Is the Asia Pacific Region Different? Technical Progress Bias and Price Elasticity Estimates for 18 OECD Countries, 1960–1992

by

*Kevin J. Fox** and *W.E. Diewert*†

University of New South Wales University of British Columbia

24 DECEMBER 1997

Abstract

What have been the effects of technological change on production in OECD economies? Are there any systematic differences between the countries in the Asia Pacific Region and other OECD countries? Estimates of aggregate and biased technological change for 18 OECD countries are generated, treating each economy as a trading economy with multiple outputs as well as multiple inputs. Productivity growth is found to be generally positive, but declining for each country over the sample period. Technical progress biases are calculated to identify the effects of technological change. The method employed also yields estimates of price elasticities. Of particular interest is the trend for labour demand to become more price sensitive for all of the countries considered. The estimated elasticity values will be of great use for general equilibrium modelling.

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* † This research has benefitted from helpful comments from an anonymous referee, Knox Lovell, Bert Balk, participants at the Taipei International Conference on Efficiency and Productivity Growth, the 1997 Conference of Economists, Hobart, and at a University of Sydney Department of Economics seminar. The authors will blame each other for any remaining errors.

Contact Information:

*School of Economics
The University of New South Wales
Sydney 2052
Australia
E-mail: K.Fox@unsw.edu.au
telephone: 61-2-9385-3320
fax: 61-2-9313-6337

†Department of Economics
The University of British Columbia
Vancouver, B.C. V6T 1Z1
Canada
diewert@econ.ubc.ca
1-604-822-2544
1-604-822-5915

1 Introduction

Productivity growth and technical progress biases for specific variables are estimated for 18 OECD countries, 1960-1992.[1] Estimates of price elasticities are also reported. Comparisons across countries and time are made, with special attention to the possibility of systematic differences between countries in the Asia-Pacfic region and other OECD member countries. The examination of regional economic differences and similarities is of timely interest, in particular due to the current trend of countries identifying economically with other countries in their region through international agreements on economic cooperation (e.g. EU, APEC, NAFTA).

The modeling approach employed follows Diewert and Wales (1992) and Kohli (1994), rather than the usual Solow (1957) style of single-output analysis. The method used allows examination of a multiple-output multiple-input context where the economies are engaging in foreign trade. Hence, it is taken into consideration that the countries in the sample are not closed economies, that multiple outputs exist as well as multiple inputs, and technical progress does not have to occur in a neutral fashion, e.g., technical progress may cause not only outward movements in the production possibility frontier, but also twists favouring one output over another. Similarly, technical progress may have asymmetric effects on the use of inputs. Estimates of these technical progress biases and price elasticities for three outputs (consumption, investment, exports) and two variable inputs (imports, labour) are generated for each observation in the sample, for each of the 18 countries considered. It is envisaged that these estimates will aid researchers in examining the economic experiences of these countries and regions over the very interesting 33 years of the sample. The price elasticities will also be of great interest for general equilibrium modelling.

The approach specifies a Normalized Quadratic[2] profit function for each country in the sample. This functional form is used as it is "flexible"[3] and globally correct curvature can be imposed without losing the flexibility property. All productivity and elasticity estimates are generated from these estimated functions, which provide estimates that are as comparable as possible across countries.

Section 2 describes the Normalized Quadratic variable profit function, and section 3 describes the methods for calculating productivity growth, technical progress biases and price elasticities. Readers not interested in the technical details may omit reading these sections. Section 4 discusses some of the results shown in figures 1 to 11, and tables 2 to 5. Section 5 concludes.

2 Normalized Quadratic Variable Profit Function

See the Appendix for the properties which define a variable profit function. The Normalized Quadratic functional form (Diewert and Wales, 1987) is a flexible functional form (Diewert, 1974; 113). The Normalized Quadratic variable profit function can be written in matrix notation as follows:

$$V(p,k,t) = a \cdot p + b \cdot pk + c \cdot pkt + 1/2 \cdot d \cdot pkt^2 + 1/2 \cdot \frac{p \cdot Bpk}{\alpha \cdot p} \tag{1}$$

where a, b, c and d are parameter vectors, $B = [b_{ij}] = B'$, t is a time trend, $t = 1, ..., T$, k denotes capital (taken to be exogenously given), there are N variable goods with prices $p = (p_1, ..., p_N)$, including both inputs and outputs, and $a \cdot p \equiv \sum_{i=1}^{N} a_i p_i$ is the inner product of the vectors a and p. Input quantities are taken to be negative, i.e., inputs are treated as negative outputs. The α vector ($\alpha \geq 0_N$) is a predetermined vector of parameters. Kohli (1991) and Diewert and Wales (1992) experimented with different values for α, but for simplicity it can be set to a vector of ones, i.e. $\alpha = 1_N$. Setting the elements of the a vector to zero results in the profit function exhibiting constant returns to scale, which for estimation purposes is the approach taken in the empirical work described in section 4 below. Differentiating (1) with respect to p gives the system of net supply equations, through Hotelling's Lemma, which is used in estimation:

