Appendix D—Detailed Regression Results

This appendix considers in detail the statistical results from regression models that examine the economic, demographic, and programmatic factors that affect the supermarket retail prices of infant formula. The quantity "unit" for which all price data are calculated is a 26-ounce reconstituted equivalent.[1]

The sample means, minimum values, and maximum values of the variables used in the regressions are presented in appendix tables D-1 and D-2 for milk-based and soy-based formula price regressions, respectively. Most of the price regressions contained a sample size of 1,261 observations.[2] The dependent mean values are averages across market areas and periods of inflation-adjusted supermarket retail prices, measured in cents. The variable *relative size of WIC if contract brand* is likewise an average across market areas and periods. The variable's low values of 0.04 or 0.03 for Carnation reflects the fact that Carnation was the contract brand for relatively few observations, which means many zeroes are averaged into the value. In contrast, the values for Ross and Mead-Johnson are higher than for Carnation, and show that these brands were the contract brand in more market areas in more periods. The *change in contract brand* variable averaged 0.59 or 0.55, reflecting that a substantial number of market areas had one or two changes in the manufacturer that held the contract brand, but that many market areas had no contract brand turnovers, bringing the cross-market average below 1. The means of the *presence of private label* and *presence of Wyeth* variables show the proportions of observations for which these variables equal 1. The sample average of *discount stores* is 2.54 stores (per 100,000), while the Herfindahl-Hirschman Index averages 1990 as conventionally measured, or 1.99 as used in the scale-adjusted specification (designated *supermarket concentration*) in the regressions. *Household income* and *poverty rate* values average $37,030 and 12.8 percent across observations. The means of *wholesale price* are, like the dependent variable, measured in (inflation-adjusted) cents.

The magnitudes and t-tests for the regression coefficients are reported in appendix tables D-3 and D-4 for regressions of milk-based formula prices and soy-based formula prices, respectively. Each table contains six regressions, distinguished by form (powdered vs. liquid concentrate) for each of the three major brands (Mead-Johnson, Ross, and Carnation) that were producing for the domestic market in September 2000, the close of this report's 1994-2000 study period.[3] To evaluate the effect of contract brand status, the differences between certain pairs of coefficients are measured and subjected to t-tests in appendix table D-5. In the following discussion, the 5 percent level of confidence is adopted for statistical significance.

The analysis that follows considers the magnitudes and interpretation of the numerical coefficients from the price regressions, and identifies which of the above effects have strong statistical support and which require greater qualification. Certain empirical results do depend somewhat on whether prices are examined for milk-based formula or soy-based formula. Inasmuch as milk is the product

[1] For example, the 26-ounce equivalent corresponds to a single 13-ounce can of liquid concentrate formula with the dilution ratio of 1 ounce of water for each ounce of concentrate.

[2] The reason for a smaller sample size for certain Carnation prices was that the not all Carnation soy-based products were available in each of the market areas in all 27 quarters of the study period.

[3] Statistical results for the Wyeth formula are not reported here. Wyeth is a formula manufacturer that no longer markets its own formula, exiting from the domestic market early in the 1994-2000 study period (during 1996). Preliminary analysis using the foreshortened price series available for Wyeth formula suggested that estimated coefficients for Wyeth were not well-behaved, sometimes taking on unexpected signs that differed from the signs predicted by economic theory and the signs exhibited by other companies. It is not known to what extent the unusual results for Wyeth are attributable to the short period for which Wyeth price information are available and how much to any other factors.

Appendix table D-1—Sample means of variables in milk-based formula price regressions

	Powder			Liquid Concentrate		
	Mead-Johnson	Ross	Carnation	Mead-Johnson	Ross	Carnation
Sample size	1,261	1,261	1,261	1,261	1,261	1,261
Dependent mean	245.39	252.47	211.37	291.54	289.76	241.62
Relative size of WIC, if contract brand	0.64	0.39	0.04	0.64	0.39	0.04
Relative size of WIC, if noncontract brand	0.50	0.75	1.11	0.50	0.76	1.11
Change in contract brand	0.59	0.59	0.59	0.59	0.59	0.59
Presence of private label	0.32	0.32	0.32	NA	NA	NA
Presence of Wyeth	0.50	0.50	0.50	0.44	0.44	0.44
Discount stores	2.54	2.54	2.54	2.54	2.54	2.54
Supermarket concentration	1.99	1.99	1.99	1.99	1.99	1.99
Household income	37.03	37.03	37.03	37.03	37.03	37.03
Poverty rate	12.83	12.83	12.83	12.83	12.83	12.83
Wholesale price	245.39	266.22	199.65	284.82	283.75	223.05
Trend	14.06	14.06	14.06	14.06	14.06	14.06

NA = not applicable.

