

TRADE IN FINAL GOODS AND MEASUREMENT OF THE IMPACT OF INNOVATION¹

By

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Abstract: It is argued that international trade in final goods has been largely ignored in discussions of the impact of innovation. This paper initially discusses how innovation in final goods at home and overseas impact upon the domestic economy and then proceeds to measure these impacts. It is shown that the impacts of innovation overseas on the domestic economy, although differing across countries and industries, are significant and thus worthy of further consideration.

Key words: Innovation, Trade, Growth of Total Factor Productivity.

JEL: E20; F43; O47; O57

¹ The research upon which this paper is based was funded by the National Endowment for Science Technology and the Arts as part of an exercise to create a new Innovation Index, the Expert Group supporting which we wish to thank for comments. Thanks are also due to Nick Oulton and others who expressed opinions on earlier drafts. Any errors that may remain are, as always, the responsibilities of the authors.

1. INTRODUCTION

This paper is concerned with conceptualising and measuring the impact of innovation in open economies and especially innovation embodied in imported and exported final products. In the UK for example, much innovation is embodied in new products imported from overseas such as mobile phones, plasma televisions, CD players, videos, personal computers. Such innovation, on the basis of casual empiricism, has made a significant impact upon our lives. However, the most commonly used indicators of the extent of, or the impact of, innovation, i.e. total (or multi) factor productivity, TFP, or its growth rate GTFP, do not reflect such innovation. Imported innovation in raw materials and intermediate inputs is allowed for in standard calculations of TFP via changes in the prices of such inputs (see for example Battisti and Stoneman, 2007). Overseas innovation, usually measured by overseas R&D embodied in new imported capital goods has also over the last decade been included as an innovation factor in TFP studies (see for instance Añón Higón, 2007). But overseas innovation embodied in imported final consumer products is not reflected in TFP², despite the huge literature that considers its measurement (Hulten, 2001). This is not surprising for, as TFP is a production orientated measure that takes no account of the impact of imported innovation on consumption, and instead essentially indicates how domestic output per unit of input and cost per unit of output (for given factor prices) change over time as a result of innovation.

² Skytesvall and Hagen (2006) seem to be heading in this direction when they say that “If a country’s export is dominated by products and services that are produced by industries with high TFP growth sold on very competitive markets, it will have to sell them at decreasing prices and thus give away a large part of the rapid TFP increase to customers in other countries”

In order to reflect the impact of innovation imported in final products it is necessary to approach the issue from the consumption rather than production side. We propose a novel approach by specifying an aggregate utility function. The main purposes of this paper are then to: (i) argue how innovation embodied in imported final goods impacts upon the economy; (ii) to measure the impact of such innovation upon utility growth; (iii) to compare the relative importance of such innovation relative to other types of innovation impacting on utility growth; and (iv) to compare the estimates of the impact of all innovations upon utility growth with the usual GTFP measure. This is done for both a sample of OECD economies and for individual industrial sectors in the UK.

The rest of the paper is organized as follows. In the next section a simple modelling framework illustrating the argument is laid out. Section 3 and 4 present the framework necessary to perform the analysis at the macro and sectoral level. Sections 5 and 6 detail data sources and present the estimates. Section 7 provides discussion and conclusion.

2. THE MODEL

Initially employing a macro perspective, assume an open economy in which only one final good, good X, is produced which is used to partly meet public and private consumption and investment demands and is also exported. The price of this good on the home market in time t is $P_x(t)$, as is the domestic currency price of exports. A second

final product³, good Y, is imported at a domestic currency price in time t of $P_y(t)$ that meets the balance of consumption and investment demands.

Production of the home produced good is governed by the production function (1)

$$(1) \quad X(t) = A \exp(\lambda_h(t)) K(t)^\alpha L(t)^{1-\alpha}$$

It is assumed that the supply of factors of production is given. The price of capital and the wage rate respectively are assumed to be r and ω and constant over time. It is further assumed that the price of the home produced good, $P_x(t)$, equals its marginal cost of production, $MC(t)$, which is invariant with respect to output, and from (1) may be written as (2).

$$(2) \quad MC(t) = AC(t) = (\alpha A \exp(\lambda_h(t)))^{-1} r(t)^\alpha \omega(t)^{1-\alpha} (\alpha/1-\alpha)^{1-\alpha}$$

Total income in the economy in time t will equal the value of domestic production, $P_x(t)X$, and total expenditure will be $P_x(t)x(t) + P_y(t)y(t)$ where $x(t)$ and $y(t)$ are consumption of x and y respectively in the domestic economy. Exports of home produced goods will be valued at $P_x(t)(X(t) - x(t))$.

Home produced goods and imports of final products can be used for private consumption, public consumption (i.e. government expenditure) or investment. Here it is assumed for simplicity that preferences for goods x and y in the domestic economy can be

³ We do not explore why the one good is imported and the other exported. Within this context, an explanation based upon differences in countries knowledge bases or technological skills might be attractive.

summarised by the aggregate utility⁴ function (3), without consideration of the type of final use.

$$(3) \quad U(t) = Bx(t)^\gamma y(t)^{1-\gamma}$$

from which it is obvious that

$$(4) \quad d\log U(t) = \gamma d\log x(t) + (1-\gamma)d\log y(t)$$

This explicitly reflects that goods produced in the home economy that are exported do not directly contribute to utility at home while imported goods do so contribute. Maximising utility subject to the constraint that expenditure equals income i.e. (5) holds,

$$(5) \quad P_x(t)x(t) + P_y(t) y(t) = P_x(t)X(t)$$

yields (6) and (7)

$$(6) \quad P_y(t)y(t)/P_x(t)X(t) = 1-\gamma$$

$$(7) \quad P_x(t)x(t)/P_x(t)X(t) = \gamma$$

with imports given by (8)

$$(8) \quad P_y(t)y(t) = (1-\gamma)(P_x(t)X(t))$$

and home usage of the domestically produced good is given by (9)

⁴ Conceptually this allows investment expenditures to contribute to current consumption. Weitzman (1976) argues that (total) investment ought not to be considered as consumption generating in its year of installation and strictly speaking he is correct. However to maintain comparability with other exercises with which we wish to compare and which have not made this correction we have not pursued this recommendation here.

$$(9) \quad P_x(t)x(t) = \gamma (P_x(t)X(t))$$

Exports are given by (10)

$$(10) \quad P_x(t)(X(t) - x(t)) = (1-\gamma)(P_x(t)X(t))$$

and because exports and imports are of the same value, the trade balance is zero.

3. THE IMPACTS OF INNOVATION

In this paper we are interested in measuring the impacts of two types of innovation, i.e. innovation at home and innovation in final goods imported from overseas. The normal procedure⁵ for estimating the impact of innovation is to measure either (i) the rate of increase in $X(t)$ that can be generated between t and $t+1$ through technological advance without any increase in inputs or (ii) the rate at which, for given factor prices, the cost of producing a given level of $X(t)$ declines as technology changes. By either approach, from (10) or (2) the impact of innovation is given by the rate of growth of Total Factor Productivity, $\lambda_h(t)$.

However, this standard approach takes no account of innovation overseas in final products. In the open economy approach the impact of innovation should be measured differently. Specifically the alternative measure should indicate, assuming given factor endowments and factor prices at home and overseas, and given exchange rates, what the

⁵ Although there is a small literature that takes a welfare based approach, see for example, Oulton (2004).

impact will be of innovation at home and overseas on aggregate utility in the domestic economy.

