

# The Impact of Economic Downturns on Income Elasticity of Demand

PreSort Barcoded Small Letters



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diversifiedspecifics

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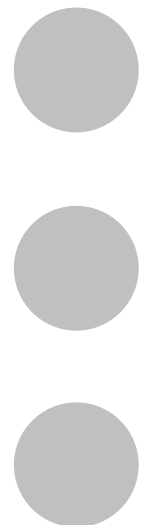
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# 1.0 ECONOMIC SLOWDOWN



## 1.1. RECENT ELASTICITY MOVEMENTS

### 1.1.1 Income Elasticity

As part of Diversified Specifics ongoing efforts to maintain and refine a complete set of predictive and explanatory mail volume models at Australia Post the following study was undertaken to analyse the degree to which the prevailing income elasticity estimates for bulk small letter items hold during conflicting periods of economic growth.

The preferred PreSort Barcoded Small Letter volume model was developed using quarterly data from the September quarter 1995 to the December quarter 2008 i.e. a total of 54 quarterly observations.

Over that period, the income elasticity of demand approximated unitary elasticity (estimated at 0.987).

Truncating the model timeframe however reveals that the income elasticity of demand has increased substantially over the course of the past six months.

Specifically, the demand for PreSort Barcoded Small Letter volumes has become increasingly elastic, as seasonally adjusted non-farm quarterly economic growth declined in the September and December quarters of 2008.

Non-farm economic growth declined by 0.6% in the September quarter 2008 and declined by 0.9% in the December quarter 2008.

At the same time, the income elasticity estimate increased by 3.5% in the September quarter 2008 and by 4.4% in the December quarter 2008.

Despite the estimated income elasticity of demand not being statistically significantly different from one another<sup>1</sup>, there does appear to be some preliminary support that demand for PreSort Barcoded Small Letter volumes may be increasingly elastic during times of economic downturn.

This however, would need to be substantiated over a longer timeframe and in a more robust manner than presented in this example and Section 2 of this document seeks to conduct such an analysis.

Table 1.1.1.1 summarises the income elasticity estimates for the PreSort Barcoded Small Letter volumes model over the total and truncated model timeframes.

**Table 1.1.1.1**

| Variable                          | Timeframe<br>(Quarterly) | Elasticity<br>Estimate | 95% confidence interval     |
|-----------------------------------|--------------------------|------------------------|-----------------------------|
| Real GDP (Non-farm) <sup>*#</sup> | Sep95 – Dec08            | 0.987                  | Lower: 0.837   Upper: 1.137 |
| Real GDP (Non-farm) <sup>*#</sup> | Sep95 – Sep08            | 0.945                  | Lower: 0.796   Upper: 1.095 |
| Real GDP (Non-farm) <sup>*#</sup> | Sep95 – Jun08            | 0.913                  | Lower: 0.759   Upper: 1.067 |
| Real GDP (Non-farm) <sup>*#</sup> | Sep95 – Mar08            | 0.875                  | Lower: 0.715   Upper: 1.034 |
| Real GDP (Non-farm) <sup>*#</sup> | Sep95 – Dec07            | 0.871                  | Lower: 0.704   Upper: 1.038 |
| Real GDP (Non-farm) <sup>*#</sup> | Sep95 – Sep07            | 0.858                  | Lower: 0.684   Upper: 1.031 |
| Real GDP (Non-farm) <sup>*#</sup> | Sep95 – Jun07            | 0.871                  | Lower: 0.689   Upper: 1.053 |

*\*Denotes: Seasonally Adjusted Variable*

*#Denotes: Natural Logarithm*

<sup>1</sup> This is evident by each of the elasticity estimates over the truncated timeframes falling within each of the determined 95% confidence intervals for Real Non-farm GDP.

Table 1.1.1.2 highlights the quarterly percentage changes in both Non-farm GDP and the PreSort Barcoded small letter income elasticity estimates.

**Table 1.1.1.2**

| Quarter | Real Non-farm GDP* | PreSort Barcoded Small Letter Income Elasticity | Non-farm GDP* (Quarterly Percentage Change) | PreSort Barcoded Small Letter Income Elasticity (Quarterly Percentage Change) |
|---------|--------------------|---|---|---|
| Jun-07  | 260862.95          | 0.871   |   |   |
| Sep-07  | 263083.06          | 0.858   | 0.9%  | -1.5%   |
| Dec-07  | 263291.59          | 0.871   | 0.1%  | 1.5%  |
| Mar-08  | 264788.00          | 0.875   | 0.6%  | 0.5%  |
| Jun-08  | 268415.25          | 0.913   | 1.4%  | 4.3%  |
| Sep-08  | 266769.06          | 0.945   | -0.6%                                       | 3.5%  |
| Dec-08  | 264403.66          | 0.987   | -0.9%                                       | 4.4%  |

\*Denotes: Seasonally Adjusted Variable  
#Denotes: Natural Logarithm

Consolidating the above findings graphically highlights the estimated PreSort Barcoded small letter income elasticity has increased for each successive quarter from September 2007 to December 2008 (see Chart 1.1.1.1).

In reality however, the estimated income elasticity of demand only significantly changed from the June quarter 2008.

As previously noted, Non-farm GDP growth has been positive for each of the examined quarters except for the final two i.e. the September and December quarters of 2008.

