Report on panel model results

Vicente López Díaz

These note is to relate several models that can use panel data.

The objective of these note is to give a broad overview of the possible models that can use panel data. There are several usual features to consider in a model with panel data, for example, changes on parameters for time or individual. Also, specification on error term is relevant for interpretation.

The note is based on Hsiao (2014). It goes from the theory in the text, to the application.

# Data plots

Here is a summary of the data available for the analysis.

Figure 1 presents the initial data points, these are used for the analysis.

I made a decision on which brands to include based on the number of observations on the period previous to the tax implementation, the tax started in january 2021, I made an exploratory analysis on the december 2020 data. This would ease the inclusion of brand explicitly in the analysis, brands with few observations, with difficulties to calculate most estimates could be analyzed after applying some criteria to make groups of brands out of the individual ones.

Figure 2 only considers the 7 most frequent brands. The graph provides some guidance on what to consider for the proposed descriptive model. In particular, there is clear trend over time and there are price adjustments in january.

Except for prices of other products, there are no other potential regressors to consider at the same level of the data.

# Dummies for each level: city, brand, time

Estimations using areg, fixed effects are imposed. Using this method there is one category with parameters "absorbed", which are not estimated as a result of the procedure.

Specification with indicators for city, brand and trend for time. Same tax effect on all the brands.

Specification with indicators for city, brand and trend for time. Effect interacted for each brand.

Results with data for the 7 brands:

Fixed Effects for city and brand

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | (1) | (2) | (3) | (4) |
| VARIABLES | ppu | ppu | ppu | ppu |
|  |  |  |  |  |
| 2.marca | -0.012\*\*\* | -0.011\*\*\* | -0.006\*\* | -0.006\*\* |
|  | (0.003) | (0.003) | (0.003) | (0.003) |
| 3.marca | -0.595\*\*\* | -0.593\*\*\* | -0.592\*\*\* | -0.591\*\*\* |
|  | (0.004) | (0.004) | (0.003) | (0.003) |
| 4.marca | -0.270\*\*\* | -0.268\*\*\* | -0.268\*\*\* | -0.266\*\*\* |
|  | (0.003) | (0.003) | (0.003) | (0.003) |
| 5.marca | 0.011\*\*\* | 0.010\*\*\* | 0.011\*\*\* | 0.010\*\*\* |
|  | (0.003) | (0.003) | (0.002) | (0.002) |
| 6.marca | -0.524\*\*\* | -0.521\*\*\* | -0.527\*\*\* | -0.524\*\*\* |
|  | (0.005) | (0.005) | (0.004) | (0.004) |
| 7.marca | -0.435\*\*\* | -0.435\*\*\* | -0.441\*\*\* | -0.440\*\*\* |
|  | (0.003) | (0.003) | (0.002) | (0.002) |
| 1.m1\_20 |  | 0.238\*\*\* |  |  |
|  |  | (0.024) |  |  |
| 1.m1\_20#2.marca |  | -0.007 |  | -0.012 |
|  |  | (0.042) |  | (0.032) |
| 1.m1\_20#3.marca |  | -0.111\*\* |  | -0.112\*\*\* |
|  |  | (0.043) |  | (0.033) |
| 1.m1\_20#4.marca |  | -0.147\*\*\* |  | -0.150\*\*\* |
|  |  | (0.039) |  | (0.030) |
| 1.m1\_20#5.marca |  | 0.052 |  | 0.051\*\* |
|  |  | (0.032) |  | (0.024) |
| 1.m1\_20#6.marca |  | -0.239\*\*\* |  | -0.235\*\*\* |
|  |  | (0.062) |  | (0.048) |
| 1.m1\_20#7.marca |  | -0.028 |  | -0.024 |
|  |  | (0.034) |  | (0.026) |
| 1.m1\_21 |  | 0.285\*\*\* |  |  |
|  |  | (0.024) |  |  |
| 1.m1\_21#2.marca |  | -0.035 |  | -0.040 |
|  |  | (0.040) |  | (0.031) |
| 1.m1\_21#3.marca |  | -0.116\*\* |  | -0.118\*\*\* |
|  |  | (0.046) |  | (0.035) |
| 1.m1\_21#4.marca |  | -0.132\*\*\* |  | -0.134\*\*\* |
|  |  | (0.038) |  | (0.029) |
| 1.m1\_21#5.marca |  | 0.022 |  | 0.021 |
|  |  | (0.032) |  | (0.024) |
| 1.m1\_21#6.marca |  | -0.361\*\*\* |  | -0.357\*\*\* |
|  |  | (0.063) |  | (0.048) |
| 1.m1\_21#7.marca |  | -0.036 |  | -0.031 |
|  |  | (0.034) |  | (0.026) |
| m1 | -0.024\*\*\* | -0.024\*\*\* | -0.069\*\*\* | -0.069\*\*\* |
|  | (0.004) | (0.004) | (0.004) | (0.004) |
| ym | 0.009\*\*\* | 0.009\*\*\* |  |  |
|  | (0.000) | (0.000) |  |  |
| m1\_20 | 0.209\*\*\* |  | -0.017\* | 0.012 |
|  | (0.011) |  | (0.009) | (0.018) |
| m1\_21 | 0.242\*\*\* |  | -0.011 | 0.032\* |
|  | (0.011) |  | (0.010) | (0.019) |
| Constant | -3.925\*\*\* | -3.926\*\*\* | 1.991\*\*\* | 1.990\*\*\* |
|  | (0.018) | (0.018) | (0.004) | (0.004) |
|  |  |  |  |  |
| Observations | 24,010 | 24,010 | 24,010 | 24,010 |
| R-squared | 0.897 | 0.897 | 0.940 | 0.940 |
| Standard errors in parentheses |  |  |  |  |
| \*\*\* p0.01, \*\* p0.05, \* p0.1 |  |  |  |  |