In domestic production, given $P_x(t)$ equals the marginal cost of production, $MC(t)$, and (from 2) that with innovation at home $MC(t)$ will fall over time at the rate $\lambda_h(t)$, i.e. the rate of domestic TFP growth, $P_x(t)$ must also fall at this rate. From (1) output of the domestic good $X(t)$ will increase at the same rate, so $P_x(t)X(t)$ remains constant. From (8), (9) and (10) it is then clear that the impact of domestic innovation is that home purchases of the domestic good $x(t)$ increase at the rate at which $P_x(t)$ falls ($\lambda_h(t)$), while imports ($y(t)$) and the value of exports do not change.

Innovation in overseas production is assumed to take place at the rate of GTFP overseas, $\lambda_m(t)$, and will for a given exchange rate, be reflected in $P_y(t)$, which if price equals marginal costs overseas will also fall over time at that rate of GTFP⁶. Given $P_x(t)X(t)$ is not affected by such innovation overseas, from (8), (9) and (10) it is clear that the purchases of imported goods, $y(t)$, increase at the rate of fall of $P_y(t)$, i.e. $\lambda_m(t)$, but $x(t)$ and the value of exports will be unaffected.

Thus domestic innovation increases purchases of the home produced good at home at a rate equal to $\lambda_h(t)$ while innovation overseas increases domestic purchases of the overseas produced good at a rate given by $\lambda_m(t)$. Substituting in (4), and using the D operator to measure the impact of innovation yields (11)

⁶ Of course this is a terms of trade effect (see Gopinath *et al*, 1995) but our interest is only in shifts in the terms of trade induced by innovation.

$$(11) \quad D\log U(t) = \gamma\lambda_h(t) + (1-\gamma)\lambda_m(t)$$

where from (9), $\gamma = P_x(t)x(t) / (P_x(t)X(t))$, the ratio of domestic expenditure on the home produced good to GDP. Equation (11) indicates that GTFP at home only yields utility growth at home from the share of output that is not exported whereas GTFP overseas contributes to domestic utility growth via imports.

Given (11) one may compare the usual indicator of the impact of innovation, $\lambda_h(t)$, with the new indicator, $\gamma\lambda_h(t) + (1-\gamma)\lambda_m(t)$, to observe differences in the measured rates of the impact of innovation. One may also calculate the relative contribution of domestic innovation and overseas innovation to the total impact of innovation given by $D\log U(t)$.

In reality, of course, there are many countries that provide imports to the domestic economy, thus $\lambda_m(t)$ needs to be calculated as the weighted sum of the rates of GTFP in these different countries where the weights are the shares in total (final good) imports. Defining $P_m(t)Y(t) = \sum_j P_{jm}(t)Y_j(t)$ where $j = 1 \dots n$ are the n different countries providing imports, $\lambda_m(t)$ is then defined as $\sum_j (\lambda_j(t)P_{jm}(t)Y_j(t) / P_m(t)Y(t))$. Estimates of the different components of (11) for different countries are provided in section 5.3.

4. THE SECTORAL LEVEL

The discussion above has been undertaken at the macro level. Commonly however the impact of innovation is also measured at the sectoral level. This is usually explored by

looking at rates of GTFP in different sectors. Given that individual industries or sectors will have very different patterns of imports and exports there would seem some advantage in also applying the utility based methodology sectorally. This will enable insights into differences between GTFP and the growth of utility across industries, and also insights by industry, on the relative importance of domestic and overseas innovation.

In order to generate industry level results the first step is to equate, perhaps rather crudely, industries and markets. Secondly, the simplest route to any results is to assume effectively that each industry or sector is a separate mini-economy on its own with no connections to other parts of the economy, with, for example each sector producing final outputs and not intermediate outputs, and that the outputs do not compete with each other. For each industry i one may then write (12)

$$(12) \quad D\log U_i(t) = \gamma_i \lambda_{hi}(t) + (1-\gamma_i) \lambda_{mi}(t)$$

where $\log U_i(t)$ is aggregate utility generated in sector i , λ_{mi} is calculated from a weighted sum of λ_{mji} for different j , with weights being the shares of country j in the total imports of product i . Import shares in value added for product i may be used to measure $1-\gamma_i$. This approach is applied to UK data in section 6.

5. ESTIMATION AND DATA: THE MACRO LEVEL

Based upon equation (11) the purpose in this section is to (i) measure the impact of innovation on aggregate utility $U(t)$ as a utility based indicator reflecting the impact of

both home produced innovation and innovation embodied in imported final products; (ii) see how different is that indicator to the commonly measured rate of growth of TFP and; (iii) explore the individual contributions of home generated and imported innovations to DlogU. We first make the calculations for the UK. This is then followed by comparative estimates for Canada, France, Germany, Italy, Japan, Spain and the US.

5.1 Data Sources

The data required refers primarily to imports (by source country), exports, GDP and estimates of GTFP for import sourcing countries. Annual data on GTFP estimates is drawn from the EU KLEMS dataset⁷ (edition March, 2008) which provides value added based⁸ estimates of GTFP for the following countries: Australia, Austria, Belgium, Czech Republic, Denmark, Spain, France, Germany, Hungary, Ireland, Italy, Japan, Netherlands, Portugal, Slovenia, Sweden and the US. We also include estimates of GTFP for Canada from the OECD Productivity database.

Data on GDP, exports and total imports comes from the OECD Nationals Accounts (2008). Bilateral data on imports is collected from the OECD Bilateral Trade dataset (2006) and spans the years 1988 to 2004. There are, however, some difficulties in separating out final goods imported from all goods imported. To obtain an estimate of the imports of final goods, we use the 1995 OECD Input-Output tables, which include the import use table at basic prices. As we only have one observation on import use, in order

⁷ A more detailed account of the EU KLEMS database is provided by Timmer *et al.* (2007). See also the EU KLEMS website (www.euklems.net).

⁸ Generally the estimates are based on single deflated rather than double deflated value added (see, for example, Francis and Stoneman, 1995, and Thomas and Feinstein, 2004).

to proceed we assume that the share of final to total imported goods for and from each country has remained constant for the period of analysis, although differs across source countries (j). Table 1 presents the resulting estimated aggregate shares of final demand⁹ in total imported goods for the sample of countries studied. The lowest share belongs to Italy, with 26.5%; while for Canada nearly 50% of imported goods go to final demand (the other half are intermediate inputs of production). Germany, with 42.3%, and the UK (42.8%) have very similar percentages.

TABLE 1
Share of final demand to total imported goods by country, 1995 (%)

	Canada	France	Germany	Italy	Japan	Spain	UK	US
m_i	47.3	38.4	42.3	26.5	37.9	32.4	42.8	46.7

Source: Data from the OECD Input–Output database (1995).

5.2. Estimates: the UK macro economy

In Table 2 the results of the UK calculations are presented for the period from 1988 – 2004. The estimates of the mean of the of growth in the utility indicator $D\log U(t)$ and the rate of growth of TFP, $\lambda_h(t)$, are very similar at 0.465 and 0.423 respectively. This suggests that in the long run the GTFP in imported final goods is not that different to that of exported goods. However, what are the relative contributions of domestic ($\lambda_h(t)\gamma$) and overseas innovation $(1-\gamma)\lambda_m(t)$ to the impact of innovation on aggregate utility?. With (from Table 1) the mean estimate of $D\log U(t)$ being 0.465, the mean of $(\lambda_h(t)\gamma)$ being 0.365 and the mean of $(1-\gamma)\lambda_m(t)$ being 0.100, the percentage of the total contribution of

⁹ The full data matrix is not included in order to save space.

innovation to aggregate utility arising from innovation in home production is 78.5% and the percentage contribution from imports is 21.5%. Additionally, although the contribution of imports is the smaller of the two, that contribution is less volatile than the contribution from domestic innovation.