**Chart 1.1.1.1**

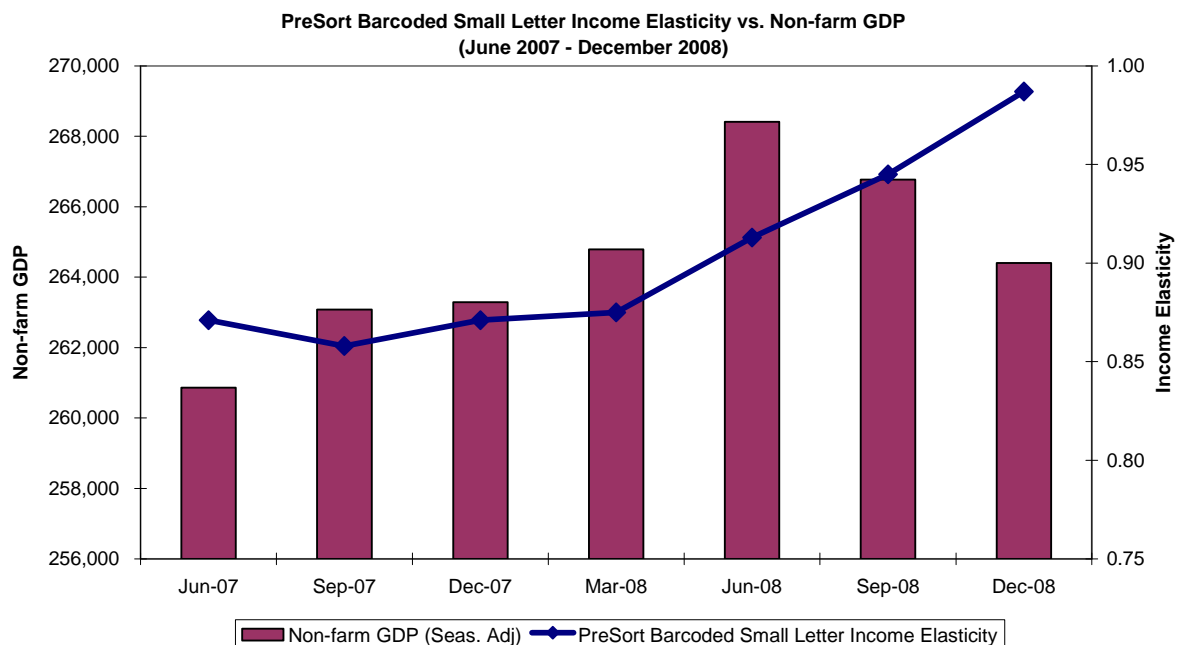
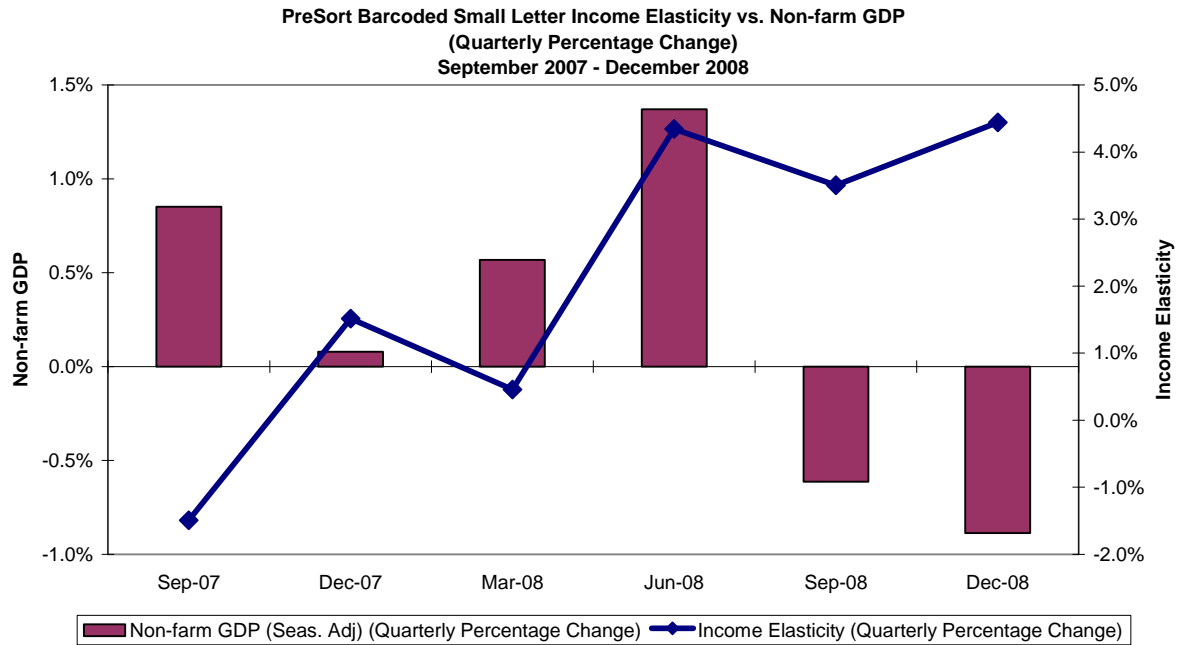


Chart 1.1.1.2 below graphically depicts the quarterly growth movements in both the estimated PreSort Barcoded small letter income elasticity and Non-farm GDP.

Whilst no conclusive pattern is evident, there is preliminary evidence that demand for PreSort Barcoded Small Letter volumes may be increasingly elastic during times of economic downturn.

**Chart 1.1.1.2**



### 1.1.2 Advertising Industry Elasticity

In contrast to the estimated PreSort Barcoded small letter income elasticity, the Advertising Industry Health Measure elasticity estimate became less elastic as the economy slowed down in the last two quarters.

The Advertising Industry Health Measure elasticity of demand was estimated to be 0.119 as at December quarter 2008; compared to 0.144 as at the September quarter 2008; 0.155 as at the June quarter 2008 and approximately 0.165 in the remaining periods to June 2007.

The Advertising Industry Health Measure itself, declined significantly from over the June quarter 2007 to December quarter 2008 period.

Specifically, the Advertising Industry Health Measure i.e. the S&P/ASX 200 Consumer Discretionary Index, fell by 58% since the June quarter 2007.

Table 1.1.2.1 below summarises the Advertising Industry Health Measure elasticity estimate for the PreSort Barcoded Small Letter volumes model over the total and truncated model timeframes.

**Table 1.1.2.1**

| Variable   | Timeframe (Quarterly) | Elasticity Estimate | 95% confidence interval     |
|--|-----------------------|---------------------|-----------------------------|
| Advertising industry health measure <sup>#</sup> | Sep95 – Dec08         | 0.119               | Lower: 0.065   Upper: 0.173 |
| Advertising industry health measure <sup>#</sup> | Sep95 – Sep08         | 0.144               | Lower: 0.088   Upper: 0.200 |
| Advertising industry health measure <sup>#</sup> | Sep95 – Jun08         | 0.155               | Lower: 0.097   Upper: 0.213 |
| Advertising industry health measure <sup>#</sup> | Sep95 – Mar08         | 0.164               | Lower: 0.106   Upper: 0.222 |
| Advertising industry health measure <sup>#</sup> | Sep95 – Dec07         | 0.165               | Lower: 0.106   Upper: 0.223 |
| Advertising industry health measure <sup>#</sup> | Sep95 – Sep07         | 0.164               | Lower: 0.104   Upper: 0.223 |
| Advertising industry health measure <sup>#</sup> | Sep95 – Jun07         | 0.165               | Lower: 0.105   Upper: 0.225 |

*\*Denotes: Seasonally Adjusted Variable*

*#Denotes: Natural Logarithm*

Table 1.1.2.2 highlights the quarterly percentage change in both the Advertising Industry Health Measure and the Advertising Industry Health Measure elasticity estimate. Both variables have trended downwards over the June quarter 2007 to December quarter 2008 period.

