WORKING PAPER

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Causality between international trade and air connectivity

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Abstract

This paper explores the relationship between air connectivity and international trade for the UK, using panel data on trade between the UK and foreign countries over the period 2000 to 2008. The data allows us to explore how the pattern (across countries) and trends (over time) of air connectivity at each of London's three main airports have influenced trade, and conversely how the pattern and trends of trade have influenced air connectivity.

We have estimated a set of econometric models that capture the bidirectional relationships between air connectivity and international trade: the pattern of air connectivity from London's major airports reflects the requirements of international trade (alongside tourism and other effects), whilst also being subject to capacity constraints. However, also we find a statistically significant influence from air connectivity at London's major hub airport (Heathrow) on international trade.

It is this second relationship that is of particular interest. Our results indicate that availability of air connectivity (particularly at hub airports) does influence the level of trade on particular routes. We therefore could expect international trade to be curtailed by restrictions on capacity for international air connectivity at Heathrow.

1. Introduction

Academic literature shows growing evidence of the role played by air connectivity on national economic performance. For example, previous studies have used survey methods to measure the impact of air connectivity on industrial location and local economic activity (Brathen, Johansen, & Lian, 2006), as well as econometric methods to study the relationship between air connectivity and urban economic development measured by employment (Brueckner, July 2003), and location of large firm headquarters (Bel & Fageda, 2008). All of these studies confirm the importance of air connectivity to local economic activity.

This paper focuses on the link between air connectivity and international trade. Previous researchers have noted the strong relationship between international trade and air connectivity (Frontier Economics, November 2012). To be clear, this relationship is not simply because traded goods are sometimes transported by air, but rather because air connectivity encourages business relationships on which international trade is built.

However, previous researchers have noted that the direction of causality of this relationship is unclear. In connection to the impact of air connectivity on employment, Brueckner writes:

> 'Given the contemporaneous relationship between employment and airline traffic, the endogeneity of traffic becomes a more series issue than in studies that use a base year value to explain subsequent employment growth. In other words, while airline traffic may affect employment, traffic itself depends partly on the contemporaneous level of employment in the metro area, which helps to determine the volume of business travel.' (Brueckner, July 2003)

In the context of our present research, does air connectivity contribute to international trade, or does international trade between countries contribute to the growth the development of air connectivity?

We hypothesis that, to some degree, both these statements are correct – in which case it is crucial for aviation policy to determine the relative strength of both directions of causality. If air connectivity simply passively responds to patterns of international trade (alongside other drivers such as tourism), then a direct policy of development of air connectivity has less importance. However, if there is a strong causal relationship also from air connectivity to international trade, then a direct policy of developing a country's air connectivity takes on more importance (CBI, 2013). This debate is particularly relevant in evaluating the case for new airport capacity where this is a constraining factor on development of new air connectivity – as currently in the UK (Airports Commission, February 2013).

A second issue is the type of airport that is most important to the international trade. Airports naturally fall into two types: hub and point to point airports. A hub airport is one where airlines bring together passengers who started their journey at different airports to enable them to fly to more places more frequently, particularly long haul, than could be supported by local demand alone. The UK, for example, is fortunate to have a leading global hub delivering excellent intercontinental connectivity. There are two basic reasons why major hub airports are so fundamental to enabling connectivity: (a) the further the distance between two cities, the smaller the demand is to travel between them; and (b) long haul flying requires longer range aircraft that are larger, with more seats than short haul aircraft. It follows from these observations that viable operation of direct services between two long haul cities requires aggregation of demand from across one or more regions to fill larger aircraft on a regular basis. Point-to-point operations, on the other hand, are typified by smaller planes, simple fleets, fast turnaround and a high frequency of flights to a more limited number of final destinations.

This raises the question of whether all airports, or just hub airports, are capable of causally generating international trade.

This paper explores the relationship between air connectivity and international trade for the UK using panel data on trade between the UK and foreign countries from 2000 to 2008 (the latest available at the time of research). This data allows us to explore how the pattern (across countries) and trend (through time) of air connectivity at each of London's three main airports have influenced trade, and conversely how the pattern and trends of trade have influenced air connectivity.

We particularly look at the direction of relationships between air connectivity and international trade, and the distinctive roles played by hub and point to point airports in these relationships.

This paper is organised as follows:

- Section 2 describes the overall approach;
- Section 3 describes the data used for modelling;
- Section 4 presents the model, estimation results and interpretation;
- Section 5 provides our conclusion.