TABLE 2
DlogU(t), GTFP, and the contributions of domestic and overseas innovation: UK
1988 – 2004 (% p.a.)

Year	DlogU(t)	$\lambda_h(t)$	$\gamma\lambda_h(t)$	$(1-\gamma)\lambda_m(t)$
1988	-0.065	-0.161	-0.144	0.079
1989	-1.177	-1.413	-1.258	0.081
1990	-0.236	-0.354	-0.315	0.078
1991	1.223	1.286	1.145	0.078
1992	1.598	1.716	1.514	0.083
1993	2.207	2.434	2.119	0.088
1994	1.051	1.106	0.951	0.100
1995	0.266	0.187	0.160	0.106
1996	0.978	1.026	0.875	0.103
1997	0.167	0.058	0.049	0.118
1998	0.073	-0.063	-0.052	0.125
1999	0.041	-0.097	-0.080	0.121
2000	0.436	0.383	0.317	0.119
2001	0.065	-0.056	-0.047	0.112
2002	-0.115	-0.265	-0.223	0.108
2003	-0.046	-0.173	-0.147	0.102
2004	1.441	1.570	1.341	0.100
Mean	0.465	0.423	0.365	0.100

Source: Authors' calculations using EU KLEMS database, March 2008, <http://www.euklems.net>

In sum, these results indicate that in the UK some 21.5% of the increase in aggregate utility generated by innovation is the results of innovation overseas rather than at home.

5.3. Estimates for a sample of OECD Counties

In this section we provide, for comparative purposes, similar estimates as those provided for the UK above, for the other seven sample OECD countries over the 1988–2004 period. The results are summarised here with detail provided for each country in Appendix 1. In Table 3 we list the mean of the per annum estimates for the seven countries of GTFP ($\lambda_h(t)$), $D\log U(t)$ and the contribution made by imported innovation $(1-\gamma)\lambda_m(t)$ and domestic innovation ($\gamma\lambda_h(t)$) to $D\log U(t)$ in levels and as a percentage of $D\log U(t)$.

TABLE 3
DlogU(t), GTFP, and the contributions of domestic and overseas innovation:
international comparisons, means p.a. 1988 – 2004

Country	DlogU(t)	GTFP	$\gamma\lambda_h(t)$ (%)	$(1-\gamma)\lambda_m(t)$ (%)
UK	0.465	0.423	0.365 (78.5)	0.100 (21.5)
Canada	0.663	0.656	0.596 (79.3)	0.067 (20.7)
France	0.805	0.814	0.725 (89.9)	0.080 (10.1)
Germany	0.617	0.600	0.490 (90.1)	0.128 (9.9)
Italy	0.392	0.371	0.353 (90.1)	0.039 (9.9)
Japan	0.490	0.496	0.475 (97.0)	0.015 (3.0)
Spain	-0.275	-0.367	-0.334 (121.4)	0.059 (*)
US	0.782	0.824	0.715 (91.4)	0.067 (8.6)

Source: Authors' calculations using EU KLEMS database, March 2008, <http://www.euklems.net>

As for the UK, the mean estimates of $D\log U(t)$ and GTFP are not much different for each of the countries. The interesting point however is that the contribution of imported innovation to aggregate utility growth differs considerably across countries. For Japan imported innovation matters little, just 3 per cent of $D\log U(t)$ is contributed by imports. For France, Germany, Italy and the US it matters, but not to any large degree (10% or less). However, to the UK and Canada it matters significantly, at around 20 per cent. For

Spain it is the only positive contribution in an overall sad picture, offsetting a negative domestic contribution.

6. ESTIMATES, THE UK INDUSTRY LEVEL

The estimates above are at the macro level for different countries. Within the macro economy individual industries will have very different patterns of imports and exports and as such, across industries, there may be larger or smaller differences between GTFP and $DlogU(t)$ and also different contributions of imported and domestic innovation to $DlogU(t)$. In order to obtain some idea of differences across industries in this section we undertake a sectoral exercise for the UK.

6.1 Data sources

Equating, perhaps rather crudely, industries and markets, the EU KLEMS data enables a disaggregation into 11 manufacturing industries (as listed in Table 4). However there are problems with getting a sufficiently fine breakdown of final good imports by industry by source. The bilateral data on exports and total imports at the 2 digit industry level comes from the OECD National Accounts (2008), while the data on total exports and imports is drawn from the ONS UK Trade in goods analyzed in terms of industry (MQ10). To obtain an estimate of the imports of final goods by industry, we use the 1995 OECD Input-Output tables, which include the import use table at basic prices. We assume that the share of final to total imported goods has remained constant for the period of analysis.

Table 4 presents the share of final demand in total imported goods for the sample of UK manufacturing industries according to the 1995 input-output tables (OECD). The lowest share belongs to the Paper industry with just 8%; while for Food and Manufacturing not elsewhere classified 68% and 86% respectively of the imported goods go to final demand. In general we observe a high degree of heterogeneity across industries with respect to the percentage of imported goods destined for final demand (as opposed to intermediate production).

TABLE 4

Share of final demand in total imported goods by industry in the UK (% , 1995)

Industry	share
Total Manufacturing	45
Food, Tobacco, Beverages	68
Textiles, textile products, leather and footwear	59
Wood and products of wood and cork	13
Pulp, paper, paper products, printing and publishing	8
Chemical, rubber, plastics and fuel products	15
Other non-metallic mineral products	21
Basic metals and fabricated metal products	18
Machinery and equipment n.e.c.	59
Electrical and optical equipment	50
Transport Equipment	53
Manufacturing n.e.c.	86

Source: Data from the OECD Input-Output database (1995).

6.2 Estimates

Estimates of the appropriate indicators over the period 1990-2004 are summarized in Table 5 with detail provided for each industry in Appendix 2. We report the annual average (over the period 1990-2004) estimates of GTFP and $D\log U_i(t)$ for manufacturing industry as a whole and for eleven manufacturing sectors. In addition we also report the

contribution made by domestic innovation, $\gamma_i\lambda_{hi}(t)$, to $D\log U_i(t)$ in levels and imported innovation, $(1-\gamma_i)\lambda_{mi}(t)$, in levels and as a percentage.

TABLE 5
GTFP, $D\log U(t)$ and the contribution of imported and domestic innovation: cross industry comparisons, means p.a. 1990 – 2004

Industry	$D\log U_i(t)$	GTFP	$\gamma_i\lambda_{hi}(t)$	$(1-\gamma_i)\lambda_{mi}(t)$	(%)
Total Manufacturing	0.933	1.233	0.533	0.400	(42.9)
Food, Beverages and Tobacco	0.265	-0.197	-0.095	0.360	(135.8)
Textiles, textile products, leather and footwear	0.801	1.428	0.593	0.208	(25.9)
Wood and products of wood and cork	-0.793	-1.011	-0.882	0.089	*
Pulp, paper, paper products, printing and publishing	-0.208	-0.243	-0.234	0.026	*
Chemical, rubber, plastics and fuel products	1.824	2.006	1.697	0.127	(7.0)
Other non-metallic mineral products	1.757	1.872	1.688	0.070	(4.0)
Basic metals and fabricated metal products	1.170	1.271	1.074	0.096	(8.2)
Machinery and equipment n.e.c	0.798	1.105	0.163	0.636	(79.6)
Electrical and optical equipment	3.241	3.815	3.102	0.139	(4.3)
Transport Equipment	0.752	1.826	-0.243	0.994	(132.3)
Manufacturing n.e.c.	0.304	-1.678	-0.222	0.526	(173.2)

Source: Authors' calculations using EU KLEMS database, March 2008, <http://www.euklems.net>

Table 5 indicates that that the differences between $D\log U_i(t)$ and GTFP are much more pronounced in some industries than was found at the aggregate level. Large disparities between the two indices are found for the Transport Equipment and the Manufacturing n.e.c. sectors while small differences are found for the Paper and the Metal industries respectively.