$$\begin{aligned} y(p,k,t) &= \nabla_p V(p,k,t) = a + bk + ckt + 1/2 \cdot dkt^2 + \frac{Bpk}{\alpha \cdot p} - 1/2 \cdot \frac{p \cdot Bpk}{(\alpha \cdot p)^2} \cdot \alpha \\ &= a + bk + ckt + 1/2 \cdot dkt^2 + Bwk - 1/2 \cdot w \cdot Bwk\alpha, \end{aligned} \tag{2}$$

where $w \equiv p/\alpha \cdot p$ and ∇_p denotes first order differentiation with respect to the vector of prices p. The following restrictions are placed on the elements of B to avoid potential problems with multicollinearity between the elements of b and B:

$$B1_N = 0_N, \tag{3}$$

i.e. the rows of B are restricted to add to zero. Therefore, we have one parameter in each row which is not independently determined. Using these restrictions, we can, for example, solve for the diagonal elements of the B matrix once the other parameters have been obtained by estimation.

Once we have estimated our supply and demand equations, we can multiply the fitted quantities by their respective prices and add them together to derive the fitted variable profit function, for each t.

A requirement on the profit function is that it satisfies convexity in prices, (see the Appendix). This is satisfied by the Normalized Quadratic if the estimated B matrix of parameters is found to be positive semidefinite. In the model described so far, there is no guarantee that this condition will hold, and in practice it will usually be violated by flexible functional forms such as this and the Translog (Fox, 1996). But one of the main advantages of the Normalized Quadratic form over other flexible functional forms, is the ability to impose curvature *globally* without sacrificing flexibility, or any of the other theoretical requirements. Curvature is imposed using the following theorem:

Theorem 1 *Let B be a symmetric $N \times N$ matrix. Then B is positive semidefinite if and only if $B = AA'$ for some lower triangular matrix A (i.e. $A = [a_{ij}]$, $a_{ij} = 0$ for $i < j$; $i, j = 1, ..., N-1$), (Wiley, Schmidt and Bramble, 1973; Diewert and Wales, 1987; Magnus and Woodland, 1988).*

The restriction on the elements of the B matrix that we imposed above, $B1_N = 0_N$, can now be written as $A'1_N = 0_N$, i.e., we now have the columns of A adding to zero. Using this restriction, we can express the elements of the B matrix in terms of the elements of the

A matrix. Substituting these expressions for the b_{ij} into the estimating equations gives us a system of net supply equations (2) whose parent function, the Normalized Quadratic profit function, has assured globally correct curvature.

3 Technical Progress and Elasticity Measures

Differentiating the log of the profit function, V, with respect to t, we get an index of technical progress (productivity growth) for each t:

$$TFP \equiv (\partial V/\partial t)(1/V) = (c \cdot pk + d \cdot pkt)/V. \tag{4}$$

This measures aggregate productivity growth, or total factor productivity change (TFP), for an economy. Similarly, a measure of the effect of technical change on each variable good can be calculated by taking the derivative of each estimated demand equation with respect to time and dividing by the estimated demands (Diewert and Wales, 1992; Kohli, 1994). Therefore, for the i^{th} good we have:

$$\tau_i \equiv (\partial y_i/\partial t)(1/y_i), \tag{5}$$

for each period $t = 1, ..., T$ and good $i = 1, ..., N$. If the good in question is an output, then a positive value indicates that more of the output is being produced due to the passing of time, i.e., if $\tau_i > 0$ (< 0) then technical progress is output i augmenting (reducing). If the good in question is an input, then a negative value suggests that less of the input is required due to the passing of time, i.e., if $\tau_i < 0$ (> 0) then technical progress is input i reducing (augmenting). We define these τ_is to be technical progress biases for each good. This approach is in the spirit of Hicks (1932) who seems to have been the first to introduce the ideas of input-reducing and output-augmenting technical progress. See Kohli (1994) for an excellent discussion of Hick's contribution and other similar frameworks.

We can get more insight into the interpretation of these biases by noting the following. Due to the linear homogeneity of $V(p, k, t)$, TFP and the τ_i are homogenous of degree zero in prices and capital (under the assumption of constant returns to scale). Using the linear homogeneity in prices property of the variable profit function, V, we can write

$$\partial V/\partial t = \sum_{i=1}^{N} (\partial^2 V/\partial t \partial p_i) p_i. \tag{6}$$

Dividing both sides of (6) by V, and using Hotelling's Lemma as in (2), yields

$$TFP = \sum_{i=1}^{N} s_i \tau_i \tag{7}$$

for each t, where $s_i = (p_i y_i)/V$, and s_i is negative for inputs. If technical progress is completely unbiased (neutral), so that all goods are affected to the same degree by technical progress, then (7) becomes

$$TFP = \tau_i = -\tau_j. \tag{8}$$

for outputs i and inputs j. This, however, is unlikely to be the case, and the estimates that follow in section 4 certainly show that technical progress is biased in favour of some goods and against others. Equations (7) and (8) suggest that comparisons between TFP and the τ_i are as of much interest as the values themselves.