2. Approach

This paper addresses empirically the issues raised by the discussion of the previous section in the case of UK air connectivity, through the use of an econometric model system based on panel data of international trade and air connectivity between the UK and individual foreign countries over a period of 9 years. The intuitive approach is as follows:

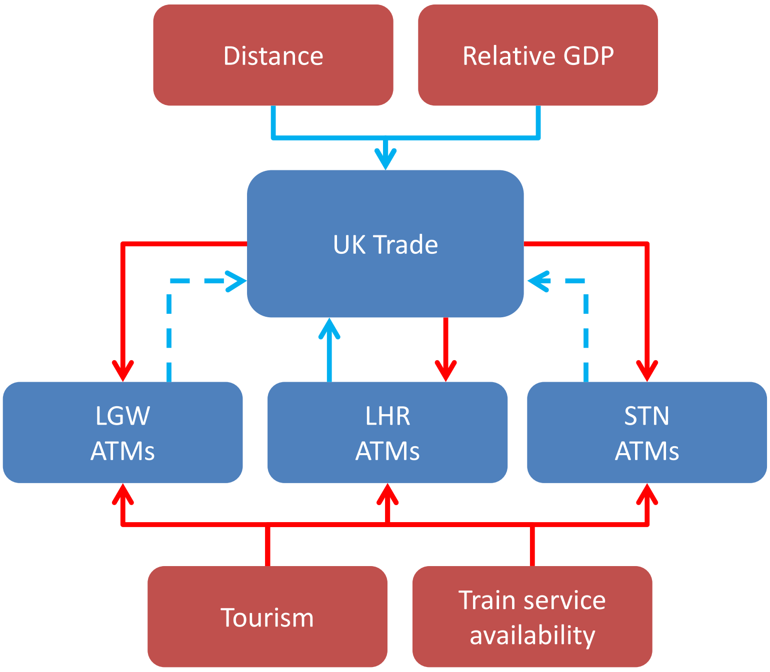
- Three models explain the link from international trade (and other factors) to the demand for air connectivity (measured by air traffic movements – or ATMs) at each of London's three main airports (Heathrow – LHR, Gatwick – LGW, and Stansted – STN). The distribution of flights, and trend over time, at each of the three main London airports to different country destinations around the world is modelled by (a) volume of trade with the country ; (b) popularity of the country as a tourist destination; (c) whether there is a viable rail substitute; (d) distance of the country principal city from London; and (e) other variables describing more precisely the nature of the destination country. The weights for each of these explanatory factors vary by airport;
- A further model explains the link from the supply of air connectivity at each of London's three main airports (and other factors) to the level of trade from the UK to each country.

Other factors again include the distance between countries, the relative state of economic development, principal language spoken, and whether there is a land border (only in the case of Ireland);

- Application of instrumental variables (IV) within the three stage least squares (3SLS) estimation method ensures that each model captures only the unidirectional effect from explanatory to dependent variables, avoiding estimation bias from endogeneity of regressors. Our aim is that the models capture respectively the influence of trade on air connectivity, and separately the influence of air connectivity on trade. The approach is the same as used in similar studies of the relationship between air connectivity and economic activity including employment (Brueckner, July 2003) and the location of the headquarters of large firms (Bel & Fageda, 2008).

Figure 1 is a schematic description of the modelled relationships. Endogenous variables are shown in the blue boxes, and exogenous variables in the red boxes.[1] The impact of air connectivity on international trade is shown by the blue lines; whilst the reverse impact of international trade on air connectivity is shown by the red lines.

Figure 1: Schematic description of the modelled relationships



[1] Note that tourism refers to the total number of tourists visiting a foreign country – not just UK tourists – and so reflects the general attractiveness of that country to tourists. It can, therefore, be treated as an exogenous variable for our purposes. We could model only UK tourists, and treat this as an endogenous variable depending on air connectivity amongst other variables. However, this would complicate the model and our interest in this paper is the link between air connectivity and international trade, rather than tourism.

3. Data

This paper uses data from the years 2000 to 2008 (the latest available at the time of research). Other than the UK, the countries included in the analysis are listed in Annex A, yielding a sample of 66 countries, over a period of 9 years. All the UK's major trading partners are covered in the sample.

For each country, we used the following data:

- UK visible and invisible, exports and imports (summed) in £ million, sourced from the UK's Office of National Statistics (ONS);
- ATMs from each of Heathrow, Gatwick and Stansted, sourced from airport databases;
- Gross Domestic Product (GDP), sourced from the World Bank;
- The number of overseas tourists visiting each country, again sourced from the World Bank.

4. Model, estimation results and interpretation

The system of equations estimated was based on the following underlying relationships:

$$ATM_{ijt} = \alpha_i GDP_{jt} + \beta_{1i} Trade_{jt} + \beta_{2i} Tourism_{jt} + other\ variables\ ; i = 1,2,3 \tag{1}$$

$$Trade_{jt} = \alpha GDP_{jt} + \sum_{i=1}^{3} \gamma_i ATM_{ijt} + other\ variables \tag{2}$$

Where:

ATM_{ij}	is the number of air traffic movements (ATMs) from London airport *i* to country *j* , in year *t*. The i indexation refers respectively to LHR, LGW and STN;
GDP_j	is Gross Domestic Product (GDP) in country *j* in year *t*;
$Trade_j$	is total trade (visible and invisible, exports and imports) between the UK and country *j*, in year *t*;
$Tourism_j$	is the total number of visitors to country *j*, in year t.

Greek letters signify model coefficients (to be estimated).

