ESTIMATING FACTORS INFLUENCING COFFEE DEMAND AND SUPPLY IN DUTCH MARKET

DSC5101 - A1
Group Assignment 1

Group Members

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Section 1: Executive Summary

Coffee is one of the most consumed beverages in developed countries such as America and European nations. Coffee producing firms worldwide, including the Dutch, are racing against time to keep up with the ever-changing phenomena of coffee demand among consumers. However, price fluctuation of coffee beans and climate change, leading to supply shortage, are some challenges faced by firms in supplying coffee to cater to the rising consumption. As such, the ability to anticipate consumers' demand for coffee and to respond to the needs of consumers are essential for firms to remain competitive in the industry.

This report focuses on providing insights and recommendations on good strategies which firms can adopt to maximize its profits in the Dutch coffee market. These strategies are drawn by estimating the demand and supply functions of the consumers and firms respectively.

Adopting the two-stage least square model (TSLS), initial findings reflected that price of roasted coffee, income per capita, bean price and wage were the most significant factors affecting demand and supply respectively.

The **estimated demand and supply functions** are as such:

$$\text{Demand:}\quad \ln(Q_D) = -5.61 - 0.31\ln\left(\frac{\widehat{p_c}}{p_o}\right) + 0.80\ln\left(\frac{y_t}{p_o}\right) - 0.02q_2 + \varepsilon_{D3}$$

$$\text{Supply:}\quad \ln(Q_S) = 4.58 + 3.18\ln\left(\frac{\widehat{p_c}}{p_o}\right) - 1.76\ln\left(\frac{p_b}{p_o}\right) - 3.21\ln\left(\frac{w_t}{p_o}\right) + 0.04q_2 + \varepsilon_{S3}$$

p_c = price of roasted coffee; y_t = income per capita; p_b= price of coffee beans; p_o = index price of other goods; w_t = price of labour per man hours and q_2 = seasonal factors; Q_D = quantity demanded; Q_S = quantity supplied.

While the outcomes were conclusive, the low adj R^2 values suggested that there may be other additional factors, not tested in the model, that affects both demand and supply of coffee consumption and production.

1.1 Business Insights

1) ***Consumer demand for coffee is price inelastic (PED = 0.31)***
   An increase in the price of roasted coffee will result in a less than proportionate decrease in quantity demanded for coffee, ceteris paribus. Existing firms in the industry may want to consider coming together and establish a joint formal collusion. Such partnerships will enable firms to come together and determine the optimal price for roasted coffee, whereby firms are able to charge individual consumers the price which is close or near to the amount that they are willing to pay. This in turn increases the revenue earned by the firms.
2) ***Positive income elasticity of demand for coffee (YED = 0.80)***
   Coffee is a normal good commonly consumed in the Dutch community where an increase in income leads to a less than proportionate increase in demand for coffee. Using this information, it is recommended that firms rebrand its coffee into two categories – standard coffee and premium coffee; and charge different pricing for these categories, with the latter priced at a higher rate. When consumers' income increases and/or for consumers who earn a higher income, they will be enticed to purchase the premium coffee which is priced at a higher rate. Furthermore, by differentiating the coffee products will ensure that firms avoid making substantial loss in the event of an economic downturn which causes consumers' income to decrease as the differentiated tiers of coffee will enable consumers the flexibility to switch to standard coffee in times of such occurrence.
3) ***Supply of coffee is price elastic (PES = 3.18)***
   An increase in coffee price will cause a more than proportionate increase in coffee production i.e. firm increases supply of roasted coffee, ceteris paribus. This provides insight to the firm's ability to respond fast and promptly by increasing coffee supply when price increases. This may be attributed to the fact that individual firms have already established their niched area in producing coffee (e.g. availability of spare capacity and use of technology in producing coffee). To further enhance and reduce cost of production, firms can consider collaborating and tap on each other's existing expertise, making use of economies of scale to further lower the cost of production, thereby achieving the objective of maximizing profits. In addition, our findings suggest that bean price affects the supply of coffee and firms tend to absorb the increase of bean prices instead of passing on to consumers (Bettendorf & Verboven, 2000), such collaboration among firms will hence help lower their cost of production to near the minimum, reaping the maximum profits earned.