It should be noted that the above approach only identifies the effects of technical progress on the demands and supplies of goods, not the sources of technical progress. This latter task is far beyond the scope of this paper. It is well known that under the assumptions of constant returns to scale and disembodied technical progress, it is impossible to identify the separate rates of technical progress for each of the inputs and outputs, but it is possible to identify the effects of technical progress on each good.[4]

As demonstrated by Jorgenson and Fraumeni (1981), there is a close relationship between the effects of the march of time on output and input quantities, and the impact of price (and factor endowment) changes on certain definitions of the rate of technological change. We define η_i to be a measure which captures the effects of a change in the price of good i on the rate of technological change, for each t:

$$\eta_i \equiv (\partial^2 \ln \pi)/(\partial t \partial \ln p_i) = \partial TFP/\partial \ln p_i \tag{9}$$

$$= s_i(\tau_i - TFP), \tag{10}$$

where s_i is negative for inputs, TFP is defined by (4) and τ_i is defined by (5). Therefore, the share weighted difference between τ_i and aggregate technological change captures the effect of changes in the price of good i on the rate of technical progress. From (7) it follows that

$$\sum_{i=1}^{N} \eta_i = 0, \tag{11}$$

i.e., if all prices change by the same proportion, then relative prices have not changed and the aggregate effect of the price changes on technical progress sums to zero.

Table 1 presents the possible relationships between τ_i and TFP which determine η_i as described by equation (10). This table will aid in the interpretation of the results presented in section 4. For example, when TFP is positive (as has typically been the case), then $\tau_i < 0$ for an output means that technical progress has been output reducing, and the impact of an increase in the price of output i, *ceteris paribus*, is that technical progress becomes more output reducing ($\eta_i < 0$).

Finally, price elasticities are calculated as follows:

$$E_{ij} = \partial y_i / \partial p_j \cdot p_j / y_i \tag{12}$$

for goods i and j, where $i, j = 1, ...N$.

4 Results

The data set consists of prices and quantities for three outputs (exports, investment, and combined private and government consumption), two variable inputs (labour and imports) and one exogenously given input (capital) for 18 OECD countries, 1960–1992. The treatment of imports as an input to the production sector is quite standard (Kohli, 1991). This recognizes that imports are often raw materials or intermediate goods, and even products which are imported as "finished" products have value added to them locally through transportation, retailing and so forth. The construction of the data set is described in detail in Fox (1997), however it is worth noting that the raw data came from primarily OECD sources. Constant returns to scale and correct curvature were imposed *a priori*. Error terms were appended to the equations (2) for estimation. All regularity conditions (see the Appendix) were satisfied by the estimated functions. The parameter estimates for each country are available on request.[5]

Measures of goodness-of-fit (R^2 between observed and predicted) for each equation in each system of equations (i.e., each country) estimated, are reported in table 2. Aggregate productivity growth and technical progress biases are reported in figures 1 to 6, and summary statistics for each country are reported in table 3.[6] Own price elasticities (i.e., $i = j$ in (12)) for each year are reported in figures 7 to 11, and summary statistics for each country are reported in table 4, while average cross price elasticities (i.e., $i \neq j$ in (12)) are in table 5. The aggregate productivity estimates in table 3 and figure 1 were calculated by dividing $(\partial V/\partial t)$ by estimated GNP, rather than by estimated profits as suggested by (4). This is in order to produce estimates which are comparable to results based on index number approaches. While figures 1 to 11 do not allow the identification of each country, it is of interest to observe the common trends across the countries for each variable.

We can see from the R^2 values in table 2 that the fit of the estimated equations is remarkably good, with most values being above 0.90. Only for Sweden do we get an R^2 of less than 0.5 (investment equation). On the whole, the model seems to fit the data extremely well, giving us confidence in the reliability of the results which follow.

Total Factor Productivity

Figure 1 confirms the much debated productivity slowdown (Bailey and Gorden, 1988; Hulten, 1992; Nordhaus, 1982, 1988; Wolff, 1996), with all countries having lower productivity growth in 1992 compared to 1960. From table 3, the average OECD productivity growth rate for 1960-1973 was 2.57%, but 1.09% for 1974-1992. This declining productivity growth result was also found by Diewert and Fox (1997) using the same data and an index-number approach (Diewert, 1992) to generating productivity growth estimates.[7] This similarity in results from alternative methods is not surprising. Kohli (1990), Diewert and Wales (1992), and Fox (1996) have noted that flexible profit function methods of obtaining technical progress estimates yield values which are smoothed versions of the estimates from the commonly used index-number approaches. From the estimates there does not appear to be a distinct regional group in terms of TFP.

Technical Progress Biases

If countries of a region are thought to be similar due to geographical location and are to be talked of as a group, then we would expect that their economies would exhibit similar characteristics, such as responding in a similar fashion to technical progress, and technical progress would be affected in a similar fashion to relative price changes. This section presents results that allows this hypothesis to be investigated.