Appendix table D-2—Sample means of variables in soy-based formula price regressions

	Powder			Liquid Concentrate		
	Mead-Johnson	Ross	Carnation	Mead-Johnson	Ross	Carnation
Sample size	1,261	1,261	1,021	1,261	1,261	1,026
Dependent mean	244.22	252.47	211.37	291.54	289.76	241.62
Relative size of WIC, if contract brand	0.66	0.39	0.03	0.66	0.39	0.03
Relative size of WIC, if noncontract brand	0.49	0.75	1.13	0.49	0.75	1.13
Change in contract brand	0.55	0.55	0.67	0.55	0.55	0.67
Presence of private label	0.40	0.40	0.49	NA	NA	NA
Presence of Wyeth	0.47	0.47	0.35	0.45	0.45	0.33
Discount stores	2.54	2.54	2.56	2.54	2.54	2.56
Supermarket concentration	1.99	1.99	1.99	1.99	1.99	1.99
Household income	37.03	37.03	37.49	37.03	37.03	37.48
Poverty rate	12.83	12.83	12.58	12.83	12.83	12.58
Wholesale price	272.48	266.22	187.55	307.28	302.65	204.51
Trend	14.06	14.06	16.63	14.06	14.06	16.58

NA = not applicable.

base that accounts for the greatest share by far of standard infant formula, our conclusions about the infant formula market "in general" are based primarily on those results.

The first coefficient listed in appendix tables D-3 and D-4 measures the effect on a brand's retail price associated with a one-unit change in the variable *relative size of WIC if contract brand*. In each of the twelve regressions, the price effect for the variable is positive and statistically significant.[4] When Mead Johnson or Ross hold the contract, an increase in a market area's relative size of WIC by one unit increases the retail prices of the two brands by, respectively, 11.92 cents to

[4] The t-scores range between 8.89 to 11.49 for the two major brands and no less than 2.57 for Carnation.

14.07 cents (per 26-oz equivalent). [5] In contrast, the price effect for Carnation is relatively low for powdered formula (at 8.19 cents) and relatively high for liquid concentrate (at 14.99 cents). For the soy-based formula of the two major brands, price effects range between 12.04 cents and 15.15 cents, with relatively low price effects for Carnation for both product forms (equaling 4.85 or 5.79 cents). The regression results strongly support the conclusion that, holding other factors constant, an increase in the relative size of WIC in a market area increases the retail price for that area's contract brand of infant formula.

The second coefficient listed in appendix tables D-3 and D-4 measures the effect on a brand's retail price associated with a one-unit change in the variable *relative size of WIC if noncontract brand*. For 11 of the 12 regressions, the price effect on a noncontract brand's retail price of an increase in the relative size of WIC is positive. The sole exception to this pattern was Carnation soy-based powdered formula, and its negative sign is not statistically significant from zero. Of the 11 positive coefficients, 10 are statistically significant (Carnation soy-based formula—this time the liquid concentrate—is the exception). In the milk-based formula price regressions, the pattern of coefficient matches the pattern already examined for the price effect of the variable *relative size of WIC if contract brand*: the price effects are relatively larger for Mead Johnson and Ross (ranging between 8.71 cents and 11.04 cents) compared with Carnation (at 2.62 and 2.73 cents). For the soy-based formula price regressions, the price effect is positive and statistically for the two major brands, although insignificant for Carnation. Given that Carnation's statistically insignificant coefficients were found only for soy-based formula, the product base that is relatively small, and that Carnation itself is a manufacturer that is relatively small, we conclude as a general result that an increase in the relative size of WIC in a market area increases retail price for that area's noncontract brands of infant formula.

