

Replication of Berry et al. (1995)

Matthew Gentzkow*

Stanford and NBER

Jesse M. Shapiro

Brown and NBER

September 2015

This document describes our MATLAB implementation of Berry et al.'s (1995) model of automobile demand (henceforth BLP).

We obtained BLP (1995)'s data from the GAUSS code for BLP (1999), which we downloaded from the Internet Archive's April 2005 web capture of James Levinsohn's (now defunct) website at the University of Michigan. Table 1 of BLP (1995) and table 2 of BLP (1999) imply that the two papers use the same dataset.

We re-implemented BLP's (1995) estimator using BLP's (1999) code as a guide. We used code from Petrin (2002), Dubé et al. (2012), and Knittel and Metaxoglou (2014) as additional references.

The tables below reproduce the corresponding tables from BLP (1995) alongside analogous results from our implementation.

We reproduce the descriptive statistics in tables 1, 2, and 3 very closely, matching exactly or almost exactly in most cases. Model parameter estimates in table 4 are similar in general, but our estimated parameters produce somewhat lower price elasticities (table 5), leading to somewhat higher estimated markups (table 8).

*E-mail: gentzkow@stanford.edu, jesse_shapiro_1@brown.edu.

References

- Berry, Steven, James Levinsohn, and Ariel Pakes. 1995. Automobile prices in market equilibrium. *Econometrica* 63(4): 841-890.
- . 1999. Voluntary export restraints on automobiles: Evaluating a trade policy. *American Economic Review* 89(3): 400-430.
- Dubé, Jean-Pierre, Jeremy T. Fox, and Che-Lin Su. 2012. Improving the numerical performance of static and dynamic aggregate discrete choice random coefficients demand estimation. *Econometrica* 80(5): 2231-2267.
- Knittel, Christopher R. and Konstantinos Metaxoglou. 2014. Estimation of random-coefficient demand models: Two empiricists' perspective. *Review of Economics and Statistics* 96(1): 34-59.
- Petrin, Amil. 2002. Quantifying the benefits of new products: The case of the minivan. *Journal of Political Economy* 110(4): 705-729.

Table 1: Descriptive statistics

(a) Berry et al. (1995)