The results also indicate that the contribution of imported innovation to aggregate utility growth differs considerably across industries. The contribution of imported innovation in

most of the industries is also considerably greater than when the whole economy was being studied - the estimate for manufacturing of 42.9% compares with our economy wide estimate of 21.5%. In all industries the contribution of imported innovation is positive, in some cases offsetting a negative contribution from GTFP.

7. CONCLUSIONS

This paper has concentrated on measuring the impact upon a domestic economy of innovation in traded final goods. Although other aspects of traded innovation, e.g. via intermediate inputs or embodied in capital goods, have been analysed in the past this issue seems to have been ignored. As the standard measure of the impact of innovation, the rate of growth of total factor productivity, is a production orientated measure, a new measure of the impact of innovation based upon the impact on an indicator of aggregate utility is suggested, which shows how domestic innovation and imported innovation contribute to changes therein. This new indicator reflects that the domestic economy only benefits (directly) from innovation at home to the extent that its production is consumed domestically but that it also benefits from innovation overseas embodied in imported final products.

Applications of the approach at the aggregate level to a sample of OECD countries show that although the overall estimates of the new measure of the impact of innovation do not differ considerably from the GTFP estimates, the new measures suggest that in some countries (especially the UK and Canada) much of the benefit from innovation arises from imported sources rather than domestic sources. At the market/industry level, for the

UK it is shown that in many industries there are considerable differences between the GTFP measure and the new measure and that in some industries imported innovation makes by far the dominant contribution to utility growth from innovation. The results generated fall within the area known as growth accounting. They are not intended therefore to approach causality. However some knowledge of the relative importance of domestic and imported sources of innovation should guide future analysis of causality.

Given that in the limit the benefit of innovation will be measured by utility gains rather than productivity gains these findings suggest that analysis and policy should take a more open economy view of innovative activity. A concentration upon GTFP ignores that the final purpose of economic activity is consumption and not production. Moreover no one economy is the source of all innovations. The more widely are innovations sourced the less reliable GTFP will be as a measure of the impact of innovation on domestic aggregate utility.

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APPENDIX 1: NON UK ESTIMATES, THE DETAIL

Canada

Table A2.1 lays out the basic data for Canada. Although the $D\log U(t)$ and $\lambda_h(t)$ measures yield similar mean estimates over the period 1988 to 2004, the percentage of the total contribution of innovation to utility growth in Canada arising from innovation in home production is 79.3% whereas the percentage contribution from innovation in imported final goods is 20.7%. This contribution is similar to that for the UK.

TABLE A1.1

DlogU(t), its component parts, and GTFP: Canada, 1988 – 2004 (% p.a.)

Year	DlogU(t)	$\lambda_h(t)$	$\gamma\lambda_h(t)$	$(1-\gamma)\lambda_m(t)$
1988	0.37	0.30	0.26	0.11
1989	-0.25	-0.40	-0.35	0.10
1990	-0.78	-1.00	-0.88	0.10
1991	-0.78	-1.00	-0.88	0.10
1992	0.80	0.80	0.70	0.11
1993	0.55	0.50	0.43	0.12
1994	1.57	1.70	1.44	0.13
1995	0.89	0.90	0.75	0.13
1996	-0.12	-0.30	-0.25	0.13
1997	2.61	3.00	2.47	0.15
1998	1.05	1.10	0.89	0.15
1999	1.62	1.80	1.46	0.15
2000	1.85	2.10	1.70	0.15
2001	0.14	0.00	0.00	0.14
2002	0.88	0.90	0.74	0.14
2003	-0.13	-0.30	-0.25	0.12
2004	0.20	0.10	0.08	0.12
Mean	0.617	0.600	0.490	0.128

Source: Authors' calculations using the OECD Productivity dataset. $\lambda_h(t)$ is the growth rate of TFP based on Value Added reported by the OECD Productivity dataset. $D\log U(t)$ is the growth of utility resulting from innovation obtained from equation 11

France

Table A1.2 lays out the basic data for France. Once more the mean estimates of $D\log U(t)$ and $\lambda_h(t)$ are similar. The percentage of the total contribution of innovation to utility

growth in France arising from innovation in non exported home production is 89.9% and the percentage contribution from imports is 10.1%. The contribution from imports in France is significantly smaller than in the UK and Canada.

TABLE A1.2

DlogU(t) , its component parts, and GTFP: France, 1988 – 2004 (% p.a.)

Year	DlogU(t)	$\lambda_h(t)$	$\gamma\lambda_h(t)$	$(1-\gamma)\lambda_m(t)$
1988	1.599	1.674	1.536	0.063
1989	2.173	2.310	2.106	0.067
1990	-0.152	-0.239	-0.218	0.066
1991	-0.013	-0.087	-0.079	0.066
1992	0.508	0.486	0.446	0.063
1993	-0.579	-0.691	-0.637	0.058
1994	0.914	0.927	0.853	0.061
1995	1.350	1.403	1.287	0.064
1996	-0.583	-0.705	-0.646	0.063
1997	0.888	0.901	0.822	0.066
1998	1.519	1.594	1.449	0.069
1999	0.371	0.331	0.301	0.070
2000	1.886	2.023	1.808	0.078
2001	-0.373	-0.500	-0.448	0.075
2002	1.128	1.171	1.057	0.071
2003	0.617	0.606	0.549	0.068
2004	0.026	-0.048	-0.044	0.069
Mean	0.663	0.656	0.596	0.067

Source: Authors' calculations using EU KLEMS database, March 2008, <http://www.euklems.net>. $\lambda_h(t)$ is the growth rate of TFP based on Value Added reported by the EUKLEMS dataset. DlogU(t) is the growth of utility resulting from innovation obtained from equation 11

Germany

Data for Germany is presented in Table A1.3. DlogU(t) and $\lambda_h(t)$ mean measures yield similar estimates, with average TFP growth estimates slightly greater than DlogU(t) (0.81%) for the period 1988 to 2004. The percentage of the total contribution of innovation to utility in Germany arising from innovation in non exported home production is 90.1% and the percentage contribution from imports is 9.9%. The

contribution from imports is very similar to that for France but significantly less than that in the UK and Canada.

TABLE A1.3

DlogU(t), its component parts, and GTFP: Germany, 1988 – 2004 (% p.a.)

Year	DlogU(t)	$\lambda_h(t)$	$\gamma\lambda_h(t)$	$(1-\gamma)\lambda_m(t)$
1988	1.493	1.578	1.424	0.070
1989	2.022	2.172	1.945	0.077
1990	1.943	2.087	1.868	0.075
1991	1.842	1.982	1.763	0.079
1992	0.595	0.582	0.521	0.074
1993	-0.393	-0.507	-0.459	0.066
1994	1.302	1.367	1.234	0.068
1995	1.349	1.420	1.279	0.070
1996	1.136	1.186	1.065	0.071
1997	0.976	1.011	0.899	0.078
1998	-1.054	-1.285	-1.137	0.082
1999	0.301	0.245	0.216	0.086
2000	1.767	1.943	1.671	0.096
2001	0.366	0.315	0.272	0.094
2002	0.118	0.034	0.030	0.089
2003	-0.267	-0.411	-0.356	0.089
2004	0.191	0.115	0.099	0.092
Mean	0.805	0.814	0.725	0.080

Source: Authors' calculations using EU KLEMS database, March 2008, <http://www.euklems.net>. $\lambda_h(t)$ is the growth rate of TFP based on Value Added reported by the EUKLEMS dataset. DlogU(t) is the growth of utility resulting from innovation obtained from equation 11.