In appendix table D-5, the two rows of figures and associated t-scores record the difference between the coefficients for the variables *relative size of WIC if contract brand* and *relative size of WIC if noncontract brand* for each given manufacturer's product (by base and form). For example, for milk-based powdered formula the price regression's two coefficients are 11.92 cents and 10.04 cents for Mead Johnson (shown in appendix table D-3) resulting in a 1.88-cent difference (shown in appendix table D-5). Thus, the figures in appendix table D-5 measure the "contract brand effect"—the difference in a product's retail price associated with the product's manufacturer changing its contract brand status between being a noncontract brand to being the contract brand in a market area. In the table, the contract brand effect is evaluated at a relative size of WIC of 1.0.[6] The contract brand effect is said to be a "positive" price effect if the product's retail price is higher when its manufacturer holds the WIC contract (holding other factors constant); the "positive" effect is a mathematical term, not a normative one meaning "desirable."

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[5] Because the relative size of WIC is constructed as the ratio of (formula-fed) WIC infants to (formula-fed) non-WIC infants, a one-unit change in the variable corresponds, for example, to a change from a local condition of one WIC infant for each non-WIC infant to a local condition of two WIC infants for each non-WIC infant.

[6] The figures and discussion in the body of this report differ slightly from the figures considered in this appendix. The figures in appendix table D-5 pertain to a relative size of WIC value of 1.0 because the coefficients in appendix table D-3 and D-4 are for one-unit changes in relative size of WIC. In contrast, in the body of the report the figures for the contract brand effect pertain to a relative size of WIC value of 1.14 because that value is the average in the sample of the relative size of WIC. The value of the contract brand effect for any given value of the relative size of WIC variable can be found by multiplying the figures in appendix table D-5 by the chosen value of the relative size of WIC. In the quarterly data, the relative size of WIC ranges from a low of 0.42 to a high of 4.2. Figure 9-1 in the text shows a range that is less broad because its figures are means across all quarters, by State, which average out the high and low values of the quarterly data. In either case, the contract brand effect in a given market area and period can be smaller than or several times larger than the figures reported in appendix table D-5.

Appendix table D-3—Regression coefficients and standard errors for supermarket infant formula prices: milk-based infant formula by product base and brand

	Powder			Liquid Concentrate		
	Mead-Johnson	Ross	Carnation	Mead-Johnson	Ross	Carnation
Relative size of WIC, if contract brand	**11.92** 9.86	**14.07** 10.12	**8.19** 5.79	**13.45** 10.36	**13.91** 8.89	**14.99** 8.84
Relative size of WIC, if noncontract brand	**10.04** 6.47	**11.04** 10.24	**2.73** 4.43	**8.71** 5.21	**12.87** 10.68	**2.62** 3.55
Change in contract brand	-0.97 0.91	**2.37** 2.46	0.05 0.10	**2.98** 2.60	**5.61** 5.24	-0.19 0.30
Presence of private label	1.56 1.06	**-2.85** 2.16	**-2.75** 3.71	NA	NA	NA
Presence of Wyeth	0.32 0.18	2.53 1.49	0.77 0.84	0.74 0.36	2.47 1.31	**-2.42** 2.10
Discount stores	**-9.17** 10.69	**-7.70** 10.09	-0.49 1.13	**-9.29** 10.26	**-9.99** 11.91	**-0.25** 4.77
Supermarket concentration	**-4.75** 8.29	**-4.93** 9.65	**-0.66** 2.26	**-2.44** 3.97	**-5.03** 8.82	0.34 0.96
Household income	0.11 0.63	0.09 0.56	**0.18** 2.08	**0.76** 4.15	**0.62** 3.60	**0.62** 5.93
Poverty rate	**-1.07** 4.60	**-0.90** 4.32	**-0.28** 2.35	***-0.47*** 1.87	**-0.55** 2.37	**-0.33** 2.30
Wholesale price	**0.56** 3.58	**0.62** 5.27	**0.56** 5.71	**0.60** 2.73	**0.66** 2.96	**0.74** 8.53
Trend	**0.45** 3.07	**0.97** 6.99	**0.52** 5.36	**0.86** 3.81	**0.94** 4.50	**0.47** 5.03
Intercept	**129.28** 3.31	**105.70** 3.57	**88.60** 4.64	***99.83*** 1.65	90.65 1.49	**54.35** 2.80
Dependent mean	244.22	252.47	211.37	291.54	289.76	241.62
Adjusted R-squared	0.24	0.42	0.35	0.38	0.44	0.45