The technical progress biases indicate that for most countries productivity growth has been output (consumption, investment, exports) augmenting, imports augmenting and labour reducing (table 3, figures 2 to 6). There are, however, a few exceptions. An interesting one is that for the U.S., Switzerland, Canada (for most of the sample) and Great Britain (from 1976) technical progress has been labour augmenting. The labour reducing aspect of technical progress for most countries is of particular interest—it confirms the perception of labour being replaced through technical progress. Japan, for example, has had technical progress that was labour reducing, until 1987.

From table 3, the OECD average technical progress biases for exports and imports are clearly lower in the post-OPEC era. For Japan, the bias for imports is positive, but very low compared with other countries, indicating that technical progress has not been assisting imports to Japan much at all.

A comparison of tables 1 and 3 allows an analysis of the effects of relative price changes on the technological biases. For example, consider a comparison between the U.S. and Japan for consumption (an output). For each period considered, the technological bias is positive for the U.S. but negative for Japan. From table 1, we see that for Japan this means that an increase in the price of consumption leads to a decline in TFP, *ceteris paribus*. For the U.S., on the other hand, an increase in the price of consumption leads to an increase in TFP. Most countries in the sample are similar to the U.S. in this regard, with only New Zealand and Austria exhibiting the same characteristic with regards to consumption as

Japan. However, we must note that the estimates for TFP for Japan seem a lot lower than the usual estimates, indicating that there may be aspects of the Japanese economy over this period that our modeling strategy is not flexible enough to capture.

Overall, the results from table 3 suggest that there is little evidence that the economies in the Asia Pacific region are a distinct group. The variation in the signs and magnitudes of biases across the countries in the sample suggests that there are no regional characteristics which cause economies to be similar, at least in terms of the effects of technical progress.

Next we examine if there is any evidence of regional similarities from the estimates of price elasticities.

Price Elasticities

Own price elasticities (table 4) indicate that labour demand has become more price sensitive over time in every country. This perhaps reflects labour markets becoming more flexible. A partial explanation for this could be pressure on labour because of the labour-reducing technical progress in many countries, as reported in table 3. Own price elasticities for exports and imports have also fallen noticeably, with elasticities being more similar across countries at the end of the sample than earlier. This could be a reflection of increased specialization due to most (perhaps all) of the countries in the sample adopting more liberal trade policies at the end of the sample than at the beginning.

The cross price elasticities reported in table 5 are (arithmetic) averages for the full sample period, 1960–1992. The degree of complementarity between both the outputs and the inputs respectively is of interest. Outputs are complementary if the elasticity estimates between them are positive. In other words, an increase in the price of one output tends to increase the supply of other outputs. However, the relationship between consumption and exports is not so clear, with elasticities of different signs for different countries. From the second to last column of table 5, we see that on average (across countries) these outputs are substitutes, e.g., an increase in the price of consumption leads to a reduction in the supply of exports. This could be due to companies preferring to sell to markets which they know well, their domestic market being the most familiar. It may also reflect other types of uncertainty, such as exchange rate volatility. It is worth noting that relatively trade-dependent economics such as Japan, New Zealand and Australia have complementary relationships between exports and consumption. However, these elasticities of either sign are quite small for each country.

Inputs are complements if the elasticity estimates between them are negative. In other words an increase in the price of one input tends to reduce the demand of other inputs. Imports and labour are complements in all countries except Norway. However, both of the relevant elasticities (E_{45} and E_{54}) are quite small (0.43 and 0.33, respectively).

Cross price elasticities between outputs and inputs can be analysed in the same way, and many other observations on the results are possible, but are left to the reader with an interest in a particular aspect of recent economic history, or a particular country. However, we can note that the estimates of price elasticities again give us no evidence that membership of a regional group seems to be determining similarities between economies.

5 Conclusion

The results from this paper provide a clear picture of the effects of technical progress on the economies of 18 OECD countries, 1960-1992. Own and cross price elasticities for each of the variable goods have also been reported. The approach has treated these as economies which engage in foreign trade and which have multiple outputs as well as multiple inputs. This is more realistic than the common approach of abstracting from foreign trade and assuming that only one output is produced. The approach is soundly based in economic theory, with the estimated functions satisfying the appropriate regularity conditions globally. The estimates for countries are as comparable as possible, given that the data aggregates were constructed in a consistent fashion and the same method was used for each country to estimate all of the measures of interest. The only factor stopping claims of complete comparability is that the raw data series may have been constructed using different techniques by different statistical agencies. However, given that these are all OECD countries, the techniques should be very similar.

The estimates of the effects of technical progress on the inputs and outputs shed light on how aggregate technical progress may be biased in favour of some goods and against others. The estimates allow both comparisons across countries and across time. Similarly, the price elasticities allow investigation into the differences between countries and the changes across time in the sensitivity of supply/demand to price changes.

There did not appear to be any systematic differences in the performance of economies based on regional differences. In particular, OECD member countries in the Asia Pacific Region, a region which experienced much change in the period 1960–1992, did not exhibit any properties which seem to set them apart from the other countries as a group.