We can reasonably assume that an intercept term is not required in these equations since, if in a hypothetical country, GDP, trade and tourism were all zero, so would be the demand for air connectivity to that country. Similarly, if GDP and the supply of air connectivity to a hypothetical country were zero, so would be trade to and from that country.

In order to alleviate heteroscedasticity of residuals in estimation, we normalise these relationships by GDP,[2] thus giving our equations for operational estimation:

[2] In doing this care was taken to use GDP in current prices to normalise trade data also in current prices, but GDP in constant prices to normalise volume measures such as ATMs and numbers of tourists.

$$\frac{ATM_{ijt}}{GDP_{jt}} = \alpha_{it} + \beta_{1i}\frac{Trade_{jt}}{GDP_{jt}} + \beta_{2i}\frac{Tourism_{jt}}{GDP_{jt}} + \beta_{3i}Train_j + \beta_{4i}Distance_j + u_{ijt} \qquad ; i = 1,2,3 \tag{3}$$

$$\frac{Trade_{jt}}{GDP_{jt}} = \alpha + \sum_{i=1}^{3}\gamma_i\frac{ATM_{ijt}}{GDP_{jt}} + \gamma_4 English_j + \gamma_5 Ireland_j + \frac{\gamma_6}{Distance_j} + \gamma_7\left(\frac{GDP}{pop}\right)_{jt} + \gamma_8\left(\frac{GDP}{pop}\right)_{jt}^2 + v_{jt} \tag{4}$$

Where other explanatory variables are:

Train$_j$	is a dummy variable taking value 1 if there is a direct train connection between London and country *j* (France and Belgium);
Distance$_j$	is the Great Circle distance between London and the principal city of country *j*;
English$_j$	is a dummy variable taking value 1 if English is the principal spoken language in country *j*;
Ireland$_j$	is a dummy variable taking value 1 if country *j* is the Republic of Ireland;
u_{ijt} and v_{jt}	are model residuals, we assume:

$$\begin{pmatrix} u_{1jt} \\ u_{2jt} \\ u_{3jt} \\ v_{jt} \end{pmatrix} \sim N(0, \Omega)$$

i.e. we allow for correlation between contemporaneous residuals in each equation.

One other change has been made to equation (3) – a time subscript has been added on the intercept term to allow for the impact of airport capacity constraints in restraining growth in the number of ATMs.

Figure 2 provides the results from estimation of equations (3) and (4), using 3SLS. Figure 2a shows an unconstrained estimation, whilst Figure 2b shows the results with the constraint that Heathrow is the only airport where air connectivity drives international trade ($\gamma_2 = \gamma_3 = 0$).

Figure 2a: Results of model estimation unconstrained

Variable	Coefficient	P value	
Demand for air connectivity at Heathrow (LHR)			
2000	0.0271	0.0086	***
2001	0.0161	0.1134	
2002	0.0129	0.2026	
2003	0.0105	0.2926	
2004	0.0135	0.1797	
2005	0.0092	0.3531	
2006	0.0037	0.7152	
2007	0.0029	0.7704	
2008	-0.0007	0.9466	
Trade	0.5959	0.0000	***
Tourism	0.0003	0.0000	***
Train	-0.0285	0.0889	*
Distance	-0.1D-05	0.0416	**
R^2	*0.3828*		
Demand for air connectivity at Gatwick (LGW)			
Intercept	-0.0471	0.1048	
Trade	1.9105	0.0000	***
Tourism	0.0009	0.0000	***
Train	-0.1413	0.0620	*
Distance	-0.6D-05	0.0780	*
R^2	*0.2085*		
Demand for air connectivity at Stansted (STN)			
Intercept	-0.0042	0.3904	
Trade	0.7123	0.0000	***
Tourism	0.0001	0.0008	***
Train	-0.0460	0.0003	***
Distance	-0.2D-05	0.0022	***
R^2	*0.2360*		
International trade			
Intercept	0.0087	0.0003	***
ATM – Heathrow	0.1444	0.0000	***
ATM – Gatwick	0.0401	0.2102	
ATM – Stansted	-0.1825	0.3693	
English	0.0015	0.7246	
Ireland	0.2271	0.0000	***
1/Distance	17.6581	0.0000	***
(GDP/pop)	1.1589	0.0000	***
$(GDP/pop)^2$	-23.9704	0.0000	***
R^2		*0.7305*	

* Significant at 10%
** Significant at 5%
*** Significant at 1%

Figure 2b: Results of model estimation constrained so that Heathrow is only airport where air connectivity drives international trade ($\gamma_2 = \gamma_3 = 0$)