**Table 1.1.2.2**

| Quarter | Advertising Industry Health Measure | Advertising Industry Health Measure Elasticity Estimate | Advertising Industry Health Measure (Quarterly Percentage Change) | Advertising Industry Health Measure Elasticity Estimate (Quarterly Percentage Change) |
|---------|-------------------------------------|---|---|---|
| Jun-07  | 3652589.00                          | 0.165   |   |   |
| Sep-07  | 3453559.00                          | 0.164   | -5.4%   | -0.6%   |
| Dec-07  | 3408487.00                          | 0.165   | -1.3%   | 0.6%  |
| Mar-08  | 2888719.00                          | 0.164   | -15.2%  | -0.6%   |
| Jun-08  | 2377116.00                          | 0.155   | -17.7%  | -5.5%   |
| Sep-08  | 2046343.00                          | 0.144   | -13.9%  | -7.1%   |
| Dec-08  | 1549273.00                          | 0.119   | -24.3%  | -17.4%  |

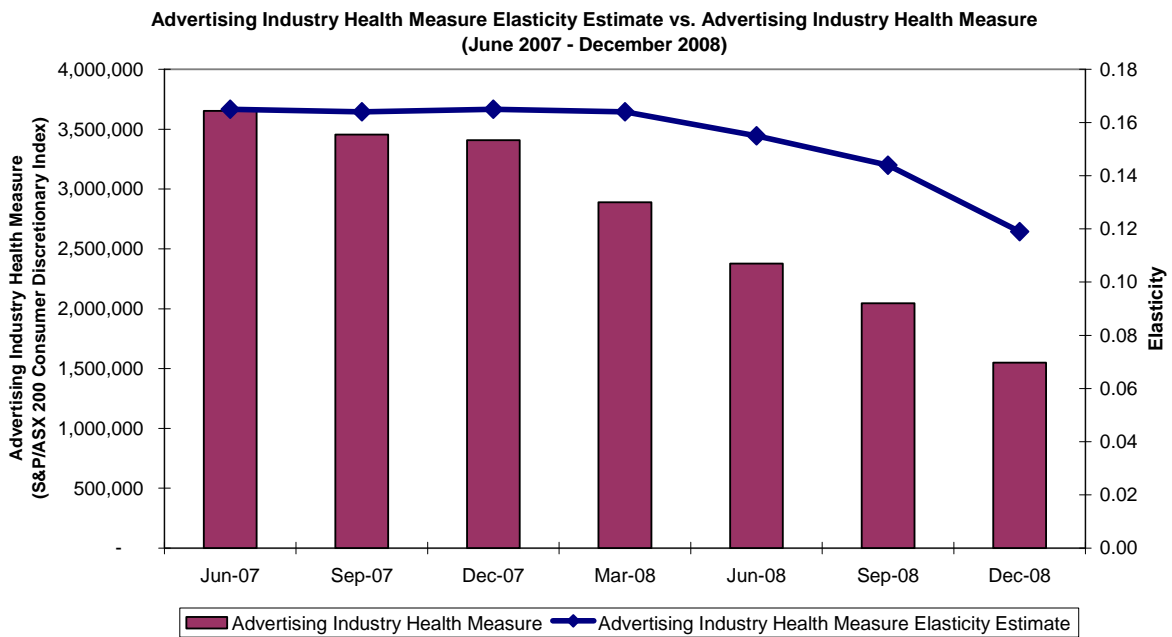


Chart 1.1.2.1 and Chart 1.1.2.2 illustrate that both the Advertising Industry Health Measure and the Advertising Industry Health Measure elasticity estimate have trended downwards over the June quarter 2007 to December quarter 2008 period.

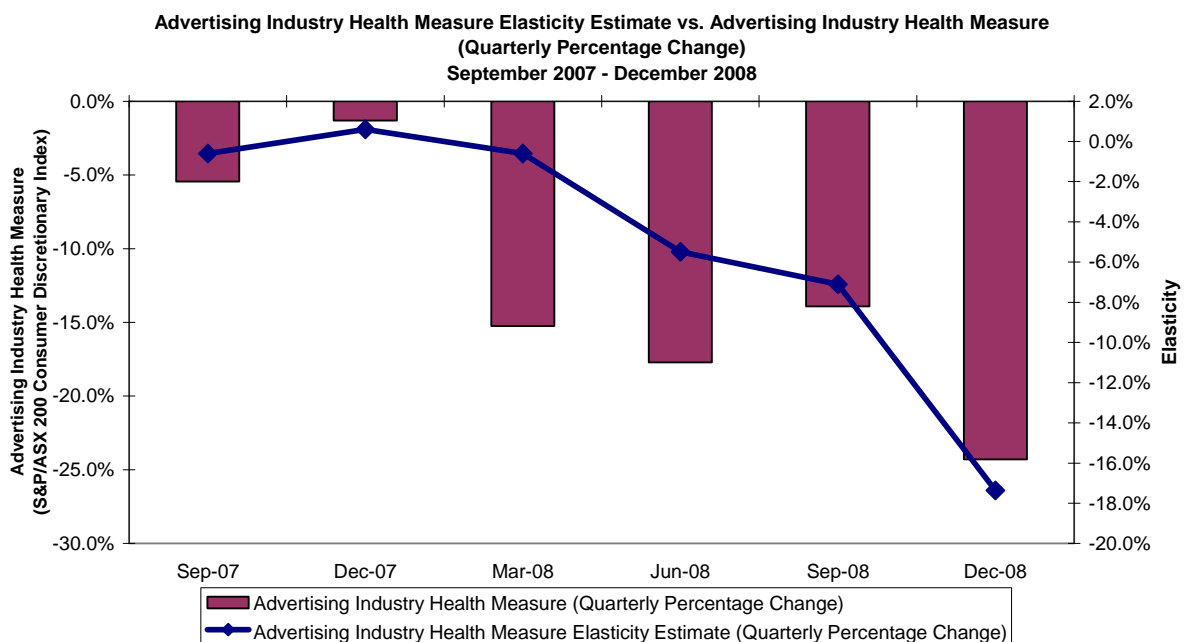
In effect, the Advertising Industry Health Measure's lower demand elasticity, suggests that fluctuations in the health of the advertising industry are now expected to have less overall influence on PreSort Barcoded small letter volume demand compared to its previous estimated impact.