Section 2: The Model

2.1 Assumptions

a. Characteristic of the Dutch coffee market is oligopolistic in nature (Bettendorf & Verboven, 2000).
b. Firms face a downward sloping market demand and choose to produce at profit maximisation output.
c. Price elasticity of demand and supply is constant; hence the logarithmic linear regression model is adopted.

2.2 Model Conceptualisation

From the year 1990 to 1996 coffee consumption and production data in the Dutch market, we identify the following possible factors that might affect the roasted coffee demand and supply functions:

Possible factors that might affect quantity of roasted coffee demanded (Q_D)	**Possible factors that might affect quantity of roasted coffee supplied** (Q_S)
p_c = price of roasted coffee per kg	p_c = price of roasted coffee per kg
p_t= price of tea per kg	p_b= price of coffee beans per kg
y_t = income per capita	w_t = price of labour per man hours
q_1, q_2, q_3, q_4 = seasonal factors	q_1, q_2, q_3, q_4 = seasonal factors

2.3 Data Transformation

Raw data was collected based on the possible factors identified in section 2.2 and transformed to prepare for the analysis subsequently.

(a) Normalisation of prices

In order to compare the relative relationship of the various prices accurately, we need to account for price difference between time periods due to inflation or geographical location. Therefore, all prices data were normalised by dividing the price index of other goods (p_o).

(b) Log Linear transformation

The coefficient in a linear equation relating ln (Y_i) to ln (X_i) has the interpretation of the elasticity of Y with respect to X (in terms of percentage). A demand function with constant price elasticity of demand is reflected as $Q_D = X * P^{-\eta}$ (where $-\eta < -1$ is the price elasticity of demand and X is demand shift parameter). By expressing in logarithmic form, $q^D = x * -\eta p$, where $q^D = \ln Q_D$; $x = \ln X$; $p = \ln P$, the demand function becomes linear and the coefficient η gives us the interpretation of elasticity of q^D with respect to p.

2.4 Modelling the Demand and Supply Functions using TSLS

Using section 2.2, we first modelled the demand and supply functions as follows.

$$\text{Demand:}\quad \ln(Q_D) = \alpha_0 + \alpha_1 \ln\left(\frac{p_c}{p_o}\right) + \alpha_2 \ln\left(\frac{y_t}{p_o}\right) + \alpha_3 \ln\left(\frac{p_t}{p_o}\right) + \alpha_4 q_1 + \alpha_5 q_2 + \alpha_6 q_3 + \varepsilon_{D1}$$

$$\text{Supply:}\quad \ln(Q_S) = \beta_0 + \beta_1 \ln\left(\frac{p_c}{p_o}\right) + \beta_2 \ln\left(\frac{p_b}{p_o}\right) + \beta_3 \ln\left(\frac{w_t}{p_o}\right) + \beta_4 q_1 + \beta_5 q_2 + \beta_6 q_3 + \varepsilon_{S1}$$

As p_c is an endogenous variable for Q_D and Q_S respectively, using p_c directly in ordinary least square (OLS) to estimate coffee demand and supply functions may lead to biased estimates. Therefore, we adopted the two stage least square (TSLS) to obtain a consistent estimate of the coefficients of the variables.

The first stage of the TSLS involve estimating $\ln\left(\frac{p_c}{p_o}\right)$ by regressing this variable on regressors, of which some are instrument variables (IV) and the rest are control variables. In employing this technique, the IVs must satisfy the following two conditions: (1) The IVs must be relevant, i.e. they must correlate to coffee price $\ln(\frac{\widehat{p_c}}{p_o})$ in our case; (2) The IVs must be exogeneous, i.e. they must not correlate to the error terms when estimating the demand and supply function.

2.5 Demand Function

Equation (1) below shows the initial first stage TSLS by regressing $\ln\left(\frac{p_c}{p_o}\right)$ on all possible variables that may influence demand and supply functions.