Variable	Coefficient	P value	
Demand for air connectivity at Heathrow (LHR)			
2000	0.0260	0.0115	**
2001	0.0152	0.1336	
2002	0.0122	0.2299	
2003	0.0098	0.3266	
2004	0.0124	0.2164	
2005	0.0087	0.3835	
2006	0.0029	0.7684	
2007	0.0024	0.8127	
2008	-0.0008	0.9328	
Trade	0.6005	0.0000	***
Tourism	0.0003	0.0000	***
Train	-0.0298	0.0739	*
Distance	-0.1D-05	0.0541	*
R^2	*0.3835*		
Demand for air connectivity at Gatwick (LGW)			
Intercept	-0.0504	0.0815	
Trade	1.9308	0.0000	***
Tourism	0.0009	0.0000	***
Train	-0.1472	0.0501	*
Distance	-0.1D-05	0.0997	*
R^2	*0.2085*		
Demand for air connectivity at Stansted (STN)			
Intercept	-0.0053	0.2695	
Trade	0.7192	0.0000	***
Tourism	0.0001	0.0004	***
Train	-0.0480	0.0001	***
Distance	-0.2D-05	0.0040	***
R^2	*0.2341*		
International trade			
Intercept	0.0062	0.0014	***
ATM – Heathrow	0.1739	0.0000	***
ATM – Gatwick	Constrained to zero		
ATM – Stansted	Constrained to zero		
English	0.0071	0.0023	***
Ireland	0.1916	0.0000	***
1/Distance	19.6860	0.0000	***
(GDP/pop)	0.9334	0.0000	***
$(GDP/pop)^2$	-19.4064	0.0000	***
R^2	*0.7258*		

* Significant at 10%

** Significant at 5%

*** Significant at 1%

Although we provide results for estimation of both the unconstrained and constrained model - the latter where Heathrow is only airport where air connectivity drives international trade ($\gamma_2 = \gamma_3 = 0$) – our first observation is that the constraint appears fully justified. From Figure 2a we see that whilst the Heathrow ATM variable is statistically significant (P=0.0000), the same is not true for either the Gatwick or Stansted ATM variables (P=0.2102 and P=0.3693 respectively). Further a formal Wald test of the linear restriction $\gamma_2 = \gamma_3 = 0$ confirms that we can't reject this hypothesis (P=0.2252). Therefore, in the following discussion we refer only to the constrained model of Figure 2b.

From the constrained model results (Figure 2b) we make the following observations:

- **Demand for air connectivity**
  - Air connectivity is proportionately greater with countries of higher overall GDP. This observation follows from the GDP normalisation;
  - The demand for air connectivity at each major London airport is driven by trade and tourism. These effects are lower at Heathrow than Gatwick, most probably because of the effect of capacity constraints at Heathrow. These effects are all statistically significant at the 1% level;
  - The availability of direct train services from London to France and Belgium reduces the demand for air connectivity on these routes. These effects are all statistically significant at the 5% level;
  - Distance is an important negative demand driver for air connectivity. The interpretation of this is that as distances increase, distance related costs (e.g. fuel) passed through to air fares, dampen demand. These effects are statistically significant at the 10% level;
- **Determinants of international trade to/from the UK**
  - The UK trades proportionately more with countries of higher overall GDP. This observation follows from the GDP normalisation;
  - The UK trades less with more distance countries. This effect is statistically significant at the 1% level;
  - The UK trades more with the Republic of Ireland than the model would otherwise predict – this most probably reflects the ease of trade across the land border between Northern Ireland and the Republic. This effect is statistically significant at the 1% level;
  - The UK trades more with countries where English is the principally spoken language. This effect is statistically significant at the 1% level;
  - The UK trades more with countries with a GDP per capita approximately half of that of the UK. The quadratic form of this variable predicts that the UK will trade most with countries that have a GDP per capita of 20% above that of the UK. Either side of this the volume of trade will reduce. This effect is statistically significant at the 1% level;
  - Finally, Heathrow's air connectivity to individual countries contributes significantly to the UK's level of overseas trade with that country. This effect is statistically significant at the 1% level (P=0.0013). On average, each daily flight to/from Heathrow, equivalent to an additional 730 ATMs, generates 730*0.17392636*0.922746=£100m of international trade in goods and services;[3]

[3] The CBI study estimates that an additional daily flight an additional daily flight to a high growth market will generate £128m of additional trade (CBI, 2013).

- The declining trend in the fixed effect dummy variables in the Heathrow equation shows the growing impact of the capacity constraint in suppressing demand over time since the year 2000. In the case of Heathrow, these individual year effects were found to be important; indicating that over time the capacity constraint was restricting growth. However, in the cases of Gatwick and Stansted individual year effects were found to be unnecessary - the Wald test that individual year effects could be constrained to the same value (effectively a constant intercept term), could not be rejected at the 5% level ($p=0.9997$).

Finally, the structure of the covariance matrix between residuals of each equation (Ω) is of interest. Figure 3 shows the correlation matrix calculated from the covariance matrix. The one element that stands out from this matrix is the correlation between ATMs of Gatwick and Stansted (0.798), whereas neither is correlated with residuals from Heathrow (0.087 and 0.017). This indicates that unmodelled factors affect both these airports – but not Heathrow. Both Gatwick and Stansted have a substantial number of low cost carrier flights, and so it seems likely that this correlation is reflecting specific factors in the low cost leisure sector.