Simultaneously, fluctuations in Non-farm GDP are now expected to have more influence on PreSort Barcoded small letter volume demand, due to the increased elasticity estimate associated with the recent deterioration on economic activity.

**Chart 1.1.2.1**



**Chart 1.1.2.2**



## 2.0 ECONOMETRIC ANALYSIS



## 2.1. INCOME ELASTICITY & GDP

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Section 1.1.1 of this document provided preliminary evidence that demand for PreSort Barcoded Small Letter volumes may be more elastic during times of economic downturn.

In other words, preliminary support was presented that suggested that, all else being equal, the negative impact of a given percentage decrease in Non-farm GDP on PreSort Barcoded Small Letter volumes will be greater than the stimulatory impact of an equivalent percentage increase in Non-farm GDP on PreSort Barcoded Small Letter volumes.

As stated in Section 1.1.1 however, this finding would need to be further validated in a more robust manner.

To this end, Diversified Specifics undertook econometric demand analysis that focused on ascertaining whether PreSort Barcoded Small Letter volumes income elasticity was statistically significantly higher in periods of lower economic growth. The results of which are presented in this section.

## 2.2. METHODOLOGY

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To assess whether the elasticity of income demand was higher in periods of lower economic growth, the quarterly data employed to develop the PreSort Barcoded Small Letter volumes model, was split into two separate samples based on low growth and non-low growth periods.

To ensure that the analysis was robust, it was imperative to split the sample data in accordance with a theoretically relevant GDP growth rate cut-off value (that accurately identified low-growth and non-low growth periods) that also ensured a sufficient number of observations in each of the samples.

Total GDP growth rather than Non-farm GDP growth was used, as this reflects the headline measure of economic activity upon which many business forecasts are based upon.

The average quarterly growth rates in total GDP over the September quarter 1995 to the December quarter 2008 period was 0.8%.

As such, the cut-off growth rate to identify low-growth periods had to be below the average value but at a rate that also ensured a sufficient number of observations in each of the samples.

With that in mind, it was determined that 0.5% best reflected the cut-off growth rate value.

That is, low growth periods were defined as total GDP quarterly growth rates less than 0.5% and non-low growth was defined as total GDP quarterly growth rates of 0.5% or higher.

This resulted in 13 observations in the low-growth sample and 41 observations in the non-low growth periods.

The objective of the analysis was to subsequently compare the income elasticities for each of the samples i.e. compare the income elasticities derived in low-growth versus non-low growth periods.

Further, to validate the findings outlined in Section 1.1.1, it was necessary to illustrate that demand for PreSort Barcoded Small Letter volumes was more elastic during times of economic downturn to a statistically significant degree (at a 95% level of confidence).

## 2.3. MODEL RESULTS

Splitting the quarterly data used to develop the PreSort Barcoded Small Letter volumes model as described in Section 2.2, provided robust support that demand for PreSort Barcoded Small Letter volumes is more elastic during times of economic downturn and/or lower economic growth periods.

The income elasticity for the Low-growth model was more elastic than the equivalent income elasticity obtained for the Non-low growth model.

Specifically, the income elasticity for the Low-growth model was 1.179 compared to 0.806 for the Non-low growth model.

Moreover, the income elasticity estimate for the Low-growth model is not contained within the Non-low growth model's 95% confidence interval.

Likewise, the income elasticity estimate of the Non-low growth model is not contained within the Low-growth model's 95% confidence interval.

This suggests that the income elasticity estimates for each model, differs to one another to a statistically significant degree at a 95% level of confidence.

Table 2.3.1.1 summarises the key results obtained.<sup>2</sup>

**Table 2.3.1.1**

| Key Results   | Low-growth Model             | Non-low Growth Model        |
|---|------------------------------|-----------------------------|
| Total GDP quarterly growth rates                        | < 0.5%                       | > or equal to 0.5%          |
| Income Elasticity                                       | 1.179*                       | 0.806*                      |
| Income Elasticity 95% Confidence Interval               | Lower: 0.849   Upper: 1.509  | Lower: 0.620   Upper: 0.992 |
| Advertising Industry Elasticity                         | .096**                       | 0.179*                      |
| Advertising Industry Elasticity 95% Confidence Interval | Lower: -0.015   Upper: 0.207 | Lower: 0.109   Upper: 0.248 |
| Adjusted R <sup>2</sup>                                 | 96.2%                        | 95.9%                       |
| Durbin-Watson Statistic                                 | 1.960                        | 1.794                       |
| Observations (N)  | 13                           | 41                          |

\* Statistically significant at a 95% level of confidence; \*\* Statistically significant at a 90% level of confidence

<sup>2</sup> Refer to Appendix A for the detailed model output.

## 2 . 4 . C O N C L U S I O N S

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The results of this study provide valid quantitative support that demand for PreSort Barcoded Small Letter volumes are more elastic during times of economic downturn.

The conclusion that may be drawn from this study therefore, is that PreSort Barcoded Small Letter volumes are more negatively impacted during times of economic slowdown compared to the upside effect on volumes during times of more prosperous economic activity.

Formally, the conclusion that may be drawn from this study is as follows:

***All else being equal, the negative impact of a given percentage decrease in economic growth on PreSort Barcoded Small Letter volumes was found to be greater than the stimulatory impact of an equivalent percentage increase in economic growth on PreSort Barcoded Small Letter volumes.***

## 3.0 MOVING FORWARD



#### **(i) Broadening the Analysis by Letter Segment and Letter Size**

The results of this study may be and should be extended to cover the following letter segments:

- PreSort Barcoded large letters;
- Other small letters; and
- Other large letters.

In particular, Diversified Specifics has shown previously that both the PreSort Barcoded large letter segment and the Other large letter segment are statistically associated with Non-farm GDP.

As such, the income elasticities for each of these segments may be assessed, to provide insight regarding the impact of changing economic conditions on income elasticity.

#### **(ii) Comparative Industry Analysis**

This study showed that income elasticity for PreSort Barcoded small letters was more elastic in times of lower economic growth.

The extent to which this finding may be generalised to other industries is not known at this point.

