WIC*, a manufacturer's brand of formula has a higher retail price when it is the contract brand than when it is the noncontract brand. This price difference is referred to as the contract brand effect.

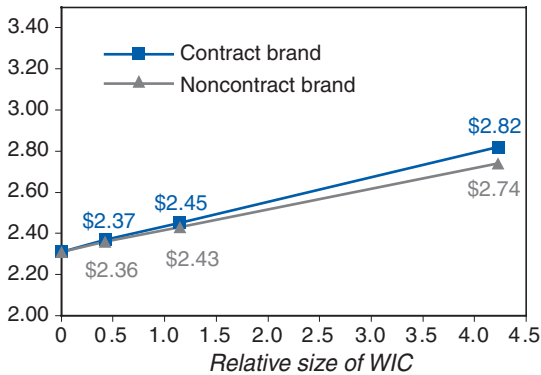
¹⁴ While the regression results indicate that *relative size of WIC* affects the retail price of infant formula, so do other variables. As a result, one should not conclude that, since *relative size of WIC* increases retail price, the retail price in an area where *relative size of WIC* is high (e.g., Nashville, TN) will necessarily be higher than an area where relative size of WIC is low (e.g., Denver, CO). Any price difference between the two areas is affected by *relative size of WIC* along with other independent variables (for example, *median household income* and *poverty rate*) that jointly influence price.

¹⁵ The effect of the *relative size of WIC* variable if noncontract brand on the retail price of Carnation's soy-based powder and liquid concentrate formulas was not statistically different from zero.

Figure 9-2

Retail price of infant formula by relative size of WIC and contract brand status: Mead Johnson, milk-based, powder

Dollars per 26 reconstituted ounces

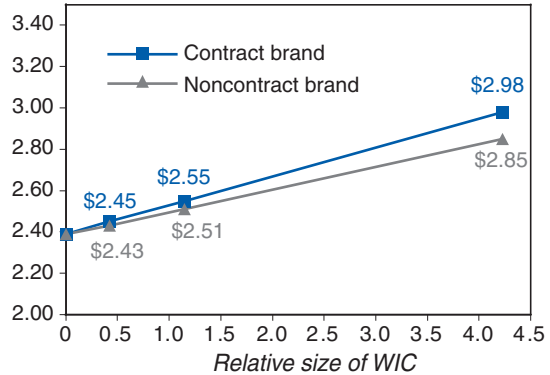


Source: ERS analysis of InfoScan supermarket data.

Figure 9-3

Retail price of infant formula by relative size of WIC and contract brand status: Ross, milk-based, powder

Dollars per 26 reconstituted ounces

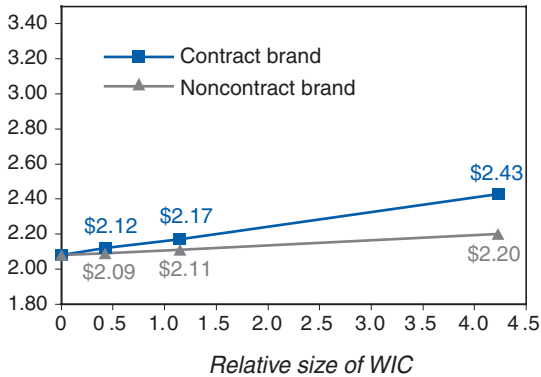


Source: ERS analysis of InfoScan supermarket data.

Figure 9-4

Retail price of infant formula by relative size of WIC and contract brand status: Carnation, milk-based, powder

Dollars per 26 reconstituted ounces

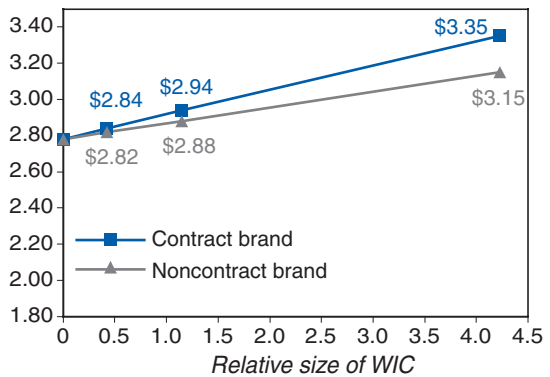


Source: ERS analysis of InfoScan supermarket data.