Figure 3: Residual correlation matrix

	Heathrow	Gatwick	Stansted	International trade
Heathrow	1.000	0.087	0.017	-0.183
Gatwick		1.000	**0.798**	-0.059
Stansted			1.000	-0.327
International trade				1.000

5. Conclusion

We have estimated a set of econometric models that capture the bidirectional relationships between air connectivity and international trade: air connectivity from London's major airports reflects the requirements of international trade (alongside tourism and other effects); whilst also there is a statistically significant influence from air connectivity at London's major hub airport (Heathrow) on international trade patterns.

It is interesting that the impact of air connectivity on international trade was found to be statistically significant only at London's international hub airport. The air connectivity provided by the point to point airports of Gatwick and Stansted certainly react to patterns in international trade (along with tourism) but does not drive this relationship.

Further research will centre on investigation of dynamic effects (e.g. are there lags in the relationship between air connectivity and trade). Endogenising tourism would also be an interesting line of further research.

6. Bibliography

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Annex A: Countries in dataset

Australia
Austria
Belgium
Bermuda
Brazil
Brunei
Bulgaria
Canada
Channel Islands
Chile
China
Colombia
Cyprus
Czech Rep
Denmark
Egypt
Estonia
Finland
France
Germany
Greece
Hong Kong
Hungary
Iceland
India
Indonesia
Irish Republic
Isle of Man
Israel
Italy
Japan
Kenya
Kuwait
Latvia
Liechtenstein
Lithuania
Luxembourg
Malaysia
Malta
Mexico
Netherlands
New Zealand
Nigeria
Norway
Pakistan
Panama
Philippines
Poland
Portugal
Romania
Russia
Saudi Arabia
Singapore
Slovakia
Slovenia
South Africa
South Korea
Spain
Sweden
Switzerland
Taiwan
Thailand
Turkey
UAE including Dubai
USA including Puerto Rica
Zimbabwe

Annex B: Model details

This annex provides the full econometric modeling output. Underlying data is available on request.

```
--> RESET
Initializing LIMDEP Version 9.0.1 (January 1, 2007).
--> RESET
Initializing LIMDEP Version 9.0.1 (January 1, 2007).
--> READ ; File = "h:\My Documents\Trade2.xls" ; Format=XLS $
--> CREATE ; Trade=VisExp+VisImp+InvExp+InvImp $
--> CREATE ; TradeY=Trade/GDPCur*1000000 $
--> CREATE ; LHRY=LHR/GDPCon*1000000  $
--> CREATE ; LGWY=LGW/GDPCon*1000000  $
--> CREATE ; STNY=STN/GDPCon*1000000  $
--> CREATE ; TouristY=Tourist/GDPCon*1000000 $
--> CREATE ; Dist1=1/Distance $
--> CREATE ; GDPCap=GDPCon/Pop/1000000000 $
--> CREATE ; GDPCap2=GDPCap^2 $
--> 3SLS ; Lhs=TradeY,LHRY,LGWY,STNY ;
    Eq1=one,LHRY,LGWY,STNY,Dist1,Ireland,English,GDPCap,GDPCap2 ;

Eq2=Y2000,Y2001,Y2002,Y2003,Y2004,Y2005,Y2006,Y2007,Y2008,TradeY,TouristY..
.
    Eq3=One,TradeY,TouristY,Train,Distance ;
    Eq4=One,TradeY,TouristY,Train,Distance ;
    Inst=Distance,Dist1,English,TouristY,Train,Ireland,GDPCap,GDPCap2,
    Y2000,Y2001,Y2002,Y2003,Y2004,Y2005,Y2006,Y2007,Y2008 ;
    Hetero ;
    Wald: b(3)=0,b(4)=0 $
Criterion function is max(abs(%chg in b(i))).
Iteration    0, 3SLS          =    1.000000
Iteration    1, 3SLS          =    1.353564
Iteration    2, 3SLS          =    .7920795E-01

+---------------------------------------------------+
| Estimates for equation: TRADEY                    |
| InstVar/GLS least squares regression              |
| Model was estimated Apr 16, 2013 at 02:15:12PM    |
| LHS=TRADEY   Mean                 =   .3783321E-01 |
|              Standard deviation   =   .4705841E-01 |
| WTS=none     Number of observs.   =        594    |
| Model size   Parameters           =          9    |
|              Degrees of freedom   =        585    |
| Residuals    Sum of squares       =   .3484876    |
|              Standard error of e  =   .2440707E-01 |
| Fit          R-squared            =   .7305435    |
|              Adjusted R-squared   =   .7268586    |
| Model test   F[  8,   585] (prob) = 198.25 (.0000) |
| Diagnostic   Log likelihood       =   1367.137    |
|              Restricted(b=0)      =   973.1321    |
|              Chi-sq [   8]  (prob) = 788.01 (.0000) |
| Info criter. LogAmemiya Prd. Crt. =  -7.410727    |
|              Akaike Info. Criter. =  -7.410729    |
| Not using OLS or no constant. Rsqd & F may be < 0. |
| Durbin-Watson 2.255 Autocorrelation =      -.1275 |
+---------------------------------------------------+
+--------+--------------+----------------+--------+--------+----------+
|Variable| Coefficient  | Standard Error |b/St.Er.|P[|Z|>z]| Mean of X|
+--------+--------------+----------------+--------+--------+----------+
 Constant|     .00867108       .00241585     3.589   .0003
 LHRY    |     .14442333       .03043331     4.746   .0000     .05014238
 LGWY    |     .04012531       .03202067     1.253   .2102     .08041625
 STNY    |    -.18246713       .20323898     -.898   .3693     .01952061
 DIST1   |    17.6580658      2.24470398     7.867   .0000     .00063647
 IRELAND |     .22712786       .03119601     7.281   .0000     .01515152
```