Furthermore, the extent to which this finding is applicable among industries characterised by high income elasticity (e.g. luxury goods, automotive industry, construction industry) and low income elasticity (e.g. retail industry) is also not known at this point.

Further econometric analysis could therefore potentially be undertaken to model the demand drivers for a select group of industries characterised by different income elasticity levels e.g. high (greater than 1), moderate (0.5 to 0.7) and low (less than 0.3).

The benefit of such an undertaking would be to assess the degree to which the notion that income elasticity of demand is more elastic in times of lower economic growth may be generalised.

This in turn may provide further support to this study's findings.



# APPENDIX A



COMPARATIVE MODELS - OUTPUT

| Model Summary(b)   |       |         |          |                   |                            |               |
|--|-------|---------|----------|-------------------|----------------------------|---------------|
| GDP - Total Qtrly Growth Less than 0.5% (Seas. Adj)  | Model | R       | R Square | Adjusted R Square | Std. Error of the Estimate | Durbin-Watson |
| Non-low Growth Periods   | 1     | .981(a) | .962     | .959              | .039887076049498           | 1.794         |
| Low-growth Periods   | 1     | .986(a) | .972     | .962              | .042626714825378           | 1.960         |
| a Predictors: (Constant), Barcoding Introduction (Oct 99), Natural Logarithm of S&P/ASX 200 Consumer Discretionary Index, Natural Logarithm of Seasonally Adjusted Nonfarm GDP |       |         |          |                   |                            |               |
| b Dependent Variable: Natural Logarithm of Seasonally Adjusted PreSort Barcoded Small Letter Volumes   |       |         |          |                   |                            |               |

| ANOVA(b)   |       |            |                |    |             |         |         |
|--|-------|------------|----------------|----|-------------|---------|---------|
| GDP - Total Qtrly Growth Less than 0.5% (Seas. Adj)  | Model |            | Sum of Squares | df | Mean Square | F       | Sig.    |
| Non-low Growth Periods   | 1     | Regression | 1.499          | 3  | .500        | 314.056 | .000(a) |
|  |       | Residual   | .059           | 37 | .002        |         |         |
|  |       | Total      | 1.558          | 40 |             |         |         |
| Low-growth Periods   | 1     | Regression | .565           | 3  | .188        | 103.574 | .000(a) |
|  |       | Residual   | .016           | 9  | .002        |         |         |
|  |       | Total      | .581           | 12 |             |         |         |
| a Predictors: (Constant), Barcoding Introduction (Oct 99), Natural Logarithm of S&P/ASX 200 Consumer Discretionary Index, Natural Logarithm of Seasonally Adjusted Nonfarm GDP |       |            |                |    |             |         |         |
| b Dependent Variable: Natural Logarithm of Seasonally Adjusted PreSort Barcoded Small Letter Volumes   |       |            |                |    |             |         |         |

| Coefficients(a)                                     |       |   |                             |            |                           |       |      |                               |             |                         |       |
|---|-------|---|-----------------------------|------------|---------------------------|-------|------|-------------------------------|-------------|-------------------------|-------|
| GDP - Total Qtrly Growth Less than 0.5% (Seas. Adj) | Model |   | Unstandardized Coefficients |            | Standardized Coefficients | t     | Sig. | 95% Confidence Interval for B |             | Collinearity Statistics |       |
|   |       |   | B                           | Std. Error | Beta                      |       |      | Lower Bound                   | Upper Bound | Tolerance               | VIF   |
|   |       |   |                             |            |                           |       |      |                               |             |                         |       |
| Non-low Growth Periods                              | 1     | (Constant)  | -6.563                      | 1.052      |                           | 6.239 | .000 | -8.695                        | -4.432      |                         |       |
|   |       | Natural Logarithm of Seasonally Adjusted Nonfarm GDP          | .806                        | .092       | .538                      | 8.763 | .000 | .620                          | .992        | .271                    | 3.689 |
|   |       | Natural Logarithm of S&P/ASX 200 Consumer Discretionary Index | .179                        | .034       | .270                      | 5.210 | .000 | .109                          | .248        | .379                    | 2.636 |
|   |       | Barcoding Introduction (Oct 99)                               | .101                        | .025       | .246                      | 4.000 | .000 | .050                          | .152        | .270                    | 3.698 |
| Low-growth Periods                                  | 1     | (Constant)  | -9.914                      | 2.164      |                           | 4.580 | .001 | 14.810                        | -5.017      |                         |       |
|   |       | Natural Logarithm of Seasonally Adjusted Nonfarm GDP          | 1.179                       | .146       | .808                      | 8.082 | .000 | .849                          | 1.509       | .313                    | 3.193 |
|   |       | Natural Logarithm of S&P/ASX 200 Consumer Discretionary Index | .096                        | .049       | .142                      | 1.955 | .082 | -.015                         | .207        | .596                    | 1.677 |
|   |       | Barcoding Introduction (Oct 99)                               | .082                        | .058       | .163                      | 1.412 | .192 | -.049                         | .212        | .236                    | 4.237 |

a Dependent Variable: Natural Logarithm of Seasonally Adjusted PreSort Barcoded Small Letter Volumes

| Collinearity Diagnostics(a)                         |       |           |            |                 |                      |  |   |                                 |
|---|-------|-----------|------------|-----------------|----------------------|--|---|---------------------------------|
| GDP - Total Qtrly Growth Less than 0.5% (Seas. Adj) | Model | Dimension | Eigenvalue | Condition Index | Variance Proportions |  |   |                                 |
|   |       |           |            |                 | (Constant)           | Natural Logarithm of Seasonally Adjusted Nonfarm GDP | Natural Logarithm of S&P/ASX 200 Consumer Discretionary Index | Barcoding Introduction (Oct 99) |
| Non-low Growth Periods                              | 1     | 1         | 3.731      | 1.000           | .00                  | .00  | .00   | .01                             |
|   |       | 2         | .269       | 3.727           | .00                  | .00  | .00   | .27                             |
|   |       | 3         | .000       | 188.832         | .07                  | .04  | .97   | .22                             |
|   |       | 4         | 1.71E-005  | 466.839         | .93                  | .96  | .03   | .51                             |
| Low-growth Periods                                  | 1     | 1         | 3.823      | 1.000           | .00                  | .00  | .00   | .00                             |
|   |       | 2         | .177       | 4.651           | .00                  | .00  | .00   | .24                             |
|   |       | 3         | .000       | 117.989         | .01                  | .04  | .63   | .01                             |
|   |       | 4         | 1.76E-005  | 465.743         | .99                  | .96  | .37   | .75                             |

a Dependent Variable: Natural Logarithm of Seasonally Adjusted PreSort Barcoded Small Letter Volumes