| Year | No. of | | Quantity | Price | Domestic | Japan | European | HP / weight | Size | Air | MPG | MP\$ |
|------|--------|--|----------|--------|----------|-------|----------|-------------|-------|-------|-------|-------|
| | models | | | | | | | | | | | |
| 1971 | 92 | | 86.892 | 7.868 | 0.866 | 0.057 | 0.077 | 0.490 | 1.496 | 0.000 | 1.662 | 1.850 |
| 1972 | 89 | | 91.763 | 7.979 | 0.892 | 0.042 | 0.066 | 0.391 | 1.510 | 0.014 | 1.619 | 1.875 |
| 1973 | 86 | | 92.785 | 7.535 | 0.932 | 0.040 | 0.028 | 0.364 | 1.529 | 0.022 | 1.589 | 1.819 |
| 1974 | 72 | | 105.119 | 7.506 | 0.887 | 0.050 | 0.064 | 0.347 | 1.510 | 0.026 | 1.568 | 1.453 |
| 1975 | 93 | | 84.775 | 7.821 | 0.853 | 0.083 | 0.064 | 0.337 | 1.479 | 0.054 | 1.584 | 1.503 |
| 1976 | 99 | | 93.382 | 7.787 | 0.876 | 0.081 | 0.043 | 0.338 | 1.508 | 0.059 | 1.759 | 1.696 |
| 1977 | 95 | | 97.727 | 7.651 | 0.837 | 0.112 | 0.051 | 0.340 | 1.467 | 0.032 | 1.947 | 1.835 |
| 1978 | 95 | | 99.444 | 7.645 | 0.855 | 0.107 | 0.039 | 0.346 | 1.405 | 0.034 | 1.982 | 1.929 |
| 1979 | 102 | | 82.742 | 7.599 | 0.803 | 0.158 | 0.038 | 0.348 | 1.343 | 0.047 | 2.061 | 1.657 |
| 1980 | 103 | | 71.567 | 7.718 | 0.773 | 0.191 | 0.036 | 0.350 | 1.296 | 0.078 | 2.215 | 1.466 |
| 1981 | 116 | | 62.030 | 8.349 | 0.741 | 0.213 | 0.046 | 0.349 | 1.286 | 0.094 | 2.363 | 1.559 |
| 1982 | 110 | | 61.893 | 8.831 | 0.714 | 0.235 | 0.051 | 0.347 | 1.277 | 0.134 | 2.440 | 1.817 |
| 1983 | 115 | | 67.878 | 8.821 | 0.734 | 0.215 | 0.051 | 0.351 | 1.276 | 0.126 | 2.601 | 2.087 |
| 1984 | 113 | | 85.933 | 8.870 | 0.783 | 0.179 | 0.038 | 0.361 | 1.293 | 0.129 | 2.469 | 2.117 |
| 1985 | 136 | | 78.143 | 8.938 | 0.761 | 0.191 | 0.048 | 0.372 | 1.265 | 0.140 | 2.261 | 2.024 |
| 1986 | 130 | | 83.756 | 9.382 | 0.733 | 0.216 | 0.050 | 0.379 | 1.249 | 0.176 | 2.416 | 2.856 |
| 1987 | 143 | | 67.667 | 9.965 | 0.702 | 0.245 | 0.052 | 0.395 | 1.246 | 0.229 | 2.327 | 2.789 |
| 1988 | 150 | | 67.078 | 10.069 | 0.717 | 0.237 | 0.045 | 0.396 | 1.251 | 0.237 | 2.334 | 2.919 |
| 1989 | 147 | | 62.914 | 10.321 | 0.690 | 0.261 | 0.049 | 0.406 | 1.259 | 0.289 | 2.310 | 2.806 |
| 1990 | 131 | | 66.377 | 10.337 | 0.682 | 0.276 | 0.043 | 0.419 | 1.270 | 0.308 | 2.270 | 2.852 |
| All | 2217 | | 78.804 | 8.604 | 0.790 | 0.161 | 0.049 | 0.372 | 1.357 | 0.116 | 2.099 | 2.086 |