ENGLISH	.00153365	.00435345	.352	.7246	.24242424
GDPCAP	1.15885254	.27275096	4.249	.0000	.01282241
GDPCAP2	-23.9704245	5.44575567	-4.402	.0000	.00031938

```
+----------------------------------------------------+
| Estimates for equation: LHRY                       |
| InstVar/GLS least squares regression               |
| Model was estimated Apr 16, 2013 at 02:15:12PM     |
| LHS=LHRY     Mean                 =   .5014238E-01 |
|              Standard deviation   =   .8628965E-01 |
| WTS=none     Number of observs.   =        594     |
| Model size   Parameters           =         13     |
|              Degrees of freedom   =        581     |
| Residuals    Sum of squares       =   2.665399     |
|              Standard error of e  =   .6773187E-01 |
| Fit          R-squared            =   .3828363     |
|              Adjusted R-squared   =   .3700893     |
| Model test   F[ 12,   581] (prob) =  30.03 (.0000) |
| Diagnostic   Log likelihood       =   762.8886     |
|              Restricted(b=0)      =   612.9780     |
|              Chi-sq [ 12]  (prob) = 299.82 (.0000) |
| Info criter. LogAmemiya Prd. Crt. =  -5.362748     |
|              Akaike Info. Criter. =  -5.362755     |
| Not using OLS or no constant. Rsqd & F may be < 0. |
| Durbin-Watson 2.179 Autocorrelation =       -.0893 |
+----------------------------------------------------+
```

Variable	Coefficient	Standard Error	b/St.Er.	P[|Z|>z]	Mean of X
Y2000	.02710265	.01031570	2.627	.0086	.11111111
Y2001	.01611696	.01017964	1.583	.1134	.11111111
Y2002	.01291814	.01013794	1.274	.2026	.11111111
Y2003	.01052871	.01000399	1.052	.2926	.11111111
Y2004	.01351280	.01007251	1.342	.1797	.11111111
Y2005	.00923905	.00994982	.929	.3531	.11111111
Y2006	.00365558	.01001993	.365	.7152	.11111111
Y2007	.00291438	.00998490	.292	.7704	.11111111
Y2008	-.00065448	.00977627	-.067	.9466	.11111111
TRADEY	.59594476	.08152687	7.310	.0000	.03783321
TOURISTY	.00026644	.259549D-04	10.266	.0000	93.1439743
TRAIN	-.02854725	.01677895	-1.701	.0889	.03030303
DISTANCE	-.142962D-05	.701753D-06	-2.037	.0416	4861.04545

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+----------------------------------------------------+
| Estimates for equation: LGWY                       |
| InstVar/GLS least squares regression               |
| Model was estimated Apr 16, 2013 at 02:15:12PM     |
| LHS=LGWY     Mean                 =   .8041625E-01 |
|              Standard deviation   =   .3440429     |
| WTS=none     Number of observs.   =        594     |
| Model size   Parameters           =          5     |
|              Degrees of freedom   =        589     |
| Residuals    Sum of squares       =   55.08702     |
|              Standard error of e  =   .3058208     |
| Fit          R-squared            =   .2085187     |
|              Adjusted R-squared   =   .2031436     |
| Model test   F[  4,   589] (prob) =  38.79 (.0000) |
| Diagnostic   Log likelihood       =  -136.5938     |
|              Restricted(b=0)      =  -208.5576     |
|              Chi-sq [  4]  (prob) = 143.93 (.0000) |
| Info criter. LogAmemiya Prd. Crt. =  -2.361130     |
|              Akaike Info. Criter. =  -2.361130     |
| Not using OLS or no constant. Rsqd & F may be < 0. |
| Durbin-Watson 1.903 Autocorrelation =        .0483 |
+----------------------------------------------------+
```