The columns 1 and 3 consider the same effect for each brand, the columns 2 and 4 estimate a different effect for each brand. The columns 1 and 2 consider a trend, columns 3 and 4 use a combination of dummy variables for year and month.

MANUAL: REMOVE THE CATEGORIES ZERO IN m1-20.marca

## Comparisons by segment

Results by brand type: premium, columns 1 and 2; medium, columns 3 and 4; low, columns 5 and 6. The omitted identifier corresponds to the reference brand.

Fixed Effects by brand type

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | (1) | (2) | (3) | (4) | (5) | (6) |
| VARIABLES | ppu | ppu | ppu | ppu | ppu | ppu |
|  |  |  |  |  |  |  |
| 2.marca | -0.008\*\*\* | -0.007\*\*\* |  |  |  |  |
|  | (0.003) | (0.003) |  |  |  |  |
| 5.marca | 0.008\*\*\* | 0.007\*\*\* |  |  |  |  |
|  | (0.002) | (0.002) |  |  |  |  |
| 1.m1\_20 |  | 0.198\*\*\* |  | 0.119\*\*\* |  | 0.225\*\*\* |
|  |  | (0.019) |  | (0.033) |  | (0.040) |
| 1.m1\_20#2.marca |  | -0.009 |  |  |  |  |
|  |  | (0.032) |  |  |  |  |
| 1.m1\_20#5.marca |  | 0.051\*\* |  |  |  |  |
|  |  | (0.025) |  |  |  |  |
| 1.m1\_21 |  | 0.235\*\*\* |  | 0.188\*\*\* |  | 0.310\*\*\* |
|  |  | (0.019) |  | (0.033) |  | (0.042) |
| 1.m1\_21#2.marca |  | -0.037 |  |  |  |  |
|  |  | (0.031) |  |  |  |  |
| 1.m1\_21#5.marca |  | 0.022 |  |  |  |  |
|  |  | (0.025) |  |  |  |  |
| m1 | -0.018\*\*\* | -0.018\*\*\* | -0.040\*\*\* | -0.040\*\*\* | -0.013 | -0.013 |
|  | (0.004) | (0.004) | (0.007) | (0.007) | (0.009) | (0.009) |
| ym | 0.010\*\*\* | 0.010\*\*\* | 0.009\*\*\* | 0.009\*\*\* | 0.007\*\*\* | 0.007\*\*\* |
|  | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) |
| m1\_20 | 0.219\*\*\* |  | 0.182\*\*\* |  | 0.191\*\*\* |  |
|  | (0.012) |  | (0.021) |  | (0.034) |  |
| m1\_21 | 0.238\*\*\* |  | 0.235\*\*\* |  | 0.231\*\*\* |  |
|  | (0.012) |  | (0.021) |  | (0.036) |  |
| 7.marca |  |  | -0.165\*\*\* | -0.166\*\*\* |  |  |
|  |  |  | (0.004) | (0.004) |  |  |
| 0b.m1\_20#7o.marca |  |  |  | 0.000 |  |  |
|  |  |  |  | (0.000) |  |  |
| 1.m1\_20#7.marca |  |  |  | 0.102\*\* |  |  |
|  |  |  |  | (0.041) |  |  |
| 1.m1\_21#7.marca |  |  |  | 0.076\* |  |  |
|  |  |  |  | (0.040) |  |  |
| 6.marca |  |  |  |  | 0.101\*\*\* | 0.102\*\*\* |
|  |  |  |  |  | (0.007) | (0.007) |
| 1.m1\_20#6.marca |  |  |  |  |  | -0.119\* |
|  |  |  |  |  |  | (0.072) |
| 1.m1\_21#6.marca |  |  |  |  |  | -0.252\*\*\* |
|  |  |  |  |  |  | (0.073) |
| Constant | -4.429\*\*\* | -4.429\*\*\* | -4.040\*\*\* | -4.041\*\*\* | -2.892\*\*\* | -2.895\*\*\* |
|  | (0.019) | (0.019) | (0.037) | (0.037) | (0.051) | (0.051) |
|  |  |  |  |  |  |  |
| Observations | 13,396 | 13,396 | 6,700 | 6,700 | 3,914 | 3,914 |
| R-squared | 0.917 | 0.918 | 0.846 | 0.846 | 0.760 | 0.761 |
| Standard errors in parentheses |  |  |  |  |  |  |
| \*\*\* p0.01, \*\* p0.05, \* p0.1 |  |  |  |  |  |  |

Table with results to test for difference of coeficients in brands.