Italy

Data for Italy is presented in Table A1.4. Once more the DlogU(t) and $\lambda_h(t)$ mean measures yield similar estimates. For Italy the average TFP growth estimate (0.37%) is slightly less than the DlogU(t) (0.39%) for the period 1988 to 2004. The percentage of the total contribution of innovation to utility in Italy arising from innovation in non exported home production is 90.1% and the percentage contribution from imports is

9.9%. The latter is very similar to that for France and Germany but significantly less than that for the UK and Canada.

TABLE A1.4
DlogU(t), its component parts, and GTFP: Italy, 1988 – 2004 (% p.a.)

Year	DlogU(t)	$\lambda_h(t)$	$\gamma\lambda_h(t)$	$(1-\gamma)\lambda_m(t)$
1988	1.930	1.992	1.896	0.034
1989	2.049	2.121	2.013	0.036
1990	0.159	0.131	0.124	0.035
1991	-0.071	-0.109	-0.104	0.033
1992	0.339	0.319	0.304	0.035
1993	0.737	0.739	0.703	0.033
1994	2.766	2.878	2.730	0.036
1995	1.858	1.930	1.818	0.041
1996	-0.907	-0.997	-0.944	0.037
1997	0.779	0.783	0.739	0.040
1998	-1.080	-1.191	-1.122	0.042
1999	-0.260	-0.322	-0.302	0.042
2000	1.376	1.429	1.331	0.046
2001	0.014	-0.033	-0.031	0.045
2002	-1.202	-1.331	-1.244	0.042
2003	-1.408	-1.546	-1.448	0.040
2004	-0.414	-0.487	-0.456	0.041
Mean	0.392	0.371	0.353	0.039

Source: Authors' calculations using EU KLEMS database, March 2008, <http://www.euklems.net>. $\lambda_h(t)$ is the growth rate of TFP based on Value Added reported by the EUKLEMS dataset. DlogU(t) is the growth of utility resulting from innovation obtained from equation 11.

Japan

Data for Japan is displayed in Table A1.5. For the period 1988 to 2004, the average TFP growth estimate (0.50%) is slightly higher than the estimate of DlogU(t) (0.49%), although the difference is very small. Using this data, the percentage of the total contribution of innovation to utility growth in Japan arising from innovation in non exported home production is 97.0% and the percentage contribution from imports is just

3.0%. The contribution from imports is the lowest of the selected sample of OECD countries considered in this paper.

TABLE A1.5
DlogU(t), its component parts, and GTFP: Japan, 1988 – 2004 (% p.a.)

Year	DlogU(t)	$\lambda_h(t)$	$\gamma\lambda_h(t)$	$(1-\gamma)\lambda_m(t)$
1988	4.263	4.407	4.247	0.017
1989	1.997	2.059	1.978	0.018
1990	2.125	2.183	2.109	0.016
1991	0.820	0.832	0.806	0.014
1992	-1.281	-1.328	-1.293	0.012
1993	-0.352	-0.375	-0.365	0.012
1994	-0.436	-0.464	-0.450	0.014
1995	0.158	0.147	0.142	0.016
1996	1.638	1.685	1.622	0.017
1997	-0.138	-0.158	-0.153	0.014
1998	-1.541	-1.608	-1.556	0.015
1999	0.160	0.150	0.144	0.015
2000	0.771	0.786	0.757	0.014
2001	-0.890	-0.940	-0.904	0.014
2002	-0.573	-0.611	-0.587	0.014
2003	0.982	1.011	0.967	0.015
2004	0.634	0.650	0.618	0.016
Mean	0.490	0.496	0.475	0.015

Source: Authors' calculations using EU KLEMS database, March 2008, <http://www.euklems.net>. $\lambda_h(t)$ is the growth rate of TFP based on Value Added reported by the EUKLEMS dataset. DlogU(t) is the growth of utility resulting from innovation obtained from equation 11.

Spain

Data for Spain is presented in Table A1.6. For the period 1988 to 2004, in contrast to the rest of the OECD countries reported, both the average annual TFP growth estimate (-0.367%) and DlogU(t) (-0.275%) are negative. Using the data reported in Table A1.6, the percentage of the total contribution of innovation to utility loss in Spain arising from innovation in non exported home production is 121.4% and the percentage contribution from imports is negative, therefore utility enhancing, and equal to -21.4%. These results

indicate that via growth accounting, a concentration upon domestic production and GTFP would underestimate the increase in utility generated by innovation by 21 %.

TABLE A1.6
DlogU(t), its component parts, and GTFP: Spain, 1988 – 2004 (% p.a.)

Year	DlogU(t)	$\lambda_h(t)$	$\gamma\lambda_h(t)$	$(1-\gamma)\lambda_m(t)$
1988	1.888	1.962	1.842	0.046
1989	-1.293	-1.436	-1.342	0.049
1990	-0.517	-0.602	-0.565	0.048
1991	0.417	0.394	0.369	0.047
1992	0.014	-0.036	-0.033	0.048
1993	-0.741	-0.838	-0.787	0.045
1994	0.686	0.681	0.635	0.051
1995	0.413	0.386	0.358	0.055
1996	-1.732	-1.934	-1.789	0.057
1997	-0.365	-0.465	-0.427	0.062
1998	-0.858	-1.014	-0.926	0.068
1999	0.067	-0.004	-0.004	0.071
2000	-0.387	-0.516	-0.463	0.075
2001	-0.470	-0.603	-0.542	0.073
2002	-0.670	-0.817	-0.739	0.069
2003	-0.588	-0.722	-0.655	0.067
2004	-0.537	-0.671	-0.606	0.068
Mean	-0.275	-0.367	-0.334	0.059

Source: Authors' calculations using EU KLEMS database, March 2008, <http://www.euklems.net>. $\lambda_h(t)$ is the growth rate of TFP based on Value Added reported by the EUKLEMS dataset. DlogU(t) is the growth of utility resulting from innovation obtained from equation 11.

The US

Finally, data for the US is presented in Table A1.7. DlogU(t) is only available for the period 1990 to 2004, as a result of missing data on bilateral imports for earlier years. For the period 1990 to 2004, DlogU(t) is slightly lower than GTFP (0.82%). On average, the percentage contribution to DlogU(t) from non exported home production is 91.4% while the percentage contribution from imports is just 8.6%.

TABLE A2.13

DlogU(t), its component parts, and GTFP: US, 1990 – 2004 (% p.a.)

Year	DlogU(t)	$\lambda_h(t)$	$\gamma\lambda_h(t)$	$(1-\gamma)\lambda_m(t)$
1988	.	1.503	1.317	.
1989	.	-0.269	-0.235	.
1990	-0.376	-0.509	-0.446	0.070
1991	-0.145	-0.235	-0.209	0.064
1992	1.612	1.749	1.547	0.065
1993	-0.459	-0.602	-0.528	0.069
1994	1.279	1.384	1.209	0.070
1995	-0.391	-0.535	-0.464	0.072
1996	0.415	0.397	0.342	0.073
1997	0.524	0.526	0.456	0.069
1998	-0.120	-0.215	-0.188	0.067
1999	1.591	1.753	1.524	0.067
2000	1.597	1.776	1.528	0.069
2001	0.332	0.305	0.263	0.069
2002	2.267	2.548	2.202	0.066
2003	1.870	2.082	1.808	0.062
2004	1.736	1.931	1.677	0.059
Mean*	0.782	0.824	0.715	0.067

Notes: Annual Average obtained for the period 1990-2004.