```
|Variable| Coefficient  | Standard Error |b/St.Er.|P[|Z|>z]| Mean of X|
+--------+--------------+----------------+--------+--------+----------+
 Constant|    -.04709549       .02903340    -1.622   .1048
 TRADEY  |    1.91048720       .36764187     5.197   .0000    .03783321
 TOURISTY|     .00093013       .00011638     7.992   .0000   93.1439743
 TRAIN   |    -.14134882       .07575193    -1.866   .0620    .03030303
 DISTANCE|   -.557927D-05    .316551D-05    -1.763   .0780   4861.04545
```

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+----------------------------------------------------+
| Estimates for equation: STNY                       |
| InstVar/GLS least squares regression               |
| Model was estimated Apr 16, 2013 at 02:15:12PM     |
| LHS=STNY     Mean                 =   .1952061E-01 |
|              Standard deviation   =   .5952036E-01 |
| WTS=none     Number of observs.   =        594     |
| Model size   Parameters           =          5     |
|              Degrees of freedom   =        589     |
| Residuals    Sum of squares       =   1.591521     |
|              Standard error of e  =   .5198147E-01 |
| Fit          R-squared            =   .2359922     |
|              Adjusted R-squared   =   .2308037     |
| Model test   F[  4,   589] (prob) =  45.48 (.0000) |
| Diagnostic   Log likelihood       =   916.0406     |
|              Restricted(b=0)      =   833.5844     |
|              Chi-sq [  4]  (prob) = 164.91 (.0000) |
| Info criter. LogAmemiya Prd. Crt. =  -5.905353     |
|              Akaike Info. Criter. =  -5.905354     |
| Not using OLS or no constant. Rsqd & F may be < 0. |
| Durbin-Watson 1.938 Autocorrelation =        .0309 |
+----------------------------------------------------+
+--------+--------------+----------------+--------+--------+----------+
|Variable| Coefficient  | Standard Error |b/St.Er.|P[|Z|>z]| Mean of X|
+--------+--------------+----------------+--------+--------+----------+
 Constant|    -.00422440       .00491806     -.859   .3904
 TRADEY  |     .71229906       .06244253    11.407   .0000    .03783321
 TOURISTY|    .661805D-04    .197627D-04     3.349   .0008   93.1439743
 TRAIN   |    -.04597638       .01285555    -3.576   .0003    .03030303
 DISTANCE|   -.164052D-05    .534719D-06    -3.068   .0022   4861.04545
```

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+----------------------------------------------------+
| Estimates for equation: TRADEY                     |
| InstVar/GLS least squares regression               |
| Model was estimated Apr 16, 2013 at 02:15:12PM     |
| LHS=TRADEY   Mean                 =   .3783321E-01 |
|              Standard deviation   =   .4705841E-01 |
| WTS=none     Number of observs.   =        594     |
| Model size   Parameters           =          9     |
|              Degrees of freedom   =        585     |
| Residuals    Sum of squares       =   .3546140     |
|              Standard error of e  =   .2462068E-01 |
| Fit          R-squared            =   .7258064     |
|              Adjusted R-squared   =   .7220568     |
| Model test   F[  8,   585] (prob) = 193.57 (.0000) |
| Diagnostic   Log likelihood       =   1361.961     |
|              Restricted(b=0)      =   973.1321     |
|              Chi-sq [  8]  (prob) = 777.66 (.0000) |
| Info criter. LogAmemiya Prd. Crt. =  -7.393299     |
|              Akaike Info. Criter. =  -7.393302     |
| Not using OLS or no constant. Rsqd & F may be < 0. |
| Durbin-Watson 2.280 Autocorrelation =       -.1401 |
| Wald test:Chi-squared[ 2]=   2.9813, Prob =  .2252 |
+----------------------------------------------------+
+--------+--------------+----------------+--------+--------+----------+
|Variable| Coefficient  | Standard Error |b/St.Er.|P[|Z|>z]| Mean of X|
+--------+--------------+----------------+--------+--------+----------+
 Constant|     .00619771       .00194422     3.188   .0014
```

LHRY	.17392636	.02507033	6.938	.0000	.05014238
LGWY	-.832667D-16	......(Fixed Parameter).......			
STNY	.555112D-15	......(Fixed Parameter).......			
DIST1	19.6860229	1.43864390	13.684	.0000	.00063647
IRELAND	.19160164	.00912812	20.990	.0000	.01515152
ENGLISH	.00706166	.00231224	3.054	.0023	.24242424
GDPCAP	.93336151	.18964402	4.922	.0000	.01282241
GDPCAP2	-19.4064302	3.59595441	-5.397	.0000	.00031938