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) |
|  | Equality of Intercept |  |  | Equality of Tax 2020 |  |  | Equality of Tax 2021 |  |  |
| Equation | Numerator | Denominator | F | Numerator | Denominator | F | Numerator | Denominator | F |
| (2.1) | 6 | 23954 | 10163.44 |  |  |  |  |  |  |
| (2.2) | 6 | 23942 | 10006.08 | 6 | 23942 | 8.15 | 6 | 23942 | 9.14 |
| (2.1) | 2 | 13344 | 19.05 |  |  |  |  |  |  |
| (2.2) | 2 | 13340 | 16.81 | 2 | 13340 | 2.89 | 2 | 13340 | 1.88 |
| (2.1) | 1 | 6649 | 1604.66 |  |  |  |  |  |  |
| (2.2) | 1 | 6647 | 1613.81 | 1 | 6647 | 6.09 | 1 | 6647 | 3.52 |
| (2.1) | 1 | 3867 | 187 |  |  |  |  |  |  |
| (2.2) | 1 | 3865 | 193.13 | 1 | 3865 | 2.74 | 1 | 3865 | 11.8 |
| All tests are significant at 1 percent level |  |  |  |  |  |  |  |  |  |

# Different parameters for each brand

Uses xtsur, user-defined, command. One estimate of each parameter for each brand. The intention was to make a unique model of Seemingly Unrelated Regressions to test the coefficients of the tax change for equality. Unfortunately, it is impossible (using the xtsur routine, in a 4th gen i7 with 16ram) to make the estimation based on the complete sample, with 7 brands. I present the test based on three groups of brands.

## Comparisons by segment

Results for premium brands

|  |  |  |  |
| --- | --- | --- | --- |
|  | (1) | (2) | (3) |
| VARIABLES | ppu1 | ppu2 | ppu5 |
|  |  |  |  |
| m1\_20 | 0.156\*\*\* | 0.135\*\*\* | 0.151\*\*\* |
|  | (0.018) | (0.018) | (0.012) |
| m1\_21 | 0.077 | 0.027 | 0.070 |
|  | (0.000) | (0.000) | (0.000) |
| m1 | 0.024\*\*\* | 0.000 | 0.003 |
|  | (0.004) | (0.004) | (0.002) |
| ym | 0.009\*\*\* | 0.009\*\*\* | 0.009\*\*\* |
|  | (0.000) | (0.000) | (0.000) |
|  |  |  |  |
| Observations | 2,543 | 2,543 | 2,543 |
| Number of cve\_ciudad | 45 | 45 | 45 |
| Standard errors in parentheses |  |  |  |
| \*\*\* p0.01, \*\* p0.05, \* p0.1 |  |  |  |

Results for lower segment brands

|  |  |  |
| --- | --- | --- |
|  | (1) | (2) |
| VARIABLES | ppu3 | ppu6 |
|  |  |  |
| m1\_20 | 0.322\*\*\* | 0.204\*\*\* |
|  | (0.047) | (0.030) |
| m1\_21 | 0.364\*\*\* | 0.446\*\*\* |
|  | (0.047) | (0.030) |
| m1 | 0.009 | -0.035\*\*\* |
|  | (0.015) | (0.010) |
| ym | 0.007\*\*\* | 0.005\*\*\* |
|  | (0.000) | (0.000) |
|  |  |  |
| Observations | 614 | 614 |
| Number of cve\_ciudad | 43 | 43 |
| Standard errors in parentheses |  |  |
| \*\*\* p0.01, \*\* p0.05, \* p0.1 |  |  |

Results for mid-range segment brands

|  |  |  |
| --- | --- | --- |
|  | (1) | (2) |
| VARIABLES | ppu4 | ppu7 |
|  |  |  |
| m1\_20 | 0.150\*\*\* | 0.071\*\*\* |
|  | (0.018) | (0.018) |
| m1\_21 | 0.050\*\*\* | 0.191\*\*\* |
|  | (0.018) | (0.018) |
| m1 | -0.013\*\*\* | -0.018\*\*\* |
|  | (0.005) | (0.005) |
| ym | 0.009\*\*\* | 0.010\*\*\* |
|  | (0.000) | (0.000) |
|  |  |  |
| Observations | 2,112 | 2,112 |
| Number of cve\_ciudad | 43 | 43 |
| Standard errors in parentheses |  |  |
| \*\*\* p0.01, \*\* p0.05, \* p0.1 |  |  |

# Constant Parameters over time

Estimations using xtreg, first static estimations, second dynamic estimates. Separate regression for each brand.

The estimation routine has the possibility to distinguish between fixed or random individual coefficients.

Separate regression for each individual defined by city and brand.

Where i represents a combination of city and brand.

## Static models

The proposed model only uses fixed regressors, the effect of the price change in every january, january 2020 and january 2021,

It includes interactions, for the effect of the price change in january 2020 and january 2021, for different brand-types.

Because there are many omitted variables captured in the individual effects, there is the question of the relevance of them as fixed or random.