Source: Authors' calculations using EU KLEMS database, March 2008, <http://www.euklems.net>. $\lambda_h(t)$ is the growth rate of TFP based on Value Added reported by the EUKLEMS dataset. DlogU(t) is the growth of utility resulting from innovation obtained from equation 11.

APPENDIX 2: UK MANUFACTURING ESTIMATES, THE DETAIL

Manufacturing

Table A2.1 lays out the basic data for UK Manufacturing industry. We observe very similar estimates of $D\log U_i(t)$ and $\lambda_{hi}(t)$ over the period 1988-2004. From Table A2.1, we obtain that the percentage of the total contribution of innovation to utility growth in manufacturing arising from innovation in imported goods is 43%. This contribution significantly contrasts with the 21.5% contribution of imported innovation obtained from the aggregate economy.

TABLE A2.1

$D\log U_i(t)$, its component parts and GTFP: UK Total Manufacturing, 1990-2004 (% p.a.)

Year	$D\log U_i(t)$	$\lambda_{hi}(t)$	$\gamma_i \lambda_{hi}(t)$	$(1-\gamma_i) \lambda_{mi}(t)$
1990	1.078	1.314	0.749	0.329
1991	1.589	2.182	1.272	0.317
1992	2.313	3.530	1.983	0.331
1993	2.036	3.106	1.698	0.338
1994	1.750	2.651	1.387	0.362
1995	-0.561	-1.905	-0.945	0.384
1996	-0.495	-1.806	-0.873	0.378
1997	-0.079	-0.954	-0.469	0.390
1998	-0.771	-2.459	-1.170	0.399
1999	1.254	1.847	0.847	0.407
2000	1.038	1.528	0.588	0.450
2001	0.751	0.818	0.301	0.450
2002	0.731	0.771	0.270	0.461
2003	1.390	2.823	0.896	0.494
2004	1.966	5.047	1.453	0.514
Mean	0.933	1.233	0.533	0.400

Source: Authors' calculations using EU KLEMS database, March 2008, <http://www.euklems.net>. $\lambda_h(t)$ is the growth rate of TFP based on Value Added reported by the EUKLEMS dataset. $D\log U(t)$ is the growth of utility resulting from innovation obtained from equation 12.

Food, Beverages and Tobacco

Data for the Food, Beverage and Tobacco industry is presented in Table A2.2. While the average annual rate of TFP growth is negative, the estimate of $D\log U_i(t)$ is positive at

0.05%. From Table A2.2, we observe that the positive contribution of innovation to the growth in utility arising from innovation in imported food outweighs the negative contribution arising from innovation in the non exported home production of food, beverages and tobacco.

TABLE A2.2

**The contribution of innovation to $D\log U_i(t)$, its component parts, and GTFP: UK
Food, Beverage and Tobacco industry, 1990 – 2004 (% p.a.)**

Year	$D\log U_i(t)$	$\lambda_{hi}(t)$	$\gamma_i \lambda_{hi}(t)$	$(1-\gamma_i)\lambda_{mi}(t)$
1990	0.779	0.801	0.481	0.298
1991	-0.180	-0.018	-0.011	-0.169
1992	1.072	3.122	1.819	-0.747
1993	0.630	0.699	0.393	0.237
1994	0.765	0.563	0.299	0.466
1995	-1.505	-3.637	-1.704	0.199
1996	-0.376	-0.328	-0.158	-0.218
1997	-1.969	-3.930	-1.979	0.010
1998	-2.579	-4.956	-2.558	-0.021
1999	-0.334	-1.544	-0.796	0.462
2000	-1.643	-2.145	-1.110	-0.533
2001	1.660	2.975	1.570	0.090
2002	2.847	4.703	2.409	0.438
2003	0.250	-1.840	-0.891	1.141
2004	1.272	2.583	1.265	0.007
Mean	0.046	-0.197	-0.065	0.111

Source: Authors' calculations using EU KLEMS database, March 2008, <http://www.euklems.net>. $\lambda_h(t)$ is the growth rate of TFP based on Value Added reported by the EUKLEMS dataset. $D\log U(t)$ is the growth of utility resulting from innovation obtained from equation 12.

Textiles

Data for the Textile industry is presented in Table A2.3. There are significant differences between the estimates of $D\log U_i(t)$ and GTFP over the 1990-2004 period. While average GTFP is equal to 1.43%, the average of $D\log U_i(t)$ is 0.80%. From Table A2.3, we observe that the contribution of innovation to utility growth arising from innovation in

non exported home production is equal to 74%, while the contribution from imports is also positive but rather smaller at 26%.

TABLE A2.3
DlogU_i(t), its component parts, and GTFP: UK Textiles, 1990 – 2004 (% p.a.)

Year	DlogU_i(t)	λ_{hi}(t)	γ_iλ_{hi}(t)	(1-γ_i)λ_{mi}(t)
1990	3.394	4.827	3.201	0.192
1991	2.628	3.719	2.444	0.183
1992	1.945	2.715	1.758	0.188
1993	-0.046	-0.346	-0.218	0.172
1994	-1.010	-1.989	-1.203	0.193
1995	-2.297	-4.217	-2.495	0.198
1996	1.454	2.161	1.254	0.200
1997	-0.770	-1.630	-0.967	0.197
1998	-3.366	-6.318	-3.579	0.213
1999	-1.275	-2.631	-1.473	0.198
2000	3.581	6.494	3.391	0.190
2001	2.221	4.394	2.013	0.208
2002	1.572	3.350	1.340	0.232
2003	3.653	10.708	3.394	0.259
2004	0.329	0.179	0.035	0.294
Mean	0.801	1.428	0.593	0.208

Source: Authors' calculations using EU KLEMS database, *March 2008*, <http://www.euklems.net>. λ_h(t) is the growth rate of TFP based on Value Added reported by the EUKLEMS dataset. DlogU(t) is the growth of utility resulting from innovation obtained from equation 12.

Wood and Wood Products

Data for the Wood and wood products industry is presented in Table A2.4. The differences between the estimates of DlogU_i(t) and GTFP are small with the average annual rate of TFP growth being -1.01% and the estimate of DlogU_i(t) being -0.79%. The results show that both rates are negatives. For the Wood industry we observe that the contribution of innovation to utility arising from innovation in imports compensates partly for the losses in utility arising from innovation in the non-exported production.

TABLE A2.4
DlogU_i(t), its component parts, and GTFP: UK Wood and Wood Products, 1990 – 2004 (% p.a.)

Year	DlogU_i(t)	λ_{hi}(t)	γ_iλ_{hi}(t)	(1-γ_i)λ_{mi}(t)
1990	-0.390	-0.580	-0.493	0.103
1991	-4.191	-4.929	-4.281	0.090
1992	-0.166	-0.296	-0.257	0.092
1993	-4.116	-5.004	-4.221	0.105
1994	2.868	3.312	2.758	0.110
1995	-0.923	-1.181	-1.014	0.091
1996	-1.412	-1.745	-1.502	0.090
1997	-1.973	-2.368	-2.058	0.086
1998	-4.013	-4.643	-4.093	0.080
1999	-3.620	-4.233	-3.699	0.079
2000	1.939	2.144	1.856	0.083
2001	-0.516	-0.691	-0.598	0.082
2002	-1.133	-1.406	-1.216	0.082
2003	5.024	5.700	4.943	0.081
2004	0.730	0.749	0.652	0.078
Mean	-0.793	-1.011	-0.882	0.089

Source: Authors' calculations using EU KLEMS database, March 2008, <http://www.euklems.net>. λ_{hi}(t) is the growth rate of TFP based on Value Added reported by the EUKLEMS dataset. DlogU(t) is the growth of utility resulting from innovation obtained from equation 12.