Notes: a. Dependent variable is supermarket retail price (average price within an InfoScan market area), measured in cents. Coefficients measure the change in price, in cents, for a one-unit change in the variable.
b. For each variable in each of the six regressions the upper figure is the variable's OLS coefficient and the lower figure is the coefficient's t-statistic (in absolute value). Bold figures are coefficients that are significantly different from zero at the 5% confidence level. Italicized bold figures are coefficients that are significantly different from zero at the 10% level but not at the 5% level.
NA = not applicable.

For all six milk-based formula price regressions, the differences in coefficients are positive, as expected, and statistically significant in five of the six cases (the exception is Ross liquid concentrate formula). The contract brand effect ranges from a low of 1.88 cents (for Mead-Johnson powdered formula) to a high of 12.37 cents (for Carnation liquid concentrate formula). For the soy-based formula price regression the results are less conclusive: positive and statistically significant price effects were found in just three of the six cases, and in one case (Mead Johnson powdered formula) the price effect was negative and statistically significant. Because milk-based formula is a much larger part of the infant formula market than soy-based formula, our conclusion about infant formula "in general" draws heavily from the milk-based results. We conclude that in a given market area, holding other factors constant, the retail price of a manufacturer's product tends to be higher than it otherwise would be if the manufacturer is the WIC contract brand.

Appendix table D-4—Regression coefficients and standard errors for supermarket infant formula prices: soy-based infant formula by product base and brand

	Powder			Liquid Concentrate		
	Mead-Johnson	Ross	Carnation	Mead-Johnson	Ross	Carnation
Relative size of WIC, if contract brand	**13.75** 11.49	**12.87** 8.07	**4.85** 3.46	**15.15** 10.04	**12.04** 6.66	**5.79** 2.57
Relative size of WIC, if noncontract brand	**15.70** 10.20	**10.98** 8.85	-0.29 0.45	**15.09** 7.76	**14.01** 10.02	0.49 0.47
Change in contract brand	-0.8 0.79	0.83 0.78	**1.36** 3.06	**-2.67** 2.08	0.16 0.14	1.35 1.88
Presence of private label	-1.90 1.18	0.11 0.07	**-2.44** 3.49	NA	NA	NA
Presence of Wyeth	-1.20 0.66	-0.45 0.24	-0.36 0.44	3.71 1.43	2.67 1.21	-1.86 1.30
Discount stores	**-8.40** 10.02	**-6.56** 7.61	**-2.58** 6.57	**-12.38** 11.62	**-10.60** 10.8	-0.18 0.28
Supermarket concentration	**-3.08** 5.47	**-4.06** 6.98	**-1.15** 4.30	***-1.28*** 1.80	**-4.36** 6.63	-0.51 1.19
Household income	0.09 0.54	0.12 0.66	***-0.12*** 1.59	**0.85** 3.98	**0.80** 4.02	***-0.23*** 1.86
Poverty rate	**-1.54** 6.81	**-1.50** 6.36	**-0.23** 1.99	**-0.74** 2.58	**-0.95** 3.56	**-0.57** 3.13
Wholesale price	**0.47** 2.75	**0.73** 4.03	**0.77** 8.57	**0.63** 3.15	**0.6** 3.19	**0.61** 3.72
Trend	**0.84** 3.89	0.24 1.42	-0.06 0.68	**1.41** 5.23	**1.11** 4.06	**0.63** 5.13
Intercept	**161.01** 3.57	**95.35** 2.00	**75.92** 4.71	**94.13** 1.60	**111.32** 2.05	**109.89** 3.32
Dependent mean	272.31	267.17	201.86	311.08	305.51	230.59
Adjusted R-squared	0.40	0.23	0.20	0.43	0.41	0.16

Notes: a. Dependent variable is supermarket retail price (average price within an IRI market area), measured in cents. Coefficients measure the change in price, in cents, for a one-unit change in the variable.
b. For each variable in each of the six regressions the upper figure is the variable's OLS coefficient and the lower figure is the coefficient's t-statistic (in absolute value). Bold figures are coefficients that are significantly different from zero at the 5% confidence level. Italicized bold figures are coefficients that are significantly different from zero at the 10% level but not at the 5% level.