The result of the Hausman test for fixed effects does not rule out the non systematic difference in coefficients, this is in favour of the random effects model: Chi2(4) = 0.60,

Similarly the Breusch-Pagan test for random effects does rule out the alternative of OLS : chibar2(01) = 7.5e+05,

The test of unit root, using the Fischer type estimation from Choi (2001): Inverse chi-squared(500) = 1112.8056 , , does not rule out the presence of unit root for any panel (defined as a combination of city and brand), except for the model that includes a drift. The result suggests to consider different trends for each brand or city, there is an estimation by brand to test for unit roots by specifications of the panel.

Next are the results from the complete sample. First two columns and last two columns are estimated using random effects. The third column using fixed effects, since the next estimates by brand suggest that most brands have fixed effects for city.

Fixed Effects for brand and city by brand type

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | (1) | (2) | (3) | (4) | (5) |
| VARIABLES | ppu | ppu | ppu | ppu | ppu |
|  |  |  |  |  |  |
| 2.marca | -0.013 | -0.013 |  | -0.009 | -0.008 |
|  | (0.024) | (0.022) |  | (0.018) | (0.017) |
| 3.marca | -0.605\*\*\* | -0.604\*\*\* |  | -0.603\*\*\* | -0.602\*\*\* |
|  | (0.024) | (0.022) |  | (0.018) | (0.017) |
| 4.marca | -0.274\*\*\* | -0.272\*\*\* |  | -0.269\*\*\* | -0.268\*\*\* |
|  | (0.024) | (0.021) |  | (0.017) | (0.017) |
| 5.marca | 0.004 | 0.004 |  | 0.007 | 0.007 |
|  | (0.022) | (0.020) |  | (0.016) | (0.016) |
| 6.marca | -0.502\*\*\* | -0.500\*\*\* |  | -0.505\*\*\* | -0.503\*\*\* |
|  | (0.028) | (0.026) |  | (0.021) | (0.020) |
| 7.marca | -0.426\*\*\* | -0.425\*\*\* |  | -0.443\*\*\* | -0.442\*\*\* |
|  | (0.023) | (0.021) |  | (0.017) | (0.017) |
| m1\_20 | 0.202\*\*\* | 0.230\*\*\* | 0.230\*\*\* | -0.015\*\* | 0.012 |
|  | (0.010) | (0.021) | (0.021) | (0.007) | (0.015) |
| m1\_21 | 0.232\*\*\* | 0.276\*\*\* | 0.275\*\*\* | -0.012 | 0.027\* |
|  | (0.010) | (0.021) | (0.021) | (0.008) | (0.016) |
| 1.m1\_20#2.marca |  |  |  |  | -0.011 |
|  |  |  |  |  | (0.026) |
| 1.m1\_20#3.marca |  |  |  |  | -0.103\*\*\* |
|  |  |  |  |  | (0.027) |
| 1.m1\_20#4.marca |  |  |  |  | -0.129\*\*\* |
|  |  |  |  |  | (0.024) |
| 1.m1\_20#5.marca |  |  |  |  | 0.052\*\*\* |
|  |  |  |  |  | (0.020) |
| 1.m1\_20#6.marca |  |  |  |  | -0.195\*\*\* |
|  |  |  |  |  | (0.039) |
| 1.m1\_20#7.marca |  |  |  |  | -0.040\* |
|  |  |  |  |  | (0.021) |
| 1.m1\_21#2.marca |  |  |  |  | -0.039 |
|  |  |  |  |  | (0.025) |
| 1.m1\_21#3.marca |  |  |  |  | -0.100\*\*\* |
|  |  |  |  |  | (0.029) |
| 1.m1\_21#4.marca |  |  |  |  | -0.113\*\*\* |
|  |  |  |  |  | (0.024) |
| 1.m1\_21#5.marca |  |  |  |  | 0.022 |
|  |  |  |  |  | (0.020) |
| 1.m1\_21#6.marca |  |  |  |  | -0.360\*\*\* |
|  |  |  |  |  | (0.039) |
| 1.m1\_21#7.marca |  |  |  |  | -0.033 |
|  |  |  |  |  | (0.021) |
| m1 | -0.023\*\*\* | -0.023\*\*\* | -0.023\*\*\* | -0.070\*\*\* | -0.070\*\*\* |
|  | (0.003) | (0.003) | (0.003) | (0.003) | (0.003) |
| ym | 0.009\*\*\* | 0.009\*\*\* | 0.009\*\*\* |  |  |
|  | (0.000) | (0.000) | (0.000) |  |  |
| 2.marca#1.m1\_20 |  | -0.012 | -0.011 |  |  |
|  |  | (0.037) | (0.037) |  |  |
| 3.marca#1.m1\_20 |  | -0.109\*\*\* | -0.108\*\*\* |  |  |
|  |  | (0.039) | (0.039) |  |  |
| 4.marca#1.m1\_20 |  | -0.125\*\*\* | -0.124\*\*\* |  |  |
|  |  | (0.034) | (0.034) |  |  |
| 5.marca#1.m1\_20 |  | 0.056\*\* | 0.056\*\* |  |  |
|  |  | (0.028) | (0.028) |  |  |
| 6.marca#1.m1\_20 |  | -0.194\*\*\* | -0.191\*\*\* |  |  |
|  |  | (0.056) | (0.056) |  |  |
| 7.marca#1.m1\_20 |  | -0.052\* | -0.053\* |  |  |
|  |  | (0.030) | (0.030) |  |  |
| 2.marca#1.m1\_21 |  | -0.047 | -0.051 |  |  |
|  |  | (0.036) | (0.036) |  |  |
| 3.marca#1.m1\_21 |  | -0.101\*\* | -0.101\*\* |  |  |
|  |  | (0.041) | (0.041) |  |  |
| 4.marca#1.m1\_21 |  | -0.117\*\*\* | -0.118\*\*\* |  |  |
|  |  | (0.034) | (0.034) |  |  |
| 5.marca#1.m1\_21 |  | 0.027 | 0.027 |  |  |
|  |  | (0.028) | (0.028) |  |  |
| 6.marca#1.m1\_21 |  | -0.364\*\*\* | -0.364\*\*\* |  |  |
|  |  | (0.056) | (0.056) |  |  |
| 7.marca#1.m1\_21 |  | -0.053\* | -0.051\* |  |  |
|  |  | (0.030) | (0.030) |  |  |
| Constant | -3.940\*\*\* | -3.940\*\*\* | -4.137\*\*\* | 1.989\*\*\* | 1.989\*\*\* |
|  | (0.023) | (0.022) | (0.017) | (0.012) | (0.012) |
|  |  |  |  |  |  |
| Observations | 23,926 | 23,926 | 23,926 | 23,926 | 23,926 |
| Number of gr\_marca\_ciudad | 263 | 263 | 263 | 263 | 263 |
| R-squared |  |  | 0.866 |  |  |
| Standard errors in parentheses |  |  |  |  |  |
| \*\*\* p0.01, \*\* p0.05, \* p0.1 |  |  |  |  |  |