Figure 9-5

Retail price of infant formula by relative size of WIC and contract brand status: Mead Johnson, milk-based, liquid concentrate

Dollars per 26 reconstituted ounces

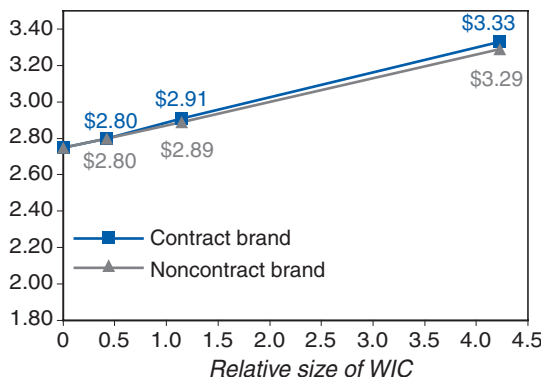


Source: ERS analysis of InfoScan supermarket data.

Figure 9-6

Retail price of infant formula by relative size of WIC and contract brand status: Ross, milk-based, liquid concentrate

Dollars per 26 reconstituted ounces

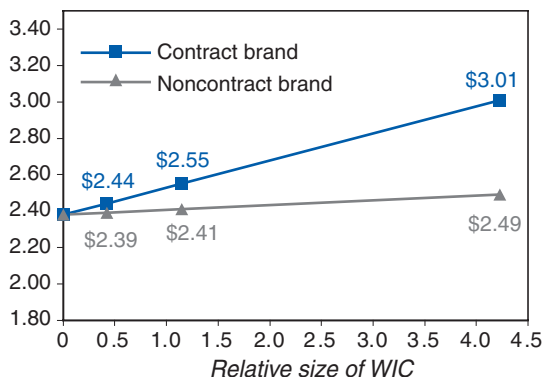


Source: ERS analysis of InfoScan supermarket data.

Figure 9-7

Retail price of infant formula by relative size of WIC and contract brand status: Carnation, milk-based, liquid concentrate

Dollars per 26 reconstituted ounces

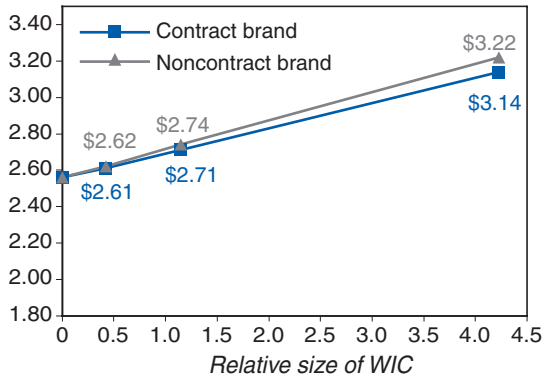


Source: ERS analysis of InfoScan supermarket data.

Figure 9-8

Retail price of infant formula by relative size of WIC and contract brand status: Mead Johnson, soy-based, powder

Dollars per 26 reconstituted ounces

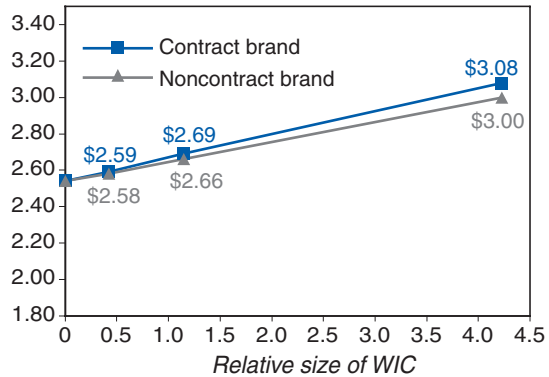


Source: ERS analysis of InfoScan supermarket data.

Figure 9-9

Retail price of infant formula by relative size of WIC and contract brand status: Ross, soy-based, powder

Dollars per 26 reconstituted ounces

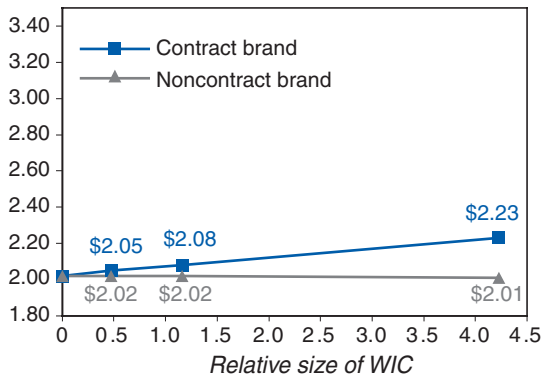


Source: ERS analysis of InfoScan supermarket data.