First Stage of TSLS - Initial Full Model with all available variables:

$$\ln(\frac{\widehat{p_c}}{p_o}) = \pi_0 + \pi_1 \ln\left(\frac{p_t}{p_o}\right) + \pi_2 \ln\left(\frac{y_t}{p_o}\right) + \pi_3 \ln\left(\frac{p_b}{p_o}\right) + \pi_4 \ln\left(\frac{w_t}{p_o}\right) + \pi_5 q_1 + \pi_6 q_2 + \pi_7 q_3 \quad (1)$$

However, including large number of regressors could result in overfitting and make the estimate $\ln(\frac{\widehat{p_c}}{p_o})$ less precise (i.e. high variance). We address this issue by using the stepwise regression algorithm. With every iteration, we remove the least useful parameter one at a time (q3, followed by q1 and $\text{In}\left(\frac{p_t}{p_o}\right)$) until we identify at least one significant instrument variable for supply and demand function. Testing this using the best subset algorithm yields the same model, where Mallow's CP value is the lowest. Refer to ***Table 1 and 2*** in appendix for results of the algorithms.

First Stage of TSLS for Demand – Reduced Forms (with significant instrument variables)

$$\ln(\frac{\widehat{p_c}}{p_o}) = -2.454 + \underbrace{0.259 \ln\left(\frac{y_t}{p_o}\right)}_{\substack{Other\ exogenous\ variable \\ of\ demand\ function}} - \underbrace{0.017 q_2}_{control\ variable} + \underbrace{0.500 \ln\left(\frac{p_b}{p_o}\right) + 0.720 \ln\left(\frac{w_t}{p_o}\right)}_{2\ IVs\ for\ demand\ function} \quad (2)$$

OLS Demand Structural Form --- results in ***Table 3*** of appendix**:**

$$\ln(Q_D) = -5.454 - 0.284 \ln\left(\frac{p_c}{p_o}\right) + 0.773 \ln\left(\frac{y_t}{p_o}\right) - 0.024 q_2 + \varepsilon_{D2} \quad (3)$$

Second Stage of TSLS for Demand - results in ***Table 3*** of appendix**:**

$$\ln(Q_D) = -5.614 - 0.309 \ln(\frac{\widehat{p_c}}{p_o}) + 0.803 \ln\left(\frac{y_t}{p_o}\right) - 0.025 q_2 + \varepsilon_{D3} \quad (4)$$

Testing for demand function instrument validity - results in ***Table 3*** of appendix**:**
For our demand function obtained by TSLS, our first stage TSLS shows that the instrument variable coefficient estimate of the coffee bean price $\ln\left(\frac{p_b}{p_o}\right)$ is significant (*p*-value = 0.000 < 0.05) while that of wage $\ln\left(\frac{w_t}{p_o}\right)$ is borderline significant (*p*-value = 0.073, near 0.05). This shows that coffee bean price and wage are ***reasonably relevant instruments*** used to estimate price shocks of coffee at the demand side. Low *p*-value = 0.000 < 0.05 for weak instrument test also tells us that these two instruments are not weak. For our demand function obtained by TSLS, our high *p*-value = 0.512 for Sargan test indicates that our instruments, coffee bean price and wage, are both ***exogeneous*** and hence satisfy both conditions for the TSLS regression.
However, Hausman test is not significant (p=0.434) shows that the OSL model is consistent with TSLS. Therefore, endogeneity in $\ln\left(\frac{p_c}{p_o}\right)$ might not be a big problem for the demand function.

Analysis for demand function
The TSLS estimate suggests that the demand for roasted coffee is rather **inelastic** with respect to prices of roasted coffee and income. An increase in the price of roasted coffee by 1% reduces the coffee consumption by only 0.31%, ceteris paribus. This might be because of the mildly addictive nature of coffee and the expected habitual coffee consumption of coffee drinkers. Similarly, an increase in income per capita by 1% increases the coffee consumption by 0.80%, ceteris paribus. This suggests that coffee is a **normal good** to the Dutch community, whereby demand for coffee increases less than proportionately when income increases.
Nonetheless, the variation in roasted coffee prices and income only explains 10.4% of the variance of roasted coffee prices in the Dutch market (Adjusted R^2 = 0.104). Therefore, demand for roasted coffee might depends on other factors that are not tested in this model.