F tests show in the specification in this stage does reject equality of coeficients.

Next are the results for brand type.

Fixed Effects/Random Effects for brand and city by brand type

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | (1) | (2) | (3) | (4) | (5) | (6) |
| VARIABLES | ppu | ppu | ppu | ppu | ppu | ppu |
|  |  |  |  |  |  |  |
| 4.marca |  |  | -4.013\*\*\* | 0.150\*\*\* |  |  |
|  |  |  | (0.041) | (0.028) |  |  |
| 1.m1\_20 |  | 0.196\*\*\* |  | 0.132\*\*\* |  | 0.212\*\*\* |
|  |  | (0.018) |  | (0.030) |  | (0.037) |
| 1.m1\_20#7.marca |  |  |  | 0.071\* |  |  |
|  |  |  |  | (0.037) |  |  |
| 1.m1\_21 |  | 0.233\*\*\* |  | 0.251\*\*\* |  | 0.295\*\*\* |
|  |  | (0.018) |  | (0.024) |  | (0.040) |
| 1.m1\_21#4.marca |  |  |  | -0.062\* |  |  |
|  |  |  |  | (0.037) |  |  |
| m1 | -0.018\*\*\* | -0.018\*\*\* | -0.039\*\*\* | -0.039\*\*\* | -0.012 | -0.012 |
|  | (0.004) | (0.004) | (0.006) | (0.006) | (0.008) | (0.008) |
| ym | 0.010\*\*\* | 0.010\*\*\* | 0.009\*\*\* | 0.009\*\*\* | 0.007\*\*\* | 0.007\*\*\* |
|  | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) |
| 1.m1\_20#2.marca |  | -0.012 |  |  |  |  |
|  |  | (0.031) |  |  |  |  |
| 1.m1\_20#5.marca |  | 0.053\*\* |  |  |  |  |
|  |  | (0.024) |  |  |  |  |
| 1.m1\_21#2.marca |  | -0.049 |  |  |  |  |
|  |  | (0.030) |  |  |  |  |
| 1.m1\_21#5.marca |  | 0.024 |  |  |  |  |
|  |  | (0.024) |  |  |  |  |
| m1\_20 | 0.218\*\*\* |  | 0.176\*\*\* |  | 0.190\*\*\* |  |
|  | (0.011) |  | (0.019) |  | (0.032) |  |
| m1\_21 | 0.235\*\*\* |  | 0.228\*\*\* |  | 0.217\*\*\* |  |
|  | (0.011) |  | (0.019) |  | (0.034) |  |
| 7.marca |  |  | -4.162\*\*\* |  |  |  |
|  |  |  | (0.041) |  |  |  |
| 1.m1\_20#6.marca |  |  |  |  |  | -0.078 |
|  |  |  |  |  |  | (0.068) |
| 1.m1\_21#6.marca |  |  |  |  |  | -0.245\*\*\* |
|  |  |  |  |  |  | (0.069) |
| Constant | -4.417\*\*\* | -4.416\*\*\* |  | -4.164\*\*\* | -2.961\*\*\* | -2.963\*\*\* |
|  | (0.019) | (0.019) |  | (0.041) | (0.050) | (0.049) |
|  |  |  |  |  |  |  |
| Observations | 13,396 | 13,396 | 6,620 | 6,620 | 3,910 | 3,910 |
| R-squared | 0.916 | 0.916 |  |  | 0.720 | 0.721 |
| Number of gr\_marca\_ciudad | 126 | 126 | 80 | 80 | 57 | 57 |
| Standard errors in parentheses |  |  |  |  |  |  |
| \*\*\* p0.01, \*\* p0.05, \* p0.1 |  |  |  |  |  |  |

By brand type, for premium(1) and low(3) brand types the Hausman test rejects the alternative of random effects in favour of fixed individual effects. The test for type 1 and 3 are Chi2(4) = 0.60, and Chi2(4) = 0.60, , respectively.