Figure 9-10

Retail price of infant formula by relative size of WIC and contract brand status: Carnation, soy-based, powder

Dollars per 26 reconstituted ounces

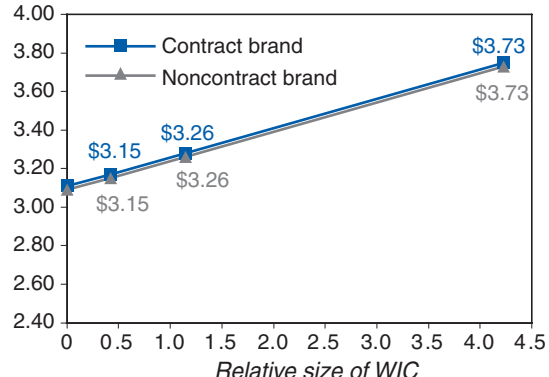


Source: ERS analysis of InfoScan supermarket data.

Figure 9-11

Retail price of infant formula by relative size of WIC and contract brand status: Mead Johnson, soy-based, liquid concentrate

Dollars per 26 reconstituted ounces

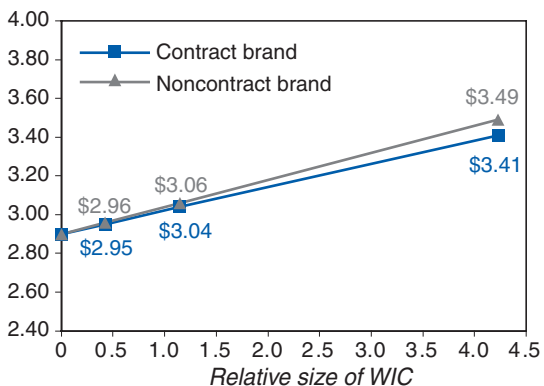


Source: ERS analysis of InfoScan supermarket data.

Figure 9-12

Retail price of infant formula by relative size of WIC and contract brand status: Ross, soy-based, liquid concentrate

Dollars per 26 reconstituted ounces

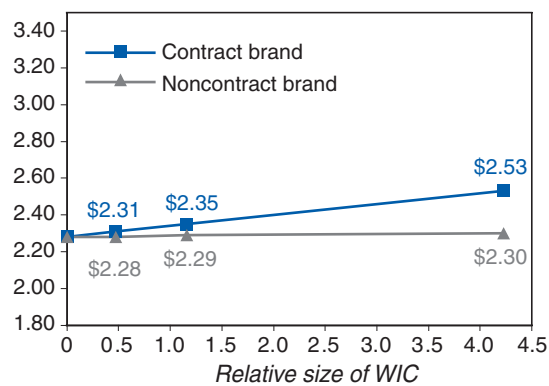


Source: ERS analysis of InfoScan supermarket data.

Figure 9-13

Retail price of infant formula by relative size of WIC and contract brand status: Carnation, soy-based, liquid concentrate

Dollars per 26 reconstituted ounces



Source: ERS analysis of InfoScan supermarket data.

This contract brand effect is shown in figures 9-2 to 9-13 as the difference between the line representing the contract brand and the line representing the noncontract brands. For example, the effect of being the contract brand of formula on Mead Johnson's milk-based powdered formula, evaluated at the mean size of WIC of 1.14 is the difference between \$2.45 (for the contract brand) and \$2.43 (for the noncontract brand) or 2 cents (shown in fig. 9-2). For five of the six types of milk-based formulas, being the contract brand was associated with statistically significant higher retail prices (the difference in the retail price of Ross' liquid concentrate formula when it was the contract brand was not significantly different from the price when it was the noncontract brand). This contract brand effect was especially noticeable for the Carnation brands (e.g., being the contract brand increased the retail price of Carnation's milk-based liquid concentrate, evaluated at the mean size of WIC of 1.14, by 14 cents per 26 reconstituted ounces). In total for milk-based formula, these results support the findings from the event-study analysis of prices—winning the WIC contract brand of formula leads to higher retail prices relative to the noncontract brands of formula.