2.6 Supply Function

To understand the supply function of roasted coffee, $\ln(\widehat{Q_S})$ is regressed on the predicted coffee price from first stage of TSLS - $\ln(\frac{\widehat{p_c}}{p_o})$, $\ln\left(\frac{p_b}{p_o}\right)$, $\ln\left(\frac{w_t}{p_o}\right)$ and q_2 in the second stage of TSLS. Refer to ***Table 4*** in appendix for results.

First Stage of TSLS for Supply – Reduced Forms (with significant instrument variable)

$$\ln(\frac{\widehat{p_c}}{p_o}) = -2.454 + \underbrace{0.259\ln\left(\frac{y_t}{p_o}\right)}_{IV\ for\ supply\ function} - \underbrace{0.017q_2}_{control\ variable} + \underbrace{0.500\ln\left(\frac{p_b}{p_o}\right) + 0.720\ln\left(\frac{w_t}{p_o}\right)}_{\substack{Other\ exogenous\ variables \\ of\ supply\ function}} \tag{5}$$

OLS Supply Structural Form --- results in ***Table 4*** of appendix**:**

$$\text{OLS:}\qquad \ln(Q_S) = -2.028 + 0.158\ln\left(\frac{p_c}{p_o}\right) - 0.179\ln\left(\frac{p_b}{p_o}\right) + 0.434\ln\left(\frac{w_t}{p_o}\right) - 0.008q_2 + \varepsilon_{S2} \tag{6}$$

Second Stage of TSLS for Supply - results in ***Table 4*** of appendix**:**

$$\text{TSLS:}\qquad \ln(Q_S) = 4.576 + 3.177\ln(\frac{\widehat{p_c}}{p_o}) - 1.757\ln\left(\frac{p_b}{p_o}\right) - 3.208\ln\left(\frac{w_t}{p_o}\right) + 0.036q_2 + \varepsilon_{S3} \tag{7}$$

Testing for supply function instrument validity - results in ***Table 4*** of appendix**:**

Similarly, for our supply function, the instrument variable coefficient estimate of income $\ln\left(\frac{y_t}{p_o}\right)$ is significant (*p*-value = 0.0022 < 0.05). This shows that income is a relevant instrument used to estimate price shocks of coffee at the supply side. Low *p*-value = 0.022 < 0.05 for weak instrument test also tells us that this instrument is not weak. Hausman test is significant (p=0.01 < 0.05) shows that the OSL model is inconsistent with TSLS and that $\ln\left(\frac{p_c}{p_o}\right)$ is an endogenous variable. However, we are unable to perform the Sargan test for the supply function as we only managed to identify one instrument to control for the coffee price (exactly identified). However, it is unlikely for income of consumers to have any correlation with random errors on the supply side of the equation and wages, which might be correlated to income, has been controlled for in the equation.

Analysis for supply function

The TSLS estimate suggests that the supply for roasted coffee, on the other hand, is **elastic** with respect to prices of roasted coffee. An increase in the price of roasted coffee by 1% increases the coffee production more than proportionately by 3.18%, ceteris paribus. This suggests that the cost of production for producing roasted coffee is relatively low, which enables firms to response to the change in price of roasted coffee promptly by increasing coffee production (supply increase). Nonetheless, the variation of the variables only explains 9.77% of the variance of roasted coffee production in the Dutch market (Adjusted R^2 = 0.0977). Therefore, supply for roasted coffee might depends on other factors that are not tested in this model.

2.7 Comparison between one step OLS and TSLS

The coffee price p_c is endogenous (correlated to demand or supply shocks) to the quantity demanded for roasted coffee. The OLS model neglects this endogeneity. As such, comparing the p_c coefficient *p*-value for OLS Model and TSLS model, the ***demand function was not altered drastically*** (*p*-value=0.004 vs 0.003, Hausman test not sig) but showed ***huge variations in the supply function*** (*p*-value= 0.615 vs 0.008, Hausman test sig p=0.01). p_c became a significant variable in the TSLS model. This suggested that the TSLS is more accurate to eliminate the p_c bias to supply function.