While there are many results of interest in the data, one of particular interest may be the labour reducing effect of technical progress for most countries, and the increasing sensitivity of labour demand to price changes in all countries.

Notes

1. The expressions "technological change", "productivity growth" and "technical progress" are used interchangeably.
2. Diewert and Wales (1987) initially called this the Symmetric Generalized McFadden functional form.
3. A functional form is "flexible" if it can provide a second order approximation to an arbitrary twice differentiable linearly homogeneous function at a point (Diewert, 1974; 113).
4. Kohli (1994:11-12) discusses the identification problem that one runs into when trying to determine whether technical progress occurs because inputs become more productive or because outputs become easier to produce.
5. The OECD country codes used in the tables are as follows: AUS=Australia, AUT=Austria, BEL=Belgium, CAN=Canada, CHE=Switzerland, DEU=West Germany, DNK=Denmark, ESP=Spain, FIN=Finland, FRA=France, GBR=Great Britain, GRC=Greece, JPN=Japan, NLD=Netherlands, NOR=Norway, NZL=New Zealand, SWE=Sweden, and USA. Other countries were excluded from consideration due to the lack of appropriate data. Countries in the sample which are in the Asia Pacific region can be defined as Australia, Japan and New Zealand, although this could be extended to include Canada and the U.S. if the APEC definition of the Asia Pacific region is used.
6. Results for each year of the sample are available on request from the authors. All computations were performed using the econometrics computer program SHAZAM (White, 1978). The optimizing algorithm for estimating the system of nonlinear equations was SHAZAM's default, the Davidson-Fletcher- Powell algorithm.
7. See Diewert and Fox (1997) for some reasons why this measured productivity slowdown may be caused by measurement error.

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Appendix

The variable profit function can be expressed as follows:

$$V(p,k) \equiv max_y(p'y : k = F(y)) \tag{13}$$

where p' denotes the transpose of the price vector, $F(y)$ is the factor requirements function and k is capital. It is assumed that (i) $p_i > 0$ for $i = 1, ..., N$, where N is the number of variable goods, (ii) $k > 0$, and (iii) $y_i > 0$ if i denotes an output, and $y_i < 0$ if i denotes an input (i.e. inputs are treated as negative outputs).

The conditions on the variable profit function, V, with constant returns imposed, are that it is (i) a nonnegative function, (ii) positive homogeneous of degree one in p, (iii) convex and continuous in p for every fixed k, (iv) positive homogeneous of degree one in k, (v) nondecreasing in k for every fixed p, and (vi) concave and continuous in k for every fixed p. (See Diewert, 1973, for proofs).

The profit maximizing supply and demand functions can then be derived by using Hotelling's Lemma — the derivative of $V(p,k)$ with respect to the price of the i^{th} good gives the supply or demand function (alternatively "net supply" function) for this good, (see e.g. Varian (1984; 52)). The convexity of V in prices implies that the matrix of second derivatives of V with respect to prices (the first partial derivatives of the net supply functions with respect to prices) is positive semidefinite.

Table 1: The Relationship between TFP, τ_i and η_i

Condition	Outputs Sign of η_i	Inputs Sign of η_i
$\underline{TFP > 0}$		
$\tau_i < 0$	< 0	> 0
$TFP > \tau_i > 0$	> 0	> 0
$\tau_i > TFP > 0$	> 0	< 0
$\underline{TFP < 0}$		
$\tau_i > 0$	> 0	< 0
$\tau_i < TFP < 0$	> 0	< 0
$TFP < \tau_i < 0$	< 0	> 0

NOTE: $\eta_i = (\partial^2 \ln V)/(\partial t \partial p_i) = s_i(\tau_i - TFP)$, where TFP is defined by (4), τ_i is defined by (5), V is the profit function defined by (1), $s_i = p_i y_i / V$, and s_i is negative for inputs.

Table 2: R^2 Values for Each Equation

	AUS	AUT	BEL	CAN	CHE	DEU	DNK	ESP	FIN	FRA	GBR	GRC	JPN	NLD	NOR	NZL	SWE	USA
Consumption	0.999	0.998	0.997	0.996	0.989	0.997	0.995	0.995	0.992	0.999	0.988	0.998	0.999	0.989	0.993	0.969	0.995	0.997
Investment	0.917	0.802	0.846	0.983	0.854	0.795	0.731	0.941	0.643	0.935	0.726	0.800	0.939	0.619	0.887	0.582	0.470	0.910
Exports	0.982	0.994	0.991	0.987	0.994	0.975	0.992	0.993	0.980	0.991	0.992	0.987	0.997	0.974	0.989	0.991	0.987	0.956
Imports	0.984	0.987	0.985	0.991	0.981	0.979	0.983	0.984	0.954	0.985	0.973	0.981	0.921	0.964	0.967	0.949	0.945	0.988
Labour	0.977	0.805	0.966	0.996	0.927	0.695	0.616	0.915	0.623	0.939	0.907	0.784	0.640	0.851	0.946	0.979	0.768	0.991