The effect of contract brand status on retail prices was less clear among soy-based formulas than among milk-based formulas. For three of the six types of soy-based formula—Ross' powdered formula and Carnation's powdered and liquid concentrate formula—being the contract brand was associated with significantly higher retail prices. Similar to the results for the milk-based formulas, the greatest effect of being the contract brand was on the Carnation brands of formula (about 6 cents for both the powdered and liquid concentrate evaluated at the mean 1.14 size of WIC). For one type of formula—Mead Johnson's soy-based powder—the effect of being the WIC contract brand was to lower the retail price, a result that is unexplained. The contract brand effect for the Mead Johnson and Ross liquid concentrate brands was not statistically significant.

The average contract brand effect across the three manufacturer's brands, two product bases, and two product forms was estimated for summary purposes. When measured at the mean 1.14 *relative size of WIC*, the average contract brand effect was 2.5 cents.

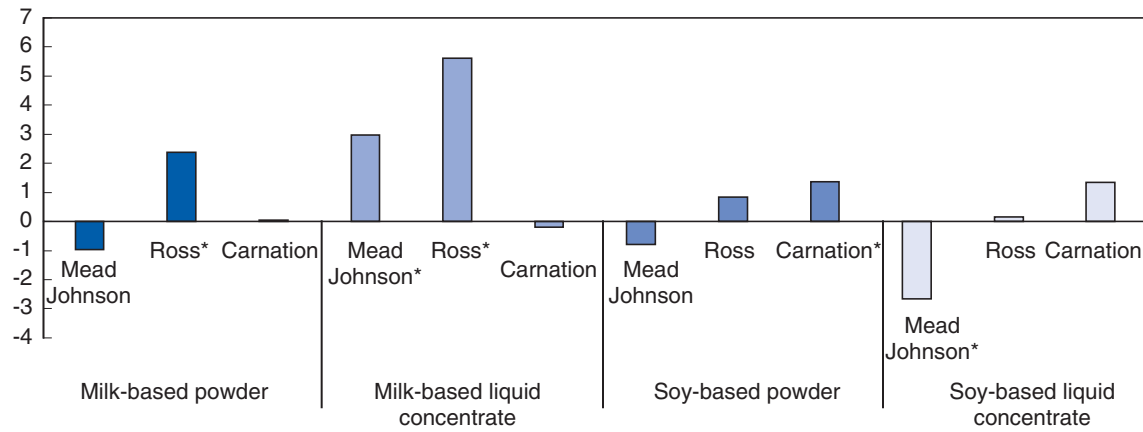
Effect of change in contract brand on retail prices. The regression model included the variable *change in contract brand* that represented a count, by quarter, of the number of times the WIC contract brand changed in a market area over the course of the 1994-2000 study period. This "trigger event" variable was found to have a statistically significant effect on retail prices for some but not all of the formulas (fig. 9-14). A change in the contract brand, holding other factors constant, was associated with an increase in the price of Ross milk-based powder (by 2.37 cents per change), and the milk-based liquid concentrate brands of Mead Johnson (2.98 cents per change) and Ross (5.61 cents per change) formulas. A change in the contract brand was also associated with an increase in the retail price of Carnation soy-based brand powder (1.36 cents per change). For unknown reasons, a change in the WIC contract brand was also associated with a decrease in the price of Mead Johnson's soy-based liquid concentrate formula of 2.67 cents. The effect of a change in the contract brand for the other types of infant formulas was not statistically significant.

Despite the statistically significant results associated with this variable for some of the formulas, it does not necessarily mean that consumers in market areas with many contract brand changes pay more for infant formula *in the long run* than consumers in market areas with few or no contract brand changes, even after controlling for other factors. Retailers may be using a change in the WIC contract brand as an occasion to re-evaluate their pricing of formula, and introduce price increases (for both the contract and noncontract brands) that otherwise would have occurred anyway (i.e., even in the absence of a change in the WIC contract brand) over a longer period, in smaller increments, and at different times by different retailers. A change in the contract brand in an area may concentrate price changes by the different retailers into the same short period. The difference in the pricing patterns between market areas that experienced changes in contract brand and those that did not experience a change may be only a difference in the timing of the increments in retail price.

Figure 9-14

Change in retail price of infant formula due to a change in the WIC contract brand

Cents per can



* = statistically significant.

Source: ERS analysis of InfoScan supermarket data.