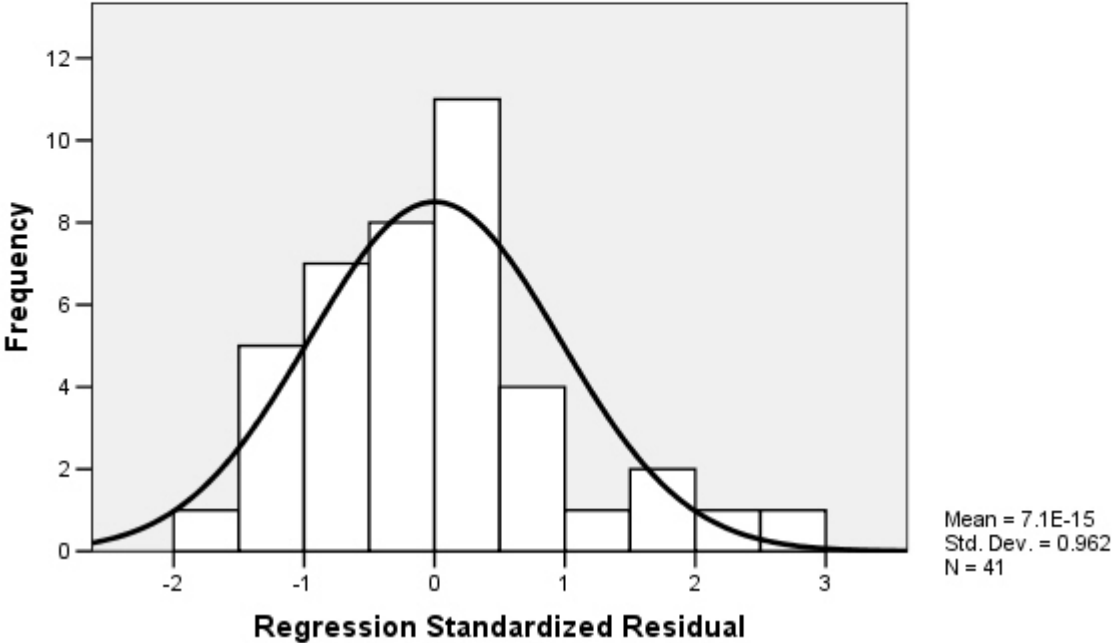
| Residuals Statistics(a)                             |                      |                  |                  |                  |                  |    |
|---|----------------------|------------------|------------------|------------------|------------------|----|
| GDP - Total Qtrly Growth Less than 0.5% (Seas. Adj) |                      | Minimum          | Maximum          | Mean             | Std. Deviation   | N  |
|   |                      |                  |                  |                  |                  |    |
| Residual  | .076834857463837     | .106394276022912 | .000000000000000 | .038362161345460 | 41               |    |
| Std. Predicted Value                                | -1.770               | 1.360            | .000             | 1.000            | 41               |    |
| Std. Residual                                       | -1.926               | 2.667            | .000             | .962             | 41               |    |
| Low-growth Periods                                  | Predicted Value      | 5.67929649353028 | 6.31656026840210 | 6.08922031885661 | .216909327346795 | 13 |
|   | Residual             | .076271608471871 | .061356518417597 | .000000000000001 | .036915817918652 | 13 |
|   | Std. Predicted Value | -1.890           | 1.048            | .000             | 1.000            | 13 |
|   | Std. Residual        | -1.789           | 1.439            | .000             | .866             | 13 |

a Dependent Variable: Natural Logarithm of Seasonally Adjusted PreSort Barcoded Small Letter Volumes

# Histogram

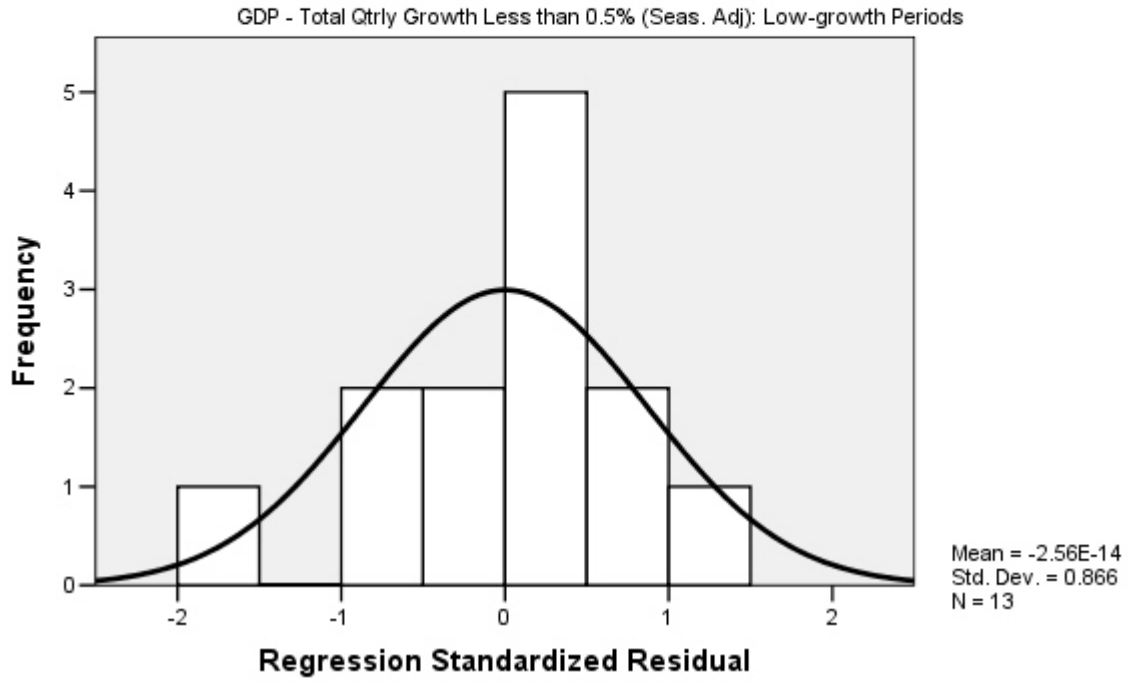
**Dependent Variable: Natural Logarithm of Seasonally Adjusted PreSort Barcoded Small Letter Volumes**