NOTE: AUS=Australia, AUT=Austria, BEL=Belgium, CAN=Canada, CHE= Switzerland, DEU=West Germany, DNK=Denmark, ESP=Spain, FIN=Finland, FRA=France, GBR= Great Britain, GRC= Greece, JPN=Japan, NLD=Netherlands, NOR=Norway NZL=New Zealand, SWE=Sweden

Table 3: TFP and Technical Progress Biases

	Period	AUS	AUT	BEL	CAN	CHE	DEU	DNK	ESP	FIN	FRA	GBR	GRC	JPN	NLD	NOR	NZL	SWE	USA	Mean	Std. Dev
	1960-1973	2.31	2.77	3.64	2.26	1.40	2.30	2.21	4.15	2.57	3.00	2.33	5.37	1.71	3.77	2.45	0.52	2.57	0.96	2.57	1.15
TFP	1974-1992	0.89	0.93	1.84	0.63	0.96	1.61	0.97	1.84	1.15	1.63	1.22	-0.12	1.71	1.02	1.84	-0.01	0.98	0.45	1.09	0.60
	1960-1992	1.49	1.71	2.61	1.32	1.15	1.90	1.50	2.82	1.75	2.21	1.69	2.21	1.71	2.19	2.10	0.21	1.65	0.67	1.72	0.63
	1960-1973	1.58	-1.84	0.85	2.16	1.57	0.06	0.70	2.61	1.02	0.49	1.84	2.71	-1.97	2.79	1.46	-0.04	0.25	1.70	1.00	1.37
Consumption	1974-1992	0.82	-1.60	-0.27	0.03	0.51	0.14	-0.42	0.61	1.53	0.44	1.95	0.18	-0.62	0.26	0.04	-1.48	0.05	0.66	0.16	0.88
	1960-1992	1.14	-1.70	0.20	0.94	0.96	0.11	0.06	1.46	1.31	0.46	1.90	1.25	-1.19	1.33	0.64	-0.87	0.13	1.10	0.51	0.97
	1960-1973	5.53	1.23	4.94	4.69	3.36	1.48	3.87	10.02	6.13	4.42	4.11	7.10	0.02	6.96	0.68	0.24	6.24	1.74	4.04	2.75
Investment	1974-1992	-0.08	-0.69	4.35	4.76	6.58	1.70	-1.16	4.78	6.43	2.03	3.47	-2.81	2.50	-0.44	-3.41	-0.20	3.69	0.79	1.79	2.99
	1960-1992	2.30	0.13	4.60	4.73	5.22	1.61	0.98	7.00	6.30	3.04	3.74	1.39	1.45	2.70	-1.67	-0.01	4.77	1.19	2.75	2.35
	1960-1973	1.05	4.18	9.25	2.88	4.53	5.41	2.36	9.52	3.80	5.16	1.66	12.86	5.84	8.79	-1.36	1.70	7.33	-2.67	4.57	3.97
Exports	1974-1992	3.26	2.80	3.68	1.55	1.50	4.07	2.89	4.22	3.89	2.51	2.05	5.31	2.91	2.80	1.45	0.86	3.28	4.68	2.98	1.21
	1960-1992	2.33	3.39	6.04	2.11	2.78	4.64	2.66	6.47	3.85	3.63	1.88	8.51	4.15	5.34	0.26	1.22	5.00	1.56	3.66	2.09
	1960-1973	3.79	2.04	8.22	3.53	5.12	4.03	3.38	15.88	5.42	4.31	3.47	6.56	0.70	9.79	-1.07	1.18	7.11	4.73	4.90	3.81
Imports	1974-1992	2.73	1.24	3.16	3.21	2.88	2.59	0.47	6.46	2.17	1.82	3.09	4.25	0.41	2.20	-1.92	0.80	2.61	3.52	2.32	1.78
	1960-1992	3.18	1.58	5.31	3.35	3.83	3.20	1.70	10.46	3.55	2.88	3.25	5.23	0.53	5.42	-1.56	0.96	4.52	4.04	3.41	2.52
	1960-1973	-0.18	-4.46	-2.36	0.58	0.65	-2.22	-1.56	-0.89	-0.81	-1.84	-0.69	-3.22	-3.71	-0.63	-1.80	-0.65	-1.08	0.42	-1.36	1.44
Labour	1974-1992	-0.37	-2.35	-1.21	0.03	0.87	-0.86	-0.82	-1.11	3.22	-0.91	0.95	-1.44	-1.21	-0.88	-1.66	-1.86	0.05	0.42	-0.51	1.30
	1960-1992	-0.29	-3.24	-1.70	0.26	0.77	-1.44	-1.13	-1.02	1.51	-1.30	0.26	-2.19	-2.27	-0.77	-1.72	-1.35	-0.43	0.42	-0.87	1.21