```
+----------------------------------------------------+
| Estimates for equation: LHRY                       |
| InstVar/GLS least squares regression               |
| Model was estimated Apr 16, 2013 at 02:15:13PM     |
| LHS=LHRY     Mean                 =   .5014238E-01 |
|              Standard deviation   =   .8628965E-01 |
| WTS=none     Number of observs.   =        594     |
| Model size   Parameters           =         13     |
|              Degrees of freedom   =        581     |
| Residuals    Sum of squares       =   2.662610     |
|              Standard error of e  =   .6769642E-01 |
| Fit          R-squared            =   .3834821     |
|              Adjusted R-squared   =   .3707485     |
| Model test   F[ 12,   581] (prob) =  30.12 (.0000) |
| Diagnostic   Log likelihood       =   763.1996     |
|              Restricted(b=0)      =   612.9780     |
|              Chi-sq [ 12]  (prob) = 300.44 (.0000) |
| Info criter. LogAmemiya Prd. Crt. =  -5.363795     |
|              Akaike Info. Criter. =  -5.363802     |
| Not using OLS or no constant. Rsqd & F may be < 0. |
| Durbin-Watson 2.180 Autocorrelation =      -.0901 |
| Wald test:Chi-squared[ 2]=   2.9813, Prob =  .2252 |
+----------------------------------------------------+
```

Variable	Coefficient	Standard Error	b/St.Er.	P[|Z|>z]	Mean of X
Y2000	.02597913	.01028489	2.526	.0115	.11111111
Y2001	.01523871	.01015765	1.500	.1336	.11111111
Y2002	.01215366	.01012235	1.201	.2299	.11111111
Y2003	.00979759	.00998844	.981	.3266	.11111111
Y2004	.01239742	.01002803	1.236	.2164	.11111111
Y2005	.00866294	.00994022	.872	.3835	.11111111
Y2006	.00294564	.01000132	.295	.7684	.11111111
Y2007	.00236389	.00997639	.237	.8127	.11111111
Y2008	-.00082376	.00977577	-.084	.9328	.11111111
TRADEY	.60045703	.08148497	7.369	.0000	.03783321
TOURISTY	.00026850	.259103D-04	10.363	.0000	93.1439743
TRAIN	-.02976726	.01665731	-1.787	.0739	.03030303
DISTANCE	-.134524D-05	.698553D-06	-1.926	.0541	4861.04545

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+----------------------------------------------------+
| Estimates for equation: LGWY                       |
| InstVar/GLS least squares regression               |
| Model was estimated Apr 16, 2013 at 02:15:13PM     |
| LHS=LGWY     Mean                 =   .8041625E-01 |
|              Standard deviation   =   .3440429     |
| WTS=none     Number of observs.   =        594     |
| Model size   Parameters           =          5     |
|              Degrees of freedom   =        589     |
| Residuals    Sum of squares       =   55.08795     |
|              Standard error of e  =   .3058234     |
| Fit          R-squared            =   .2085053     |
|              Adjusted R-squared   =   .2031302     |
| Model test   F[  4,   589] (prob) =  38.79 (.0000) |
| Diagnostic   Log likelihood       =  -136.5989     |
|              Restricted(b=0)      =  -208.5576     |
|              Chi-sq [  4]  (prob) = 143.92 (.0000) |
```

```
| Info criter. LogAmemiya Prd. Crt. =  -2.361113     |
|              Akaike Info. Criter. =  -2.361113     |
| Not using OLS or no constant. Rsqd & F may be < 0. |
| Durbin-Watson 1.904 Autocorrelation =        .0478 |
| Wald test:Chi-squared[ 2]=   2.9813, Prob =  .2252 |
+----------------------------------------------------+
```

Variable	Coefficient	Standard Error	b/St.Er.	P[|Z|>z]	Mean of X
Constant	-.05039050	.02892345	-1.742	.0815	
TRADEY	1.93081945	.36745265	5.255	.0000	.03783321
TOURISTY	.00093865	.00011621	8.077	.0000	93.1439743
TRAIN	-.14720511	.07514106	-1.959	.0501	.03030303
DISTANCE	-.518636D-05	.315007D-05	-1.646	.0997	4861.04545

```
+----------------------------------------------------+
| Estimates for equation: STNY                       |
| InstVar/GLS least squares regression               |
| Model was estimated Apr 16, 2013 at 02:15:13PM     |
| LHS=STNY     Mean                 =   .1952061E-01 |
|              Standard deviation   =   .5952036E-01 |
| WTS=none     Number of observs.   =        594     |
| Model size   Parameters           =          5     |
|              Degrees of freedom   =        589     |
| Residuals    Sum of squares       =   1.595369     |
|              Standard error of e  =   .5204427E-01 |
| Fit          R-squared            =   .2341453     |
|              Adjusted R-squared   =   .2289443     |
| Model test   F[  4,   589] (prob) =  45.02 (.0000) |
| Diagnostic   Log likelihood       =   915.3235     |
|              Restricted(b=0)      =   833.5844     |
|              Chi-sq [  4]  (prob) = 163.48 (.0000) |
| Info criter. LogAmemiya Prd. Crt. =  -5.902939     |
|              Akaike Info. Criter. =  -5.902939     |
| Not using OLS or no constant. Rsqd & F may be < 0. |
| Durbin-Watson 1.940 Autocorrelation =        .0300 |
| Wald test:Chi-squared[ 2]=   2.9813, Prob =  .2252 |
+----------------------------------------------------+
```

Variable	Coefficient	Standard Error	b/St.Er.	P[|Z|>z]	Mean of X
Constant	-.00534704	.00484227	-1.104	.2695	
TRADEY	.71922650	.06231310	11.542	.0000	.03783321
TOURISTY	.690823D-04	.196456D-04	3.516	.0004	93.1439743
TRAIN	-.04797169	.01243241	-3.859	.0001	.03030303
DISTANCE	-.150665D-05	.524030D-06	-2.875	.0040	4861.04545