Pulp, paper, paper products, printing and publishing industry

Table A2.5 lays out the basic data for Pulp, paper, paper products, printing and publishing over the period 1990 to 2004. Once more the mean of DlogU_i(t) and GTFP measures yield very similar estimates. As in the case of the wood industry, we observe that the contribution of innovation to utility growth arising from imports compensates partly for the losses in utility growth arising from innovation in non-exported production.

TABLE A2.5
DlogU_i(t), its component parts, and GTFP: UK Pulp, paper, paper products, printing and publishing, 1990 – 2004 (% p.a.)

Year	DlogU_i(t)	λ_{hi}(t)	γ_iλ_{hi}(t)	(1-γ_i)λ_{mi}(t)
1990	1.692	1.721	1.661	0.032
1991	-5.194	-5.400	-5.223	0.029
1992	1.859	1.889	1.832	0.027
1993	3.762	3.848	3.736	0.026
1994	-2.761	-2.875	-2.787	0.027
1995	-1.918	-2.018	-1.948	0.030
1996	-0.866	-0.924	-0.894	0.028
1997	-0.853	-0.906	-0.879	0.026
1998	-2.540	-2.639	-2.564	0.025
1999	1.970	2.000	1.947	0.023
2000	-0.261	-0.293	-0.285	0.024
2001	-1.044	-1.102	-1.069	0.025
2002	0.407	0.393	0.382	0.025
2003	-1.400	-1.469	-1.425	0.025
2004	4.033	4.130	4.008	0.025
Mean	-0.208	-0.243	-0.234	0.026

Source: Authors' calculations using EU KLEMS database, March 2008, <http://www.euklems.net>. λ_h(t) is the growth rate of TFP based on Value Added reported by the EUKLEMS dataset. DlogU(t) is the growth of utility resulting from innovation obtained from equation 12.

Chemical, rubber, plastics and fuel products

Data for the chemical, rubber, plastics and fuel products industry over the period 1990 to 2004 is presented in Table A2.6. In particular, the average annual growth rate of TFP is an estimated 2.01%, while the average of DlogU_i(t) is slightly lower (1.82%). From Table A2.6 we also observe that, on average, the contribution of innovation to utility growth arising from innovation in non exported home production is equal to 93%, while the contribution from imports is also positive but much smaller at 7%.

TABLE A2.6
DlogU_i(t), its component parts, and GTFP: UK Chemical, rubber, plastics and fuel products, 1990 – 2004 (% p.a.)

Year	DlogU_i(t)	λ_{hi}(t)	γ_iλ_{hi}(t)	(1-γ_i)λ_{mi}(t)
1990	0.681	0.670	0.582	0.098
1991	7.456	8.431	7.358	0.098
1992	5.416	6.071	5.321	0.096
1993	2.013	2.202	1.903	0.110
1994	6.381	7.270	6.269	0.112
1995	2.133	2.364	2.014	0.120
1996	-2.996	-3.680	-3.119	0.123
1997	-1.213	-1.564	-1.333	0.120
1998	-2.478	-3.033	-2.596	0.118
1999	1.263	1.344	1.138	0.125
2000	2.749	3.181	2.605	0.144
2001	1.402	1.540	1.255	0.148
2002	-0.836	-1.228	-0.991	0.155
2003	1.488	1.682	1.323	0.165
2004	3.898	4.841	3.727	0.171
Mean	1.824	2.006	1.697	0.127

Source: Authors' calculations using EU KLEMS database, *March 2008*, <http://www.euklems.net>. λ_h(t) is the growth rate of TFP based on Value Added reported by the EUKLEMS dataset. DlogU(t) is the growth of utility resulting from innovation obtained from equation 12.

Other non-metallic mineral products

Data for the other non-metallic mineral products industry over the period 1990 to 2004 is presented in Table A2.7. Once more the mean estimates of DlogU_i(t) and GTFP are very similar. The average annual growth rate of TFP is 1.82% while the average of DlogU_i(t) is 1.76%. For the mineral industry both the contribution of innovation to utility growth arising from imports and that arising from the non-exported production are positive and represent respectively around 4% and 96% of the growth in utility due to innovation.

TABLE A2.7
DlogU_i(t), its component parts, and GTFP: UK other non-metallic mineral products,
1990 – 2004 (% p.a.)

Year	DlogU=(t)	λ_{hi}(t)	γ_iλ_{hi}(t)	(1-γ_i)λ_{mi}(t)
1990	-4.561	-5.022	-4.630	0.069
1991	2.710	2.871	2.641	0.069
1992	3.040	3.246	2.968	0.072
1993	10.089	10.916	10.021	0.068
1994	-0.298	-0.392	-0.362	0.064
1995	-0.564	-0.676	-0.626	0.062
1996	-2.503	-2.787	-2.568	0.065
1997	1.468	1.522	1.402	0.066
1998	-2.193	-2.465	-2.261	0.067
1999	0.333	0.291	0.267	0.066
2000	0.445	0.410	0.372	0.073
2001	4.495	4.879	4.423	0.071
2002	0.779	0.782	0.706	0.073
2003	4.996	5.485	4.917	0.079
2004	8.123	9.016	8.044	0.079
Mean	1.757	1.872	1.688	0.070

Source: Authors' calculations using EU KLEMS database, *March 2008*, <http://www.euklems.net>. λ_h(t) is the growth rate of TFP based on Value Added reported by the EUKLEMS dataset. DlogU(t) is the growth of utility resulting from innovation obtained from equation 12.

Basic metals and fabricated metal products

Table A2.8 lays out the data for basic metals and fabricated metal products over the period 1990 to 2004. As for the previous case, the difference between the estimated annual average growth rate of TFP (1.27%) and the DlogU_i(t) (1.17%) is small. For the metal industry both the contribution of innovation to utility growth arising from imports and that arising from the non-exported production are positive, and represent around 8% and 92% respectively of the growth in utility due to innovation.

TABLE A2.8
The contribution of innovation to $D\log U_i(t)$, its component parts, and GTFP: UK
Basic metals and fabricated metal products, 1990 – 2004 (% p.a.)

Year	$D\log U_i(t)$	$\lambda_{hi}(t)$	$\gamma_i \lambda_{hi}(t)$	$(1-\gamma_i) \lambda_{mi}(t)$
1990	0.447	0.404	0.355	0.092
1991	1.735	1.875	1.648	0.087
1992	0.950	0.990	0.873	0.077
1993	0.887	0.931	0.815	0.072
1994	-0.187	-0.312	-0.273	0.086
1995	-0.937	-1.196	-1.031	0.094
1996	-0.986	-1.252	-1.078	0.092
1997	2.485	2.745	2.394	0.091
1998	-1.400	-1.699	-1.485	0.085
1999	1.271	1.353	1.193	0.079
2000	2.629	2.960	2.526	0.102
2001	0.598	0.575	0.485	0.113
2002	4.479	5.169	4.367	0.112
2003	0.330	0.251	0.209	0.120
2004	5.244	6.274	5.113	0.130
Mean	1.170	1.271	1.074	0.096

Source: Authors' calculations using EU KLEMS database, *March 2008*, <http://www.euklems.net>. $\lambda_{hi}(t)$ is the growth rate of TFP based on Value Added reported by the EUKLEMS dataset. $D\log U(t)$ is the growth of utility resulting from innovation obtained from equation 12.