Table 4: Own Price Elasticities

	Period	AUS	AUT	BEL	CAN	CHE	DEU	DNK	ESP	FIN	FRA	GBR	GRC	JPN	NLD	NOR	NZL	SWE	USA	Mean	Std. Dev
	1960-1973	0.03	0.24	0.16	0.05	0.42	0.23	0.19	0.41	0.43	0.08	0.88	0.27	0.34	0.07	0.56	0.12	0.08	0.82	0.30	0.25
Consumption	1974-1992	0.03	0.25	0.12	0.07	0.41	0.15	0.29	0.41	0.52	0.11	0.89	0.13	0.64	0.06	0.59	0.15	0.12	0.69	0.31	0.26
	1960-1992	0.03	0.24	0.13	0.06	0.41	0.18	0.25	0.41	0.48	0.10	0.88	0.19	0.52	0.06	0.57	0.13	0.10	0.74	0.31	0.25
	1960-1973	2.50	0.84	1.83	2.61	2.29	1.31	1.38	1.87	1.99	0.99	0.93	1.54	1.02	2.17	0.36	0.38	1.82	1.54	1.52	0.68
Investment	1974-1992	2.60	1.02	1.99	1.94	2.24	1.62	2.15	1.90	3.02	1.14	1.12	1.32	1.40	2.41	0.31	0.45	2.35	1.42	1.69	0.73
	1960-1992	2.56	0.94	1.92	2.23	2.26	1.49	1.82	1.89	2.58	1.08	1.04	1.41	1.24	2.31	0.33	0.42	2.13	1.47	1.62	0.68
	1960-1973	0.18	0.38	2.76	0.65	0.08	0.55	0.16	0.29	0.64	0.06	0.47	1.21	1.32	0.66	0.31	0.03	0.63	2.57	0.72	0.79
Exports	1974-1992	0.11	0.22	1.37	0.34	0.04	0.31	0.15	0.18	0.57	0.03	0.26	0.31	0.54	0.29	0.17	0.03	0.48	1.22	0.37	0.37
	1960-1992	0.14	0.29	1.96	0.47	0.05	0.41	0.16	0.22	0.60	0.04	0.35	0.69	0.87	0.45	0.23	0.03	0.55	1.79	0.52	0.55
	1960-1973	-1.07	-0.46	-2.87	-2.74	-0.94	-0.36	-0.90	-3.45	-1.06	-0.67	-0.61	-2.76	-0.23	-1.92	-2.29	-0.39	-1.19	-0.49	-1.36	1.03
Imports	1974-1992	-0.69	-0.24	-1.29	-1.25	-0.37	-0.15	-0.66	-1.08	-0.69	-0.35	-0.33	-0.96	-0.10	-0.72	-1.82	-0.33	-0.76	-0.29	-0.67	0.46
	1960-1992	-0.85	-0.33	-1.96	-1.88	-0.61	-0.24	-0.76	-2.09	-0.85	-0.49	-0.45	-1.72	-0.15	-1.23	-2.02	-0.36	-0.94	-0.37	-0.96	0.68
	1960-1973	-0.45	-0.20	-0.30	-0.52	-0.74	-0.26	-0.67	-0.61	-1.19	-0.42	-0.84	-0.12	-0.49	-0.42	-0.39	-0.23	-0.60	-0.80	-0.51	0.27
Labour	1974-1992	-0.60	-0.46	-0.55	-0.68	-1.07	-0.42	-1.24	-1.23	-2.48	-0.76	-1.40	-0.19	-1.27	-0.64	-0.69	-0.31	-0.91	-0.79	-0.87	0.53
	1960-1992	-0.53	-0.35	-0.44	-0.61	-0.93	-0.35	-1.00	-0.96	-1.93	-0.61	-1.16	-0.16	-0.94	-0.54	-0.57	-0.28	-0.78	-0.79	-0.72	0.41