GDP - Total Qtrly Growth Less than 0.5% (Seas. Adj): Non-low Growth Periods



## Histogram

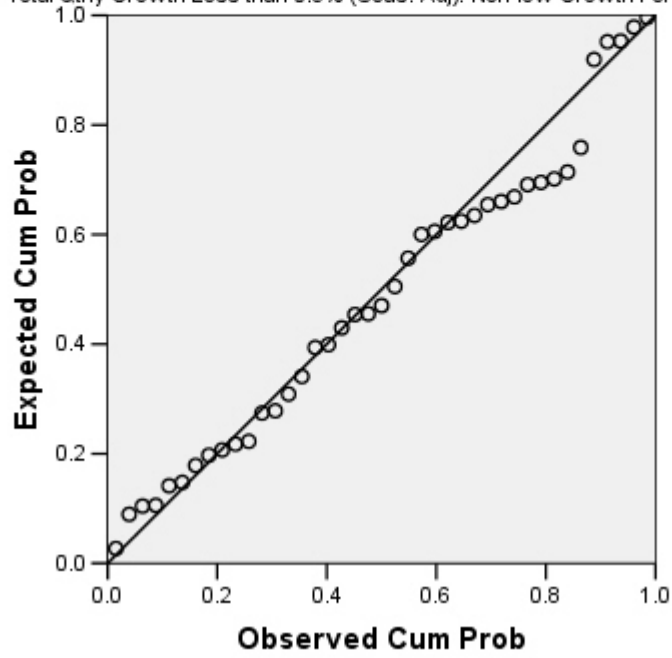
**Dependent Variable: Natural Logarithm of Seasonally Adjusted PreSort  
Barcoded Small Letter Volumes**



## Normal P-P Plot of Regression Standardized Residual

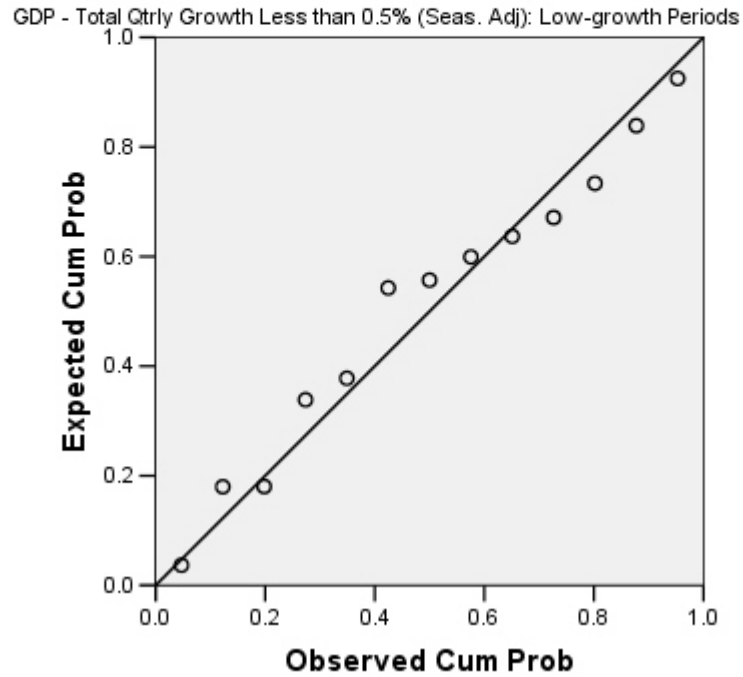
**Dependent Variable: Natural Logarithm of Seasonally Adjusted PreSort  
Barcoded Small Letter Volumes**