NA = not applicable

Appendix table D-5—Estimated contract brand effect[1]

	Powder			Liquid Concentrate		
	Mead-Johnson	Ross	Carnation	Mead-Johnson	Ross	Carnation
Milk-based formula	**1.88** 1.99	**3.03** 3.45	**5.46** 4.27	**4.74** 4.67	1.03 1.07	**12.37** 8.02
Soy-based formula	**-1.95** 2.16	**1.89** 1.95	**5.14** 4.11	0.05 0.05	***-1.97*** 1.78	**5.30** 2.62

[1] Differences between coefficients of *relative size of WIC if contract brand* and *relative size of WIC if noncontract brand* by product base, product form, and brand.

Note: Bold figures are coefficients that are significantly different from zero at the 5% confidence level. Italicized bold figures are coefficients that are significantly different from zero at the 10% level but not at the 5% level.

The variable change in contract brand measures, by quarters, the number of times the contract brand had changed between any two manufacturers in a market area, capturing whether turnover in the identity of the contract brand has effects on supermarket price for the product of each manufacturer (whether or not it was a contract winner, contract loser, or not involved with the contract turnover). In the milk-based price regressions in appendix table D3, results for the variable show that liquid concentrate formula prices exhibited a turnover effect that is positive and significant for each of the two major brands, but powdered formula prices exhibited such an effect for only one major brand (Ross); for neither product base does Carnation exhibit any price effect associated with the number of contract brand changes. In the soy-based formula price regressions, in contrast, Carnation formula was the only formula exhibiting a positive, statistically significant effect, while Mead Johnson exhibited an effect that is significant but negative. We conclude that the price effect of the variable is not strongly conclusive, with a positive turnover effect identified in some but not all cases.

The variable *presence of private label* had negative and statistically significant coefficients in the Ross and Carnation price regressions for milk-based formula. The interpretation of this result is that households consider private label formula to be a substitute for these brands, lowering the prices of these brands by about 2.85 cents and 2.75 cents, respectively. For the soy-based formula price regression, the coefficient is negative (at –2.44 cents) and statistically significant only for Carnation.

The variable *presence of Wyeth* has a negative and statistically significant effect in only one instance (Carnation milk-based liquid concentrate). Therefore, we conclude that the exit of Wyeth from the domestic market did not have an effect on infant formula retail prices in general (for given levels of wholesale prices of the remaining manufacturers).[7]

For Mead Johnson and Ross infant formula, each additional *discount store* (per 100,000 population) in a market area lowers supermarket retail price by a statistically significant amount for all product bases and forms. The amounts of price decreases ranged between 7.70 and 9.99 cents for milk-based formula, and between 6.56 and 12.38 cents for soy-based formula. Carnation formula had significant coefficients in two cases, equaling 2.58 cents and 0.25 cents, and in two other cases Carnation's coefficient for *discount stores* was insignificant. Even with those two cases of statistical insignificance, we considered it reasonable to conclude for infant formula in general that retail prices in the supermarket sector decrease in response to a greater presence of discount stores.

As explained in appendix C, if infant formula serves as an "attractor" item (of which a "loss leader" item is an extreme example), its price may be expected to decrease as supermarket concentration rises. For milk-based formula price regressions, the *supermarket concentration* variable has a negative, statistically significant coefficient in five out of six cases. For the two major brands, an increase in supermarket concentration as measured by a one-unit change in the variable (a 1000-unit change in the underlying Herfindahl-Hirschman Index) lowers retail price by as much as 4.75 cents to 4.93 cents. Carnation's coefficient for powdered formula was statistically significant, but much lower in magnitude (in absolute value) at just –0.66; Carnation's coefficient for liquid concentrated formula was statistically insignificant. For soy-based infant formula, a negative and statistically significant price effect was found in four out of six cases. We conclude for infant formula in general that supermarket concentration lowers—rather than increases—supermarket retail prices. We interpret this result as one that is consistent with the joint conditions that market power raises price for other supermarket items and infant formula serves as an "attractor" item.