Model	Demand Function		Supply Function	
	Coefficient for p_c	***p*-value**	**Coefficient for p_c**	***p*-value**
OLS	-0.284	0.004	0.158	0.615
TSLS	-0.309	0.003	3.18	0.008**

Appendix

Table 1: Stepwise Regression

With every iteration, we remove the least useful parameter one at a time (q3, followed by q1 and In$\left(\frac{p_t}{p_o}\right)$) until we identify at least one significant instrument variable for supply and demand function (marginally significant at p<0.1). The IVs for demand function are ln $\left(\frac{p_b}{p_o}\right)$ and ln $\left(\frac{w_t}{p_o}\right)$ IV for supply function is ln $\left(\frac{y_t}{p_o}\right)$.

Parameter	1st Stage of TSLS							
	Model 1		Model 2		Model 3		Model 4	
	Coeff. (Std. Error)	*p*-value	Coeff. (Std. Error)	*p*-value	Coeff. (Std. Error)	*p*-value	Coeff. (Std. Error)	*p*-value
q_3	-0.0025 (0.0128)	0.8420						
q_1	-0.0075 (0.0132)	0.5720	-0.0060 (0.0108)	0.5810				
$\ln\left(\frac{p_t}{p_o}\right)$	-0.2124 (0.2034)	0.3000	-0.2064 (0.1999)	0.3050	-0.1988 (0.1985)	0.3200		
q_2	-0.0182 (0.0123)	0.1420	-0.0170 (0.0106)	0.1110	-0.0153 (0.0100)	0.1320	-0.0173 (0.0098)	0.0832 .
$\ln\left(\frac{w_t}{p_o}\right)$	0.6765 (0.4227)	0.1140	0.6588 (0.4107)	0.1130	0.6317 (0.4060)	0.1240	0.7202 (0.3963)	0.0729 .
$\ln\left(\frac{y_t}{p_o}\right)$	0.1490 (0.1504)	0.3250	0.1587 (0.1413)	0.2650	0.1801 (0.1353)	0.1870	0.2585 (0.1103)	0.0217 *
$\ln\left(\frac{p_b}{p_o}\right)$	0.5001 (0.0204)	0.0000 ***	0.4994 (0.0200)	0.0000 ***	0.4985 (0.0198)	0.0000 ***	0.5000 (0.0198)	0.0000 ***
F Statistic	132.7		156.7		189.7		236.9	

Table 2: R code and results for best subset algorithm

Using best-subset algorithm in R, we obtained the same results as stepwise regression in Table 1.
Based on the Mallow's Cp values, subsets (3), (4) and (5) below are good predictors for ln $(\frac{p_c}{p_o})$. We will choose to build our model using subset (4) with the lowes t Mallow's Cp value (3.325), i.e. regressing ln $(\frac{p_c}{p_o})$ on ln $(\frac{y_t}{p_o})$, q_2, ln $(\frac{p_b}{p_o})$ and ln $(\frac{w_t}{p_o})$.

```
> library(readxl)
> Project1Data <- read_excel("C:/Users/chene/Desktop/Project1Data.xlsx")
> library(leaps)
> best_subset <- regsubsets(ln_n_cprice~.,Project1Data, nvmax=5)
> best_subset_summary <- summary(best_subset)
> best_subset_summary$outmat
         ln_n_tprice ln_n_income q2  q3  q4  ln_n_bprice ln_n_wprice
1  ( 1 ) " "         " "         " " " " " " "*"         " "
2  ( 1 ) "*"         " "         " " " " " " "*"         " "
3  ( 1 ) "*"         " "         " " " " " " "*"         "*"
4  ( 1 ) " "         "*"         "*" " " " " "*"         "*"
5  ( 1 ) "*"         "*"         "*" " " " " "*"         "*"
> best_subset_summary$cp
[1] 16.361427  5.054551  3.671231  3.324586  4.343110
```