Similarly the Breusch-Pagan test for random effects does rule out the alternative of OLS : chibar2(01) = 7.5e+05,

The test of unit root, using the Fischer type estimation from Choi (2001): Inverse chi-squared(500) = 1112.8056 , , does not rule out the presence of unit root for any panel (defined as a combination of city and brand), except for the model that includes a drift. The result suggests to consider different trends for each brand or city, there is an estimation by brand to test for unit roots by specifications of the panel.

F tests or Chi2 estimated for equality of coeficients.

Testing difference in brand effects, F corresponds to models by fixed effects, chi2 corresponds to models estimated by random effects.

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) |
|  | Equality of Intercept |  |  | Equality of Tax 2020 |  |  | Equality of Tax 2021 |  |  |
| Equation | Num/gl-chi2 | Den | F/Chi2 | Num/gl-chi2 | Den | F/Chi2 | Num/gl-chi2 | Den | F/Chi2 |
| (4.1) | 6 |  | 1287.39\*\*\* |  |  |  |  |  |  |
| (4.2) | 6 |  | 1547.03\*\*\* | 6 |  | 51.86\*\*\* | 6 |  | 67.31\*\*\* |
| (4.1) | 125 | 13266 | 22.32\*\*\* |  |  |  |  |  |  |
| (4.2) | 125 | 13262 | 22.32\*\*\* | 2 | 13262 | 3.51\*\* | 2 | 13262 | 3.08\*\*\* |
| (4.1) | 2 |  | 11224.48\*\*\* |  |  |  |  |  |  |
| (4.2) | 1 |  | 28.63\*\*\* | 1 |  | 3.62\* | 1 |  | 2.85\* |
| (4.1) | 56 | 3849 | 41.93\*\*\* |  |  |  |  |  |  |
| (4.2) | 56 | 3847 | 42.17\*\*\* | 1 | 3847 | 1.32 | 1 | 3847 | 12.43\* |
| \*\*\* p0.01, \*\* p0.05, \* p0.1 |  |  |  |  |  |  |  |  |  |

The next table presents the static results by brand. Considering the Hausman test, the model was estimated using random or fixed effects, for each brand. The column number corresponds to the brand label.

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
|  | (1) | (2) | (3) | (4) | (5) | (6) | (7) |
| VARIABLES | ppu | ppu | ppu | ppu | ppu | ppu | ppu |
|  |  |  |  |  |  |  |  |
| m1\_20 | 0.193\*\*\* | 0.202\*\*\* | 0.202\*\*\* | 0.202\*\*\* | 0.202\*\*\* | 0.202\*\*\* | 0.202\*\*\* |
|  | (0.018) | (0.010) | (0.010) | (0.010) | (0.010) | (0.010) | (0.010) |
| m1\_21 | 0.231\*\*\* | 0.232\*\*\* | 0.232\*\*\* | 0.232\*\*\* | 0.232\*\*\* | 0.232\*\*\* | 0.232\*\*\* |
|  | (0.018) | (0.010) | (0.010) | (0.010) | (0.010) | (0.010) | (0.010) |
| m1 | -0.013\*\* | -0.023\*\*\* | -0.023\*\*\* | -0.023\*\*\* | -0.023\*\*\* | -0.023\*\*\* | -0.023\*\*\* |
|  | (0.006) | (0.003) | (0.003) | (0.003) | (0.003) | (0.003) | (0.003) |
| ym | 0.010\*\*\* | 0.009\*\*\* | 0.009\*\*\* | 0.009\*\*\* | 0.009\*\*\* | 0.009\*\*\* | 0.009\*\*\* |
|  | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) |
|  |  |  |  |  |  |  |  |
| Observations | 4,650 | 23,926 | 23,926 | 23,926 | 23,926 | 23,926 | 23,926 |
| R-squared | 0.921 | 0.865 | 0.865 | 0.865 | 0.865 | 0.865 | 0.865 |
| Number of gr\_marca\_ciudad | 44 | 263 | 263 | 263 | 263 | 263 | 263 |
| Standard errors in parentheses |  |  |  |  |  |  |  |
| \*\*\* p0.01, \*\* p0.05, \* p0.1 |  |  |  |  |  |  |  |

## Dynamic models

Since we cannot rule the presence of unit roots for each panel, by city, except for a model with drift, an alternative is to consider dynamics in the equation, in particular the lagged dependent variable.

Similar to the previous section, estimations include interactions, to consider the effect of the price change in every january, january 2020 and january 2021.