GDP - Total Qtrly Growth Less than 0.5% (Seas. Adj): Non-low Growth Periods



## Normal P-P Plot of Regression Standardized Residual

**Dependent Variable: Natural Logarithm of Seasonally Adjusted PreSort  
Barcoded Small Letter Volumes**

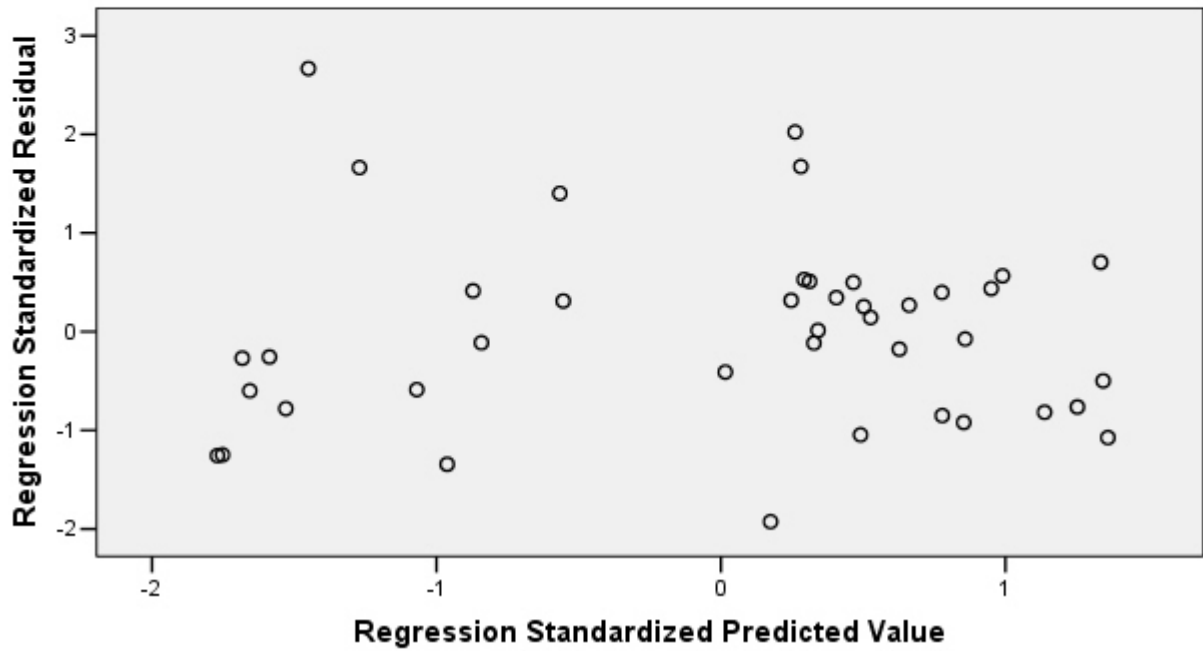




## Scatterplot

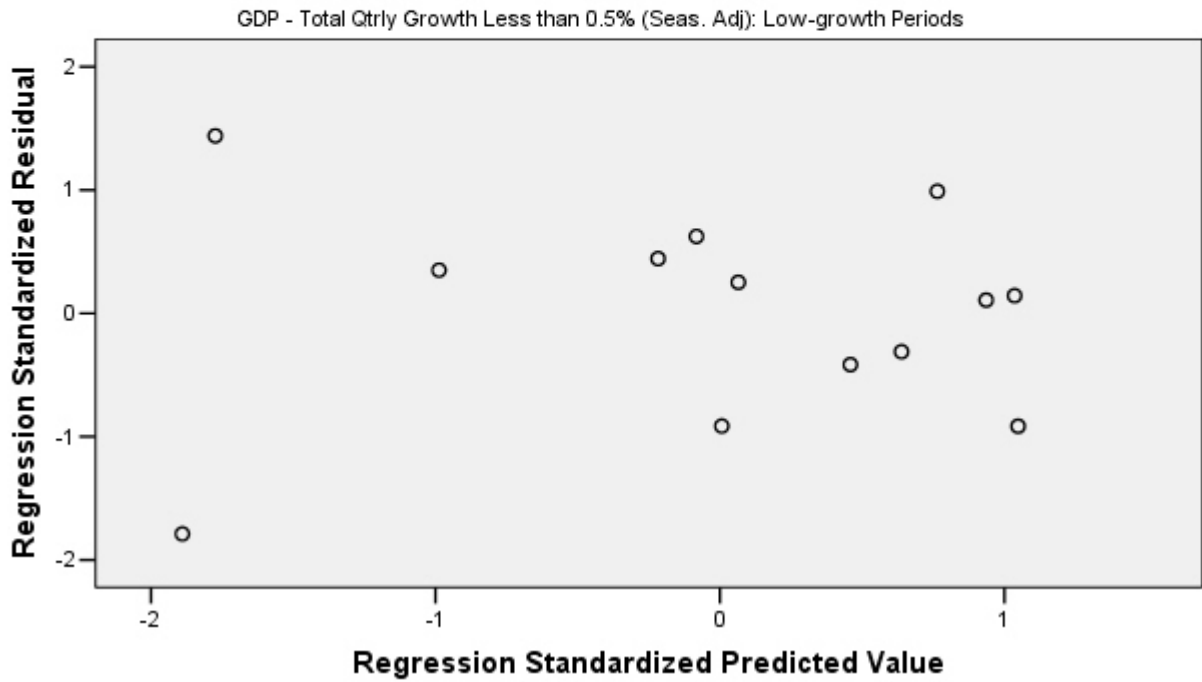
**Dependent Variable: Natural Logarithm of Seasonally Adjusted PreSort  
Barcoded Small Letter Volumes**

GDP - Total Qtrly Growth Less than 0.5% (Seas. Adj): Non-low Growth Periods

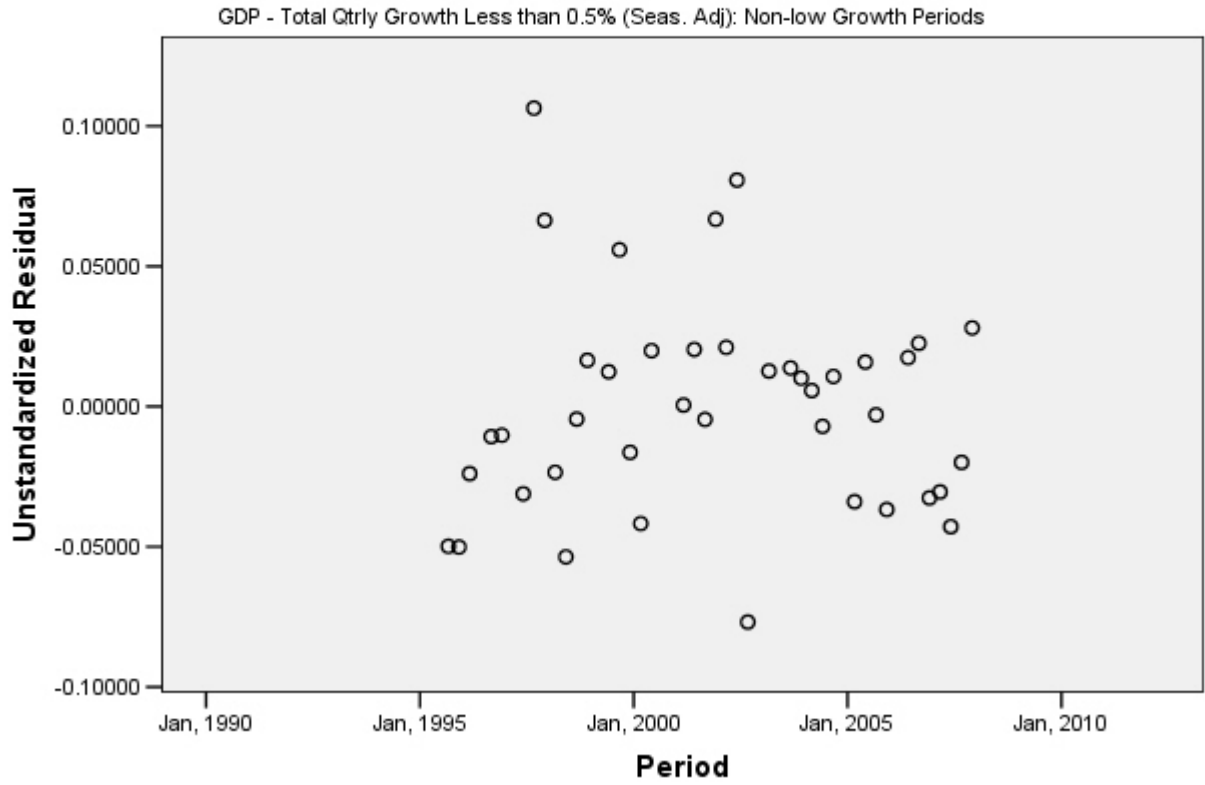


## Scatterplot

**Dependent Variable: Natural Logarithm of Seasonally Adjusted PreSort  
Barcoded Small Letter Volumes**



## Unstandardised Residuals Over Time



## Unstandardised Residuals Over Time