Table 3: Demand Function

TSLS – Dependent variable = $\ln(Q_D)$; Endogenous variable = $\ln\left(\frac{p_c}{p_o}\right)$; IVs = $\ln\left(\frac{p_b}{p_o}\right)$ and $\ln\left(\frac{w_t}{p_o}\right)$; Exogenous variable = $\ln\left(\frac{y_t}{p_o}\right)$; Control variable = q_2

Parameters	Model 1				Model 2				Model 3				Model 4 (Final Model)					
	1st Stage of TSLS		2nd Stage of TSLS		1st Stage of TSLS		2nd Stage of TSLS		1st Stage of TSLS		2nd Stage of TSLS		OLS		1st Stage of TSLS		2nd Stage of TSLS	
	Coeff. (SD)	*p*-value	Coeff. (SD)	*p*-value	Coeff. (SD)	*p*-value	Coeff. (SD)	*p*-value	Coeff. (SD)	*p*-value	Coeff. (SD)	*p*-value	Coeff. (SD)	*p*-value	Coeff. (SD)	*p*-value	Coeff. (SD)	*p*-value
Intercept	-0.873 (1.89)	0.645	-5.093 (3.789)	0.183	-0.905 (1.871)	0.630	-8.460 (3.871)	0.032*	-0.996 (1.856)	0.593	-9.890 (3.827)	0.012*	-5.454 (1.934)	0.006**	-2.454 (1.150)	0.036*	-5.614 (1.938)	0.005**
$\ln\left(\frac{p_c}{p_o}\right)$			-0.277 (0.093)	0.004**			-0.302 (0.098)	0.003**			-0.310 (0.0994)	0.003**	-0.284 (0.096)	0.004**			-0.309 (0.100)	0.003**
$\ln\left(\frac{y_t}{p_o}\right)$	0.149 (0.150)	0.325	0.625 (0.360)	0.087.	0.159 (0.1413)	0.265	0.955 (0.367)	0.011*	0.180 (0.135)	0.187	1.114 (0.360)	0.003**	0.773 (0.271)	0.005**	0.259 (0.110)	0.022*	0.803 (0.272)	0.004**
$\ln\left(\frac{p_t}{p_o}\right)$	-0.212 (0.203)	0.300	0.280 (0.505)	0.580	-0.206 (0.200)	0.305	0.595 (0.526)	0.261	-0.199 (0.199)	0.320	0.680 (0.529)	0.203						
$\ln\left(\frac{p_b}{p_o}\right)$	0.500 (0.020)	0.000***			0.499 (0.020)	0.000***			0.499 0.020)	0.000***					0.500 (0.020)	0.000***		
$\ln\left(\frac{w_t}{p_o}\right)$	0.677 (0.423)	0.114			0.659 (0.411)	0.113			0.632 (0.406)	0.124					0.720 (0.396)	0.073.		
q_1	-0.008 (0.013)	0.572	-0.108 (0.033)	0.001**	-0.006 (0.0108)	0.581	-0.050 (0.029)	0.087.										
q_2	-0.018 (0.012)	0.142	-0.093 (0.030)	0.003**	-0.017 (0.011)	0.111	-0.045 (0.028)	0.114	-0.015 (0.010)	0.132	-0.031 (0.027)	0.256	-0.024 (0.027)	0.378	-0.017 (0.010)	0.083.	-0.025 (0.027)	0.361
q_3	-0.003 (0.013)	0.842	-0.104 (0.032)	0.002**														
Adj R^2	0.917		0.2302		0.9184		0.1343		0.9191		0.1147		0.0977		0.9191		0.1044	
Weak Instrument test (*p*-value)																	0.000***	
Wu- Hausman test (*p*-value)																	0.434	
Sargan test (*p*-value)																	0.512	