(b) Replication

| Year | No. of | | Quantity | Price | Domestic | Japan | European | HP / weight | Size | Air | MPG | MP\$ |
|------|--------|--|----------|--------|----------|-------|----------|-------------|-------|-------|-------|-------|
| | models | | | | | | | | | | | |
| 1971 | 92 | | 86.892 | 7.868 | 0.866 | 0.057 | 0.077 | 0.490 | 1.496 | 0.000 | 1.662 | 1.849 |
| 1972 | 89 | | 98.623 | 7.979 | 0.892 | 0.042 | 0.066 | 0.391 | 1.510 | 0.014 | 1.619 | 1.875 |
| 1973 | 86 | | 92.785 | 7.535 | 0.932 | 0.040 | 0.028 | 0.364 | 1.529 | 0.022 | 1.589 | 1.818 |
| 1974 | 72 | | 105.119 | 7.506 | 0.887 | 0.050 | 0.064 | 0.347 | 1.510 | 0.026 | 1.567 | 1.452 |
| 1975 | 93 | | 84.775 | 7.821 | 0.853 | 0.083 | 0.064 | 0.337 | 1.479 | 0.054 | 1.584 | 1.503 |
| 1976 | 99 | | 93.382 | 7.787 | 0.876 | 0.081 | 0.043 | 0.338 | 1.508 | 0.059 | 1.759 | 1.696 |
| 1977 | 95 | | 97.727 | 7.651 | 0.837 | 0.112 | 0.051 | 0.340 | 1.467 | 0.032 | 1.947 | 1.835 |
| 1978 | 95 | | 99.444 | 7.645 | 0.855 | 0.107 | 0.039 | 0.346 | 1.405 | 0.034 | 1.982 | 1.929 |
| 1979 | 102 | | 82.742 | 7.599 | 0.803 | 0.158 | 0.038 | 0.348 | 1.343 | 0.047 | 2.061 | 1.657 |
| 1980 | 103 | | 71.567 | 7.718 | 0.773 | 0.191 | 0.036 | 0.350 | 1.296 | 0.078 | 2.215 | 1.466 |
| 1981 | 116 | | 62.030 | 8.349 | 0.741 | 0.213 | 0.046 | 0.349 | 1.286 | 0.094 | 2.363 | 1.559 |
| 1982 | 110 | | 61.893 | 8.831 | 0.714 | 0.235 | 0.051 | 0.347 | 1.277 | 0.134 | 2.440 | 1.817 |
| 1983 | 115 | | 67.878 | 8.821 | 0.734 | 0.215 | 0.051 | 0.351 | 1.276 | 0.126 | 2.601 | 2.087 |
| 1984 | 113 | | 85.933 | 8.870 | 0.783 | 0.179 | 0.038 | 0.361 | 1.293 | 0.129 | 2.469 | 2.117 |
| 1985 | 136 | | 78.143 | 8.938 | 0.761 | 0.191 | 0.048 | 0.372 | 1.265 | 0.140 | 2.261 | 2.024 |
| 1986 | 130 | | 83.756 | 9.382 | 0.733 | 0.216 | 0.050 | 0.379 | 1.249 | 0.176 | 2.416 | 2.856 |
| 1987 | 143 | | 67.667 | 9.965 | 0.702 | 0.245 | 0.052 | 0.395 | 1.246 | 0.229 | 2.327 | 2.789 |
| 1988 | 150 | | 67.078 | 10.069 | 0.717 | 0.237 | 0.045 | 0.396 | 1.251 | 0.237 | 2.334 | 2.919 |
| 1989 | 147 | | 62.914 | 10.321 | 0.690 | 0.261 | 0.049 | 0.406 | 1.259 | 0.289 | 2.310 | 2.806 |
| 1990 | 131 | | 66.377 | 10.337 | 0.682 | 0.276 | 0.043 | 0.419 | 1.270 | 0.308 | 2.270 | 2.852 |
| All | 2217 | | 78.804 | 8.604 | 0.790 | 0.161 | 0.049 | 0.372 | 1.357 | 0.116 | 2.099 | 2.086 |

Table 2: The range of continuous demand characteristics (and associated models)

| (a) Berry et al. (1995) | | (b) Replication | | | | |
|-------------------------|------------|-----------------|--------|---------|---------|--|
| Variable | Percentile | | | | | |
| | 0 | 25 | 50 | 75 | 100 | |
| Price | 3.393 | 6.711 | 8.728 | 13.074 | 68.597 | |
| Sales | 0.049 | 15.479 | 47.345 | 109.002 | 577.313 | |
| HP / weight | 0.170 | 0.337 | 0.375 | 0.428 | 0.948 | |
| Size | 0.756 | 1.131 | 1.270 | 1.453 | 1.888 | |
| MP\$ | 8.46 | 15.57 | 20.10 | 24.86 | 64.37 | |
| MPG | 9 | 17 | 20 | 25 | 53 | |

| Variable | Percentile | | | | |
|-------------|------------|--------|--------|---------|---------|
| | 0 | 25 | 50 | 75 | 100 |
| Price | 3.393 | 6.714 | 8.729 | 13.074 | 68.597 |
| Sales | 0.049 | 15.603 | 47.350 | 109.002 | 646.526 |
| HP / weight | 0.170 | 0.337 | 0.375 | 0.428 | 0.948 |
| Size | 0.756 | 1.131 | 1.270 | 1.453 | 1.888 |
| MP\$ | 8.46 | 15.57 | 20.10 | 24.83 | 64.37 |
| MPG | 9 | 17 | 20 | 25 | 53 |