Machinery and equipment n.e.c

Table A2.9 lays out the basic data for machinery and equipment n.e.c. over the period 1990 to 2004. The difference between the estimated annual average growth rate of TFP (1.11%) and $D\log U_i(t)$ (0.80%) is quite significant. For the machinery industry, on average, the contribution of innovation to utility growth arising from imports is much larger (80%) than the contribution arising from non-exported production (20%) We observe also that the differences between the two indices over time are significant.

TABLE A2.9
DlogU_i(t), its component parts, and GTFP: UK Machinery and equipment n.e.c.,
1990 – 2004 (% p.a.)

Year	DlogU_i(t)	λ_{hi}(t)	γ_iλ_{hi}(t)	(1-γ_i)λ_{mi}(t)
1990	0.83	0.75	0.27	0.56
1991	-0.41	-2.76	-0.98	0.57
1992	1.08	1.52	0.49	0.59
1993	2.43	5.85	1.82	0.61
1994	2.48	5.70	1.89	0.59
1995	-0.33	-3.21	-0.95	0.62
1996	-0.02	-2.25	-0.63	0.62
1997	0.59	-0.02	-0.01	0.60
1998	-0.44	-3.25	-1.03	0.59
1999	0.19	-1.66	-0.44	0.63
2000	0.38	-1.53	-0.31	0.69
2001	1.50	4.49	0.80	0.70
2002	0.80	0.53	0.08	0.72
2003	1.54	6.23	0.82	0.72
2004	1.35	6.18	0.62	0.74
Mean	0.798	1.105	0.163	0.636

Source: Authors' calculations using EU KLEMS database, *March 2008*, <http://www.euklems.net>. λ_h(t) is the growth rate of TFP based on Value Added reported by the EUKLEMS dataset. DlogU_i(t) is the growth of utility resulting from innovation obtained from equation 12.

Electrical and optical equipment

Table A2.10 lays out the basic data for the electrical and optical equipment industry over the period 1990 to 2004. Although having one of the highest average growth rates, the difference between the estimated annual average growth rate of TFP (3.82%) and DlogU_i(t) (3.24%) is modest. For the electrical industry both the contribution of innovation to utility growth arising from imports and that arising from the non-exported production are positive, with the former being the smaller (4.3%).

TABLE A2.10
DlogU_i(t), its component parts, and GTFP: UK Electrical and optical equipment,
1990 – 2004 (% p.a.)

Year	DlogU_i(t)	λ_{hi}(t)	γ_iλ_{hi}(t)	(1-γ_i)λ_{mi}(t)
1990	6.058	6.860	5.951	0.108
1991	3.958	4.437	3.852	0.106
1992	4.106	4.690	3.988	0.118
1993	4.657	5.419	4.531	0.126
1994	6.901	8.157	6.770	0.131
1995	-0.177	-0.390	-0.317	0.140
1996	-1.023	-1.437	-1.160	0.137
1997	-0.895	-1.260	-1.029	0.134
1998	2.251	2.584	2.120	0.131
1999	7.376	8.849	7.246	0.130
2000	8.833	10.953	8.685	0.149
2001	-2.537	-3.399	-2.689	0.152
2002	-3.490	-4.651	-3.645	0.155
2003	6.177	7.938	6.002	0.175
2004	6.417	8.480	6.230	0.187
Mean	3.241	3.815	3.102	0.139

Source: Authors' calculations using EU KLEMS database, *March 2008*, <http://www.euklems.net>. λ_{hi}(t) is the growth rate of TFP based on Value Added reported by the EUKLEMS dataset. DlogU(t) is the growth of utility resulting from innovation obtained from equation 12.

Transport Equipment

Table A2.11 lays out the basic data for the transport equipment industry over the period 1990 to 2004. This industry shows one of the greatest differences between the estimated annual average growth rate of TFP (1.826%) and the utility innovation ratio (0.752%). As the results show, the contribution of innovation to utility growth arising from imports compensates to a great extent for the loss arising from the non-exported production.

TABLE A2.11
DlogU_i(t), its component parts, and GTFP: UK Transport equipment, 1990 – 2004
(% p.a.)

Year	DlogU_i(t)	λ_{hi}(t)	γ_iλ_{hi}(t)	(1-γ_i)λ_{mi}(t)
1990	0.373	-0.832	-0.204	0.577
1991	2.428	6.718	1.873	0.555
1992	1.518	6.037	0.836	0.682
1993	1.322	6.878	0.565	0.756
1994	1.016	4.178	0.237	0.779
1995	0.874	-4.581	0.010	0.864
1996	1.213	-5.461	0.331	0.881
1997	0.904	1.321	-0.121	1.025
1998	1.226	-1.418	0.174	1.052
1999	0.257	4.416	-0.845	1.103
2000	2.261	-4.728	1.107	1.154
2001	1.776	-1.142	0.460	1.316
2002	1.411	-0.021	0.011	1.400
2003	-2.899	8.106	-4.324	1.425
2004	-2.407	7.913	-3.755	1.348
Mean	0.752	1.826	-0.243	0.994

Source: Authors' calculations using EU KLEMS database, *March 2008*, <http://www.euklems.net>. λ_{hi}(t) is the growth rate of TFP based on Value Added reported by the EUKLEMS dataset. DlogU(t) is the growth of utility resulting from innovation obtained from equation 12.

Manufacturing n.e.c.

Finally, Table A2.12 lays out the basic data for the manufacturing n.e.c. over the period 1990 to 2004. In this case, the difference between the estimated annual average growth rate of TFP (-1.68%) and DlogU_i(t) (0.304%) is quite significant. For this industry as in the transport equipment sector, the contribution of innovation to utility growth arising from imports compensates to a great extent for the loss arising from the non-exported production. The differences between DlogU_i(t) and GTFP are significant, particularly during the second half of the 1995s. Once more, DLogU_i(t) is less volatile than the growth accounting TFP estimate.

TABLE A2.12

DlogU_i(t), its component parts, and GTFP: UK Manufacturing n.e.c., 1990-2004
(% p.a.)

Year	DlogU_i(t)	λ_{hi}(t)	γ_iλ_{hi}(t)	(1-γ_i)λ_{mi}(t)
1990	0.536	-0.272	-0.014	0.550
1991	0.359	-4.585	-0.193	0.553
1992	0.632	3.338	0.093	0.539
1993	0.514	-1.069	0.005	0.509
1994	0.159	-3.352	-0.302	0.460
1995	-1.291	-11.086	-1.724	0.433
1996	0.677	1.508	0.206	0.471
1997	-0.364	-6.683	-0.833	0.468
1998	-0.261	-4.818	-0.732	0.471
1999	0.808	2.644	0.350	0.458
2000	0.367	-4.276	-0.145	0.512
2001	0.562	2.111	0.023	0.539
2002	0.262	2.320	-0.373	0.635
2003	0.519	0.494	-0.127	0.646
2004	1.080	-1.452	0.428	0.652
Mean	0.304	-1.678	-0.222	0.526

Source: Authors' calculations using EU KLEMS database, *March 2008*, <http://www.euklems.net>. λ_h(t) is the growth rate of TFP based on Value Added reported by the EUKLEMS dataset. DlogU(t) is the growth of utility resulting from innovation obtained from equation 12.