The table shows the results prefered by the Hausmann test, in this case fixed effects. It shows also the estimates by type. The first two columns correspond to the model estimation without interactions. The third and fourth include interactions by brand. The fifth and sixth columns consider interactions by brand type. Columns 2, 4 and 6 present, for reference, an estimation without lagged dependent variable.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | (1) | (2) | (3) | (4) | (5) | (6) |
| VARIABLES | ppu | ppu | ppu | ppu | ppu | ppu |
|  |  |  |  |  |  |  |
| m1\_20 | 0.182\*\*\* | 0.202\*\*\* | 0.207\*\*\* | 0.230\*\*\* |  | 0.253\*\*\* |
|  | (0.003) | (0.010) | (0.006) | (0.021) |  | (0.013) |
| m1\_21 | 0.044\*\*\* | 0.232\*\*\* | 0.083\*\*\* | 0.275\*\*\* |  | 0.278\*\*\* |
|  | (0.003) | (0.010) | (0.006) | (0.021) |  | (0.013) |
| m1 | 0.022\*\*\* | -0.023\*\*\* | 0.022\*\*\* | -0.023\*\*\* | 0.022\*\*\* | -0.023\*\*\* |
|  | (0.001) | (0.003) | (0.001) | (0.003) | (0.001) | (0.003) |
| ym | 0.000\*\*\* | 0.009\*\*\* | 0.000\*\*\* | 0.009\*\*\* | 0.000\*\*\* | 0.009\*\*\* |
|  | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) |
| 2.marca#1.m1\_20 |  |  | -0.018\* | -0.011 |  |  |
|  |  |  | (0.010) | (0.037) |  |  |
| 3.marca#1.m1\_20 |  |  | -0.043\*\*\* | -0.108\*\*\* |  |  |
|  |  |  | (0.010) | (0.039) |  |  |
| 4.marca#1.m1\_20 |  |  | -0.088\*\*\* | -0.124\*\*\* |  |  |
|  |  |  | (0.009) | (0.034) |  |  |
| 5.marca#1.m1\_20 |  |  | 0.031\*\*\* | 0.056\*\* |  |  |
|  |  |  | (0.008) | (0.028) |  |  |
| 6.marca#1.m1\_20 |  |  | -0.049\*\*\* | -0.191\*\*\* |  |  |
|  |  |  | (0.015) | (0.056) |  |  |
| 7.marca#1.m1\_20 |  |  | -0.073\*\*\* | -0.053\* |  |  |
|  |  |  | (0.008) | (0.030) |  |  |
| 2.marca#1.m1\_21 |  |  | -0.069\*\*\* | -0.051 |  |  |
|  |  |  | (0.010) | (0.036) |  |  |
| 3.marca#1.m1\_21 |  |  | -0.023\*\* | -0.101\*\* |  |  |
|  |  |  | (0.011) | (0.041) |  |  |
| 4.marca#1.m1\_21 |  |  | -0.083\*\*\* | -0.118\*\*\* |  |  |
|  |  |  | (0.009) | (0.034) |  |  |
| 5.marca#1.m1\_21 |  |  | -0.013\* | 0.027 |  |  |
|  |  |  | (0.008) | (0.028) |  |  |
| 6.marca#1.m1\_21 |  |  | -0.059\*\*\* | -0.364\*\*\* |  |  |
|  |  |  | (0.015) | (0.056) |  |  |
| 7.marca#1.m1\_21 |  |  | -0.069\*\*\* | -0.051\* |  |  |
|  |  |  | (0.008) | (0.030) |  |  |
| L.ppu | 0.967\*\*\* |  | 0.966\*\*\* |  | 0.967\*\*\* |  |
|  | (0.002) |  | (0.002) |  | (0.002) |  |
| 2.tipo#1.m1\_20 |  |  |  |  | -0.089\*\*\* |  |
|  |  |  |  |  | (0.006) |  |
| 3.tipo#1.m1\_20 |  |  |  |  | -0.055\*\*\* |  |
|  |  |  |  |  | (0.008) |  |
| 2.tipo#1.m1\_21 |  |  |  |  | -0.056\*\*\* |  |
|  |  |  |  |  | (0.006) |  |
| 3.tipo#1.m1\_21 |  |  |  |  | -0.016\* |  |
|  |  |  |  |  | (0.009) |  |
| Constant | -0.170\*\*\* | -4.138\*\*\* | -0.171\*\*\* | -4.137\*\*\* | -0.170\*\*\* | -4.137\*\*\* |
|  | (0.009) | (0.017) | (0.009) | (0.017) | (0.009) | (0.017) |
|  |  |  |  |  |  |  |
| Observations | 23,616 | 23,926 | 23,616 | 23,926 | 23,616 | 23,926 |
| R-squared | 0.990 | 0.865 | 0.990 | 0.866 | 0.990 | 0.866 |
| Number of gr\_marca\_ciudad | 262 | 263 | 262 | 263 | 262 | 263 |
| Standard errors in parentheses |  |  |  |  |  |  |
| \*\*\* p0.01, \*\* p0.05, \* p0.1 |  |  |  |  |  |  |

The results show that the lag effect is captured, when ommitted, by the parameter of the linear trend and the effect of the tax in january 2021.