Table 3: Results with logit demand and marginal cost pricing (2217 observations)

| Variable | (a) Berry et al. (1995) | | (b) Replication | |
|-------------------------------|-------------------------|-----------------------|------------------------|-----------------------|
| | OLS logit demand | IV logit demand | OLS logit demand | IV logit demand |
| Constant | -10.068 (0.253) | -9.273 (0.493) | -10.069 (0.253) | -9.274 (0.493) |
| HP / weight | -0.121 (0.277) | 1.965 (0.909) | -0.121 (0.277) | 1.965 (0.909) |
| Air | -0.035 (0.073) | 1.289 (0.248) | -0.035 (0.073) | 1.289 (0.248) |
| MP\$ | 0.263 (0.043) | 0.052 (0.086) | 0.263 (0.043) | 0.052 (0.086) |
| MPG | — | — | — | — |
| Size | 2.341 (0.125) | 2.355 (0.247) | 2.341 (0.125) | 2.355 (0.247) |
| Trend | — | — | — | — |
| Price | -0.089 (0.004) | -0.216 (0.123) | -0.089 (0.004) | -0.216 (0.123) |
| No. inelastic demands | 1494 (1429-1617) | 22 (7-101) | 1494 (1429-1617) | 22 (6-294) |
| R^2 | 0.387 | n.a. | 0.387 | n.a. |
| $\ln(\text{price})$ on w | 1.882 (0.119) | 1.882 (0.119) | 1.882 (0.119) | 1.882 (0.119) |

Table 4: Estimated parameters of the demand and pricing equations: BLP specification (2217 observations)

| (a) Berry et al. (1995) | | | | (b) Replication | | | |
|--|----------------------------------|--------------------|----------------|----------------------------------|-------------|--------------------|----------------|
| Demand side parameters | Variable | Parameter estimate | Standard error | Demand side parameters | Variable | Parameter estimate | Standard error |
| Means (β 's) | Constant | -7.061 | 0.941 | Means (β 's) | Constant | -7.728 | 1.722 |
| | HP / weight | 2.883 | 2.019 | | HP / weight | 4.620 | 1.682 |
| | Air | 1.521 | 0.891 | | Air | -1.226 | 2.059 |
| | MP\$ | -0.122 | 0.320 | | MP\$ | 0.293 | 0.233 |
| Std. Deviations (σ_{β} 's) | Size | 3.460 | 0.610 | Size | 3.992 | 0.527 | |
| | Constant | 3.612 | 1.485 | Constant | 2.522 | 3.779 | |
| | HP / weight | 4.628 | 1.885 | HP / weight | 3.525 | 4.236 | |
| | Air | 1.818 | 1.695 | Air | 4.166 | 2.106 | |
| Term on price (α) | MP\$ | 1.050 | 0.272 | MP\$ | 0.393 | 0.419 | |
| | Size | 2.056 | 0.585 | Size | 1.937 | 0.889 | |
| | $\ln(y-p)$ | 43.501 | 6.427 | $\ln(y-p)$ | 42.870 | 8.280 | |
| | Constant | 0.952 | 0.194 | Constant | 2.751 | 0.125 | |
| Cost side parameters | $\ln(\text{HP} / \text{weight})$ | 0.477 | 0.056 | $\ln(\text{HP} / \text{weight})$ | 0.812 | 0.089 | |
| | Air | 0.619 | 0.038 | Air | 0.430 | 0.079 | |
| | $\ln(\text{MPG})$ | -0.415 | 0.055 | $\ln(\text{MPG})$ | -0.610 | 0.073 | |
| | $\ln(\text{size})$ | -0.046 | 0.081 | $\ln(\text{size})$ | -0.352 | 0.164 | |
| | Trend | 0.019 | 0.002 | Trend | 0.027 | 0.002 | |

Notes: Table focuses on the main BLP specification and omits two columns from an auxiliary specification.