[7] If the exit of Wyeth resulted in an increase in the wholesale prices of other manufacturers, retail prices of other brands would be expected to increase.

In four of the six milk-based formula price regressions, the coefficient on *household income* was positive and significant. Three of those four coefficients are found in the three regressions for liquid concentrate. The coefficients' magnitudes ranged from 0.62 to 0.76. For the Ross and Carnation liquid concentrate regressions, the coefficient of 0.62 means that an increase in a market area's median household income by $10,000 results in a supermarket retail price increase of 6.2 cents. In the soy-based formula price regression, the *household income* coefficient was positive and significant only for the two major manufacturers' liquid concentrate formula, as is the case for their milk-based price regression counterparts. In contrast, Carnation's two *household income* coefficients for its soy-based formula were each negative, although statistically insignificant. We conclude that, for the two major brands, there seems to be a qualitative difference between the two major forms of infant formula: household income affects supermarket prices for liquid concentrate formula but not for powdered formula.

The variable *poverty rate* is included in the regression as a rough proxy for the overall shape of the income distribution within a market area. In the six milk-based regressions, the sign is negative and statistically significant in five out of six cases. The magnitudes of the coefficient were smallest (in absolute value) for Carnation products (at -0.28 and –0.33), and ranged up to –1.07 for Mead Johnson powdered formula. Thus, an increase in a market area's *poverty rate* by one percentage point is associated with a reduction in the supermarket retail price of Mead Johnson powdered formula by 1 cent. In the soy-based formula price regressions, all six coefficients were negative and statistically significant, and again Carnation had the two lowest coefficients. We conclude that supermarket infant formula prices in general respond negatively to a market area's *poverty rate*.

The coefficients on the variable *wholesale price* are all positive and statistically significant, ranging between 0.56 and 0.74 in the six milk-based formula price regressions and 0.47 and 0.77 in the soy-based formula price regressions. The interpretation of these results is that an increase in the price paid by supermarkets to a brand's manufacturer results in an increase in that brand's supermarket retail price, but by less than the increase in the wholesale price. For example, the coefficient of 0.56 for Mead-Johnson powdered formula means that a 10-cent increase in Mead-Johnson's wholesale price results in an increase of 5.6 cents in that product's retail price.[8]

The variable *trend* captures any changes in a brand's retail price, on average over time, that is not statistically accounted for by other independent variables in the model (which already includes *wholesale price* and accounts for inflation in the general price level). The coefficients on *trend* are all positive and statistically significant for milk-based formula prices, ranging from 0.5 cents to 0.9 cents, and positive and statistically significant in four out of six cases for soy-based formula prices. Because the *trend* coefficients measure price changes per quarter, these magnitudes on an annual basis are higher than the coefficients by a factor of four, ranging from 2.0 cents to 3.6 cents per annum.

Alternative regression specifications were examined to identify the robustness of the model, including introducing some variables (such as regional dummy variables, market area population, and an interaction variable between contract brand status and *supermarket concentration*), and dropping certain variables (such as *change in contract brand* and *presence of Wyeth*). Two types of results are sensitive to regression specification. First, for various specifications of Ross milk-based liquid concentrate regressions, the coefficients on *relative size of WIC if contract brand* and *relative size of WIC if noncontract brand* were always positive, but in some specifications the coef-

[8] As discussed in appendix C, the result that the coefficients are positive fractions is consistent with the specification of linear infant formula demand curves adopted by the theoretical model on which the regression specifications are based.

ficient on *relative size of WIC if contract brand* is smaller than the coefficient on *relative size of WIC if noncontract brand*, yielding a negative contract brand price effect—a result that did not match the results found for the five other milk-based formula products. Second, the introduction of regional dummy variables diminishes the role played by *household income*, probably because the values of household income across market areas are related to the geographical region in which the market area is located. The specification reported here provides clean, straightforward interpretations of coefficients and yields the same basic results as alternative specifications—notably, the coefficients for *relative size of WIC if contract brand* and *relative size of WIC if noncontract brand* are positive and statistically significant under alternative specifications.