Estimates by type.

|  |  |  |  |
| --- | --- | --- | --- |
|  | (1) | (2) | (3) |
| VARIABLES | ppu | ppu | ppu |
|  |  |  |  |
| 1.m1\_20 | 0.199\*\*\* | 0.199\*\*\* | 0.199\*\*\* |
|  | (0.005) | (0.005) | (0.005) |
| 1.m1\_20#2.marca | -0.018\*\* | -0.018\*\* | -0.018\*\* |
|  | (0.009) | (0.009) | (0.009) |
| 1.m1\_20#5.marca | 0.031\*\*\* | 0.031\*\*\* | 0.031\*\*\* |
|  | (0.007) | (0.007) | (0.007) |
| 1.m1\_21 | 0.076\*\*\* | 0.076\*\*\* | 0.076\*\*\* |
|  | (0.005) | (0.005) | (0.005) |
| 1.m1\_21#2.marca | -0.069\*\*\* | -0.069\*\*\* | -0.069\*\*\* |
|  | (0.008) | (0.008) | (0.008) |
| 1.m1\_21#5.marca | -0.013\*\* | -0.013\*\* | -0.013\*\* |
|  | (0.007) | (0.007) | (0.007) |
| m1 | 0.030\*\*\* | 0.030\*\*\* | 0.030\*\*\* |
|  | (0.001) | (0.001) | (0.001) |
| ym | 0.000\*\*\* | 0.000\*\*\* | 0.000\*\*\* |
|  | (0.000) | (0.000) | (0.000) |
| L.ppu | 0.961\*\*\* | 0.961\*\*\* | 0.961\*\*\* |
|  | (0.002) | (0.002) | (0.002) |
| Constant | -0.195\*\*\* | -0.195\*\*\* | -0.195\*\*\* |
|  | (0.012) | (0.012) | (0.012) |
|  |  |  |  |
| Observations | 13,255 | 13,255 | 13,255 |
| R-squared | 0.994 | 0.994 | 0.994 |
| Number of gr\_marca\_ciudad | 125 | 125 | 125 |
| Standard errors in parentheses |  |  |  |
| \*\*\* p0.01, \*\* p0.05, \* p0.1 |  |  |  |

MANUAL: REMOVE THE ZEROS

Interpretation: With premium for the first label, it shows that the medium brands have the smallest tax impact , although, counterintuitively the lowest impact is estimated for the medium brands with a decrease of 8.9 cents while the lower brand only decreased 5 cents, both with respect to the premium brands average.

F tests for equality of coeficients, the significant indicate there is difference in the coeficients, the first two rows correspond to the complete sample. The third and fourth to the premium brands, where the equality is still relevant. Fifth and sixth rows are medium brands, where only is difference for the impact of the tax in 2021. The last two rows correspond to the lower priced brands, here there is no difference in the coefficients for each brand.

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) |
|  | Equality of Intercept |  |  | Equality of Tax 2020 |  |  | Equality of Tax 2021 |  |  |
| Equation | Num | Den | F | Num | Den | F | Num | Den | F |
| (4.3) | 261 | 23349 | 1.6\*\*\* |  |  |  |  |  |  |
| (4.4) | 261 | 23337 | 1.62\*\*\* | 6 | 23337 | 47.36\*\*\* | 6 | 23337 | 25.88\*\*\* |
| (4.3) | 124 | 13125 | 0.59 |  |  |  |  |  |  |
| (4.4) | 124 | 13121 | 0.6 | 2 | 13121 | 20.34\*\*\* | 2 | 13121 | 35.05\*\*\* |
| (4.3) | 79 | 6439 | 0.92 |  |  |  |  |  |  |
| (4.4) | 79 | 6437 | 0.93 | 1 | 6437 | 2.17 | 1 | 6437 | 1.9\*\*\* |
| (4.3) | 56 | 3775 | 0.94 |  |  |  |  |  |  |
| (4.4) | 56 | 3773 | 0.95 | 1 | 3773 | 0.1 | 1 | 3773 | 2.93 |
| \*\*\* p0.01, \*\* p0.05, \* p0.1 |  |  |  |  |  |  |  |  |  |

# Consistent estimation for Variable Intercept

This models are based on Andrews, et al. (2006). The initial model comes from the transformation of:

Given the interest only on the fixed independent variables, we can define an heterogeneity measure on brand and city (s), take the averages at that level, and make the transformation of variables, following:

Results in the left have the same estimate for the effect. Estimates in second column correspond to the first labeled brand, Benson.

|  |  |  |
| --- | --- | --- |
|  | (1) | (2) |
| VARIABLES | dm\_ppu\_cm | dm\_ppu\_cm |
|  |  |  |
| dm\_m1\_20\_cm | 0.202\*\*\* | 0.230\*\*\* |
|  | (0.010) | (0.021) |
| dm\_m1\_21\_cm | 0.232\*\*\* | 0.275\*\*\* |
|  | (0.010) | (0.021) |
| dm\_m1\_cm | -0.023\*\*\* | -0.023\*\*\* |
|  | (0.003) | (0.003) |
| ym | 0.009\*\*\* | 0.009\*\*\* |
|  | (0.000) | (0.000) |
|  |  |  |
| Observations | 23,926 | 23,926 |
| R-squared | 0.865 | 0.866 |
| Number of gr\_marca\_ciudad | 263 | 263 |
| Standard errors in parentheses |  |  |
| \*\*\* p0.01, \*\* p0.05, \* p0.1 |  |  |

RESULTADOS DE PRUEBAS DE DIFERENCIA DEL EFECTO POR MARCA FUERON NO SIGNIFICATIVOS.