Table 5: A sample from 1990 of estimated demand elasticities with respect to attributes and price (based on table 4 estimates)

| (a) Berry et al. (1995) | | (b) Replication | | | |
|-------------------------|----------------------------|-----------------|--------|-------|--------|
| Model | Value of attribute / price | | | | |
| | HP / weight | Air | MP\$ | Size | Price |
| Mazda 323 | 0.366 | 0.000 | 3.645 | 1.075 | 5.049 |
| | 0.458 | 0.000 | 1.010 | 1.338 | 6.358 |
| Sentra | 0.391 | 0.000 | 3.645 | 1.092 | 5.661 |
| | 0.440 | 0.000 | 0.905 | 1.194 | 6.528 |
| Escort | 0.401 | 0.000 | 4.022 | 1.116 | 5.663 |
| | 0.449 | 0.000 | 1.132 | 1.176 | 6.031 |
| Cavalier | 0.385 | 0.000 | 3.142 | 1.179 | 5.797 |
| | 0.423 | 0.000 | 0.524 | 1.360 | 6.433 |
| Accord | 0.457 | 0.000 | 3.016 | 1.255 | 9.292 |
| | 0.282 | 0.000 | 0.126 | 0.873 | 4.798 |
| Taurus | 0.304 | 0.000 | 2.262 | 1.334 | 9.671 |
| | 0.180 | 0.000 | -0.139 | 1.304 | 4.220 |
| Century | 0.387 | 1.000 | 2.890 | 1.312 | 10.138 |
| | 0.326 | 0.701 | 0.077 | 1.123 | 6.755 |
| Maxima | 0.518 | 1.000 | 2.513 | 1.300 | 13.695 |
| | 0.322 | 0.396 | -0.136 | 0.932 | 4.845 |
| Legend | 0.510 | 1.000 | 2.388 | 1.292 | 18.944 |
| | 0.167 | 0.237 | -0.070 | 0.596 | 4.134 |
| TownCar | 0.373 | 1.000 | 2.136 | 1.720 | 21.412 |
| | 0.089 | 0.211 | -0.122 | 0.883 | 4.320 |
| Seville | 0.517 | 1.000 | 2.011 | 1.374 | 24.353 |
| | 0.092 | 0.116 | -0.053 | 0.416 | 3.973 |
| LS400 | 0.665 | 1.000 | 2.262 | 1.410 | 27.544 |
| | 0.073 | 0.037 | -0.007 | 0.149 | 3.085 |
| BMW 735i | 0.542 | 1.000 | 1.885 | 1.403 | 37.490 |
| | 0.061 | 0.011 | -0.016 | 0.174 | 3.515 |