Table 4: Supply Function

TSLS – Dependent variable = $\ln(Q_S)$; Endogenous variable = $\ln\left(\frac{p_c}{p_o}\right)$; IV = $\ln\left(\frac{y_t}{p_o}\right)$; Exogenous variables = $\ln\left(\frac{p_b}{p_o}\right)$ and $\ln\left(\frac{w_t}{p_o}\right)$; Control variable = q_2

Parameters	**Model 1**				**Model 2**				**Model 3**				**Model 4 (Final Model)**					
	1st Stage of TSLS		**2nd Stage of TSLS**		**1st Stage of TSLS**		**2nd Stage of TSLS**		**1st Stage of TSLS**		**2nd Stage of TSLS**		**OLS**		**1st Stage of TSLS**		**2nd Stage of TSLS**	
	Coeff. (SD)	*p*-value	Coeff. (SD)	*p*-value	Coeff. (SD)	*p*-value	Coeff. (SD)	*p*-value	Coeff. (SD)	*p*-value	Coeff. (SD)	*p*-value	Coeff. (SD)	*p*-value	Coeff. (SD)	*p*-value	Coeff. (SD)	*p*-value
Intercept	-0.873 (1.890)	0.645	-1.522 (3.879)	0.696	-0.905 (1.871)	0.630	1.297 (4.063)	0.750	-0.996 (1.856)	0.593	2.319 (4.025)	0.566	-2.028 (3.362)	0.548	-2.454 (1.150)	0.036*	4.576 (4.070)	0.264
$\ln\left(\frac{p_c}{p_o}\right)$			0.754 (1.135)	0.509			1.617 (1.179)	0.174			2.145 (1.104)	0.056.	0.158 (0.313)	0.615			3.177 (1.176)	0.009**
$\ln\left(\frac{y_t}{p_o}\right)$	0.149 (0.150)	0.325			0.159 (0.141)	0.265			0.180 (0.135)	0.187					0.259 (0.110)	0.022*		
$\ln\left(\frac{p_t}{p_o}\right)$	-0.212 (0.203)	0.300			-0.206 (0.200)	0.305			-0.199 (0.199)	0.320								
$\ln\left(\frac{p_b}{p_o}\right)$	0.500 (0.020)	0.000***	-0.493 (0.594)	0.410	0.499 (0.020)	0.000***	-0.946 (0.617)	0.129	0.499 (0.020)	0.000***	-1.217 (0.579)	0.039*	-0.179 (0.171)	0.299	0.500 (0.020)	0.000***	-1.757 (0.656)	0.006**
$\ln\left(\frac{w_t}{p_o}\right)$	0.677 (0.423)	0.114	-0.024 (1.635)	0.988	0.659 (0.411)	0.113	-1.359 (1.695)	0.425	0.632 (0.406)	0.124	-1.963 (1.636)	0.234	0.434 (1.042)	0.678	0.720 (0.396)	0.073.	-3.208 (1.697)	0.062.
q_1	-0.008 (0.013)	0.572	-0.116 (0.035)	0.002**	-0.006 (0.011)	0.581	-0.049 (0.032)	0.127										
q_2	-0.018 (0.012)	0.142	-0.078 (0.040)	0.057.	-0.017 (0.011)	0.111	-0.003 (0.036)	0.930	-0.015 (0.010)	0.132	0.021 (0.032)	0.516	-0.008 (0.029)	0.771	-0.017 (0.010)	0.083.	0.036 (0.032)	0.264
q_3	-0.003 (0.013)	0.842	-0.115 (0.032)	0.001**														
Adj R^2	0.9173		0.2184		0.9184		0.0896		0.9191		0.0593		0.0176		0.9191		0.0977	
Weak Instrument test (*p*-value)																	0.0217*	
Wu- Hausman test (*p*-value)																	0.0101*	
Sargan test (*p*-value)																	N.A. (equally identified)	

Reference

1. Bettendorf, L, & Verboven, F. (2000). *Incomplete transmission of coffee bean prices: evidence from The Netherlands*, 27, 1-16
2. Soderbom, M (2011) *Advanced Industrial Organization I Identification of Demand Functions*
3. Stock, J.H, & Watson, M.W (2015) *Introduction to Econometrics (3rd ed)*, Pearson