| Model | Value of attribute / price | | | | |
|-----------|----------------------------|--------|-------|-------|--------|
| | HP / weight | Air | MP\$ | Size | Price |
| Mazda 323 | 0.366 | 0.000 | 3.645 | 1.075 | 5.049 |
| | 0.682 | -0.000 | 0.516 | 1.717 | 4.033 |
| Sentra | 0.391 | 0.000 | 3.645 | 1.092 | 5.661 |
| | 0.623 | -0.000 | 0.447 | 1.476 | 4.009 |
| Escort | 0.401 | 0.000 | 4.022 | 1.116 | 5.663 |
| | 0.624 | -0.000 | 0.528 | 1.453 | 3.872 |
| Cavalier | 0.385 | 0.000 | 3.142 | 1.179 | 5.797 |
| | 0.609 | -0.000 | 0.315 | 1.681 | 3.933 |
| Accord | 0.457 | 0.000 | 3.016 | 1.255 | 9.292 |
| | 0.325 | -0.000 | 0.152 | 0.715 | 3.310 |
| Taurus | 0.304 | 0.000 | 2.262 | 1.334 | 9.671 |
| | 0.159 | -0.000 | 0.075 | 0.787 | 3.150 |
| Century | 0.387 | 1.000 | 2.890 | 1.312 | 10.138 |
| | 0.368 | 0.624 | 0.155 | 0.842 | 6.128 |
| Maxima | 0.518 | 1.000 | 2.513 | 1.300 | 13.695 |
| | 0.232 | 0.238 | 0.075 | 0.283 | 4.972 |
| Legend | 0.510 | 1.000 | 2.388 | 1.292 | 18.944 |
| | 0.117 | 0.103 | 0.032 | 0.139 | 3.668 |
| TownCar | 0.373 | 1.000 | 2.136 | 1.720 | 21.412 |
| | 0.022 | 0.020 | 0.016 | 0.151 | 3.185 |
| Seville | 0.517 | 1.000 | 2.011 | 1.374 | 24.353 |
| | 0.061 | 0.034 | 0.013 | 0.116 | 2.981 |
| LS400 | 0.665 | 1.000 | 2.262 | 1.410 | 27.544 |
| | 0.063 | 0.020 | 0.012 | 0.094 | 3.039 |
| BMW 735i | 0.542 | 1.000 | 1.885 | 1.403 | 37.490 |
| | 0.056 | -0.006 | 0.021 | 0.153 | 2.872 |

Notes (BLP 1995): The value of the attribute or, in the case of the last column, price, is the top number and the number below it is the elasticity of demand with respect to the attribute (or, in the last column, price.)

Table 8: A sample from 1990 of estimated price-marginal cost markups and variable profits (based on table 4 estimates)

| (a) Berry et al. (1995) | | | | | (b) Replication | | | | |
|-------------------------|----------|-----------------------------|--|--|-----------------|----------|-----------------------------|--|--|
| Model | Price | Markup over MC ($p - MC$) | Variable profits (in \$'000's) $q(p - MC)$ | | Model | Price | Markup over MC ($p - MC$) | Variable profits (in \$'000's) $q(p - MC)$ | |
| Mazda 323 | \$5,049 | \$801 | \$18,407 | | Mazda 323 | \$5,049 | \$1,269 | \$29,158 | |
| Sentra | \$5,661 | \$880 | \$43,554 | | Sentra | \$5,661 | \$1,442 | \$71,371 | |
| Escort | \$5,663 | \$1,077 | \$311,068 | | Escort | \$5,663 | \$1,717 | \$495,787 | |
| Cavalier | \$5,797 | \$1,302 | \$384,263 | | Cavalier | \$5,797 | \$2,082 | \$614,302 | |
| Accord | \$9,292 | \$1,992 | \$830,842 | | Accord | \$9,292 | \$2,889 | \$1,205,400 | |
| Taurus | \$9,671 | \$2,577 | \$807,212 | | Taurus | \$9,671 | \$3,427 | \$1,073,448 | |
| Century | \$10,138 | \$2,420 | \$271,446 | | Century | \$10,138 | \$2,966 | \$332,782 | |
| Maxima | \$13,695 | \$2,881 | \$288,291 | | Maxima | \$13,695 | \$2,812 | \$281,343 | |
| Legend | \$18,944 | \$4,671 | \$250,695 | | Legend | \$18,944 | \$5,239 | \$281,156 | |
| TownCar | \$21,412 | \$5,596 | \$832,082 | | TownCar | \$21,412 | \$7,582 | \$1,127,369 | |
| Seville | \$24,353 | \$7,500 | \$249,195 | | Seville | \$24,353 | \$10,294 | \$342,044 | |
| LS400 | \$27,544 | \$9,030 | \$371,123 | | LS400 | \$27,544 | \$9,184 | \$377,478 | |
| BMW 735i | \$37,490 | \$10,975 | \$114,802 | | BMW 735i | \$37,490 | \$13,368 | \$139,829 | |