Table 5: Average Cross Price Elasticities

	AUS	AUT	BEL	CAN	CHE	DEU	DNK	ESP	FIN	FRA	GBR	GRC	JPN	NLD	NOR	NZL	SWE	USA	Mean	Std. Dev.
E_{11}	0.03	0.24	0.13	0.06	0.41	0.18	0.25	0.41	0.48	0.10	0.88	0.19	0.52	0.06	0.57	0.13	0.10	0.74	0.31	0.25
E_{12}	0.05	0.18	-0.02	0.21	0.42	-0.05	0.33	0.48	0.62	0.18	0.42	-0.06	0.09	0.18	0.12	0.06	0.19	0.15	0.20	0.19
E_{13}	0.03	-0.17	0.21	0.03	-0.08	-0.17	0.13	-0.02	0.07	-0.01	-0.19	-0.06	0.03	0.06	-0.01	0.03	0.08	-0.29	-0.02	0.12
E_{14}	-0.07	-0.20	-0.33	-0.13	-0.34	-0.08	-0.24	-0.41	-0.40	-0.09	-0.28	-0.11	-0.10	-0.18	-0.24	-0.14	-0.18	-0.04	-0.20	0.11
E_{15}	-0.04	-0.05	-0.01	-0.17	-0.41	0.11	-0.46	-0.46	-0.77	-0.17	-0.83	0.04	-0.54	-0.12	-0.44	-0.09	-0.19	-0.55	-0.29	0.28
E_{21}	0.13	0.42	-0.05	0.63	1.06	-0.13	1.09	1.40	1.58	0.51	1.61	-0.18	0.18	0.54	0.27	0.19	0.64	0.57	0.58	0.56
E_{22}	2.56	0.94	1.92	2.23	2.26	1.49	1.82	1.89	2.58	1.08	1.04	1.41	1.24	2.31	0.33	0.42	2.13	1.47	1.62	0.68
E_{23}	0.01	-0.10	0.55	0.27	-0.18	0.13	0.49	0.11	0.19	-0.02	-0.13	0.67	-0.23	1.23	0.30	0.07	0.89	-0.46	0.21	0.42
E_{24}	-0.88	-0.48	-1.11	-1.35	-0.86	-0.36	-1.46	-1.35	-1.19	-0.37	-0.68	-1.30	-0.14	-2.30	-1.03	-0.15	-1.47	-0.25	-0.93	0.58
E_{25}	-1.82	-0.78	-1.31	-1.78	-2.27	-1.13	-1.94	-2.05	-3.16	-1.19	-1.84	-0.60	-1.05	-1.77	0.13	-0.53	-2.19	-1.33	-1.48	0.77
E_{31}	0.13	-0.34	0.28	0.09	-0.17	-0.46	0.28	-0.15	0.16	-0.06	-0.61	-0.39	0.16	0.09	-0.01	0.09	0.19	-3.22	-0.22	0.79
E_{32}	0.01	-0.10	0.19	0.27	-0.17	0.11	0.33	0.11	0.17	-0.05	-0.11	1.26	-0.79	0.62	0.20	0.06	0.70	-1.32	0.08	0.55
E_{33}	0.14	0.29	1.96	0.47	0.05	0.41	0.16	0.22	0.60	0.04	0.35	0.69	0.87	0.45	0.23	0.03	0.55	1.79	0.52	0.55
E_{34}	-0.26	0.26	-1.83	-0.88	0.15	0.21	-0.22	0.21	-0.01	0.14	0.18	-1.09	0.06	-0.66	-0.66	-0.10	-0.55	0.63	-0.25	0.60
E_{35}	-0.02	-0.10	-0.60	0.06	0.13	-0.27	-0.54	-0.40	-0.92	-0.07	0.20	-0.47	-0.31	-0.49	0.25	-0.09	-0.90	2.12	-0.14	0.66
E_{41}	0.27	0.35	0.41	0.36	0.68	0.22	0.46	1.83	0.93	0.31	0.75	0.34	0.49	0.26	0.34	0.33	0.43	0.44	0.51	0.38
E_{42}	1.22	0.37	0.40	1.28	0.71	0.37	0.87	2.15	1.11	0.48	0.48	1.25	0.40	1.14	0.63	0.13	1.10	0.64	0.82	0.49
E_{43}	0.23	-0.22	1.71	0.81	-0.14	-0.21	0.19	-0.16	0.01	-0.12	-0.15	0.53	-0.06	0.63	0.62	0.09	0.50	-0.58	0.20	0.53
E_{44}	-0.85	-0.33	-1.96	-1.88	-0.61	-0.24	-0.76	-2.09	-0.85	-0.49	-0.45	-1.72	-0.15	-1.23	-2.02	-0.36	-0.94	-0.37	-0.96	0.68
E_{45}	-0.86	-0.17	-0.56	-0.56	-0.64	-0.14	-0.77	-1.74	-1.19	-0.18	-0.63	-0.40	-0.67	-0.80	0.43	-0.19	-1.08	-0.13	-0.57	0.49
E_{51}	0.04	0.06	0.01	0.19	0.42	-0.12	0.52	0.53	0.80	0.19	0.96	-0.09	0.49	0.13	0.47	0.11	0.20	0.63	0.31	0.31
E_{52}	0.75	0.34	0.42	0.67	0.92	0.42	0.65	0.79	1.29	0.46	0.55	0.34	0.52	0.67	-0.06	0.22	0.69	0.39	0.56	0.29
E_{53}	0.01	0.05	0.55	-0.02	-0.07	0.11	0.27	0.10	0.38	0.03	-0.07	0.17	0.05	0.39	-0.17	0.04	0.37	-0.22	0.11	0.21
E_{54}	-0.26	-0.10	-0.53	-0.23	-0.33	-0.05	-0.44	-0.46	-0.54	-0.06	-0.27	-0.27	-0.13	-0.66	0.33	-0.10	-0.48	-0.01	-0.26	0.24
E_{55}	-0.53	-0.35	-0.44	-0.61	-0.93	-0.35	-1.00	-0.96	-1.93	-0.61	-1.16	-0.16	-0.94	-0.54	-0.57	-0.28	-0.78	-0.79	-0.72	0.41

NOTE: 1=CONSUMPTION, 2=INVESTMENT, 3=EXPORTS, 4=IMPORTS, 5=LABOUR

Figure 1: Productivity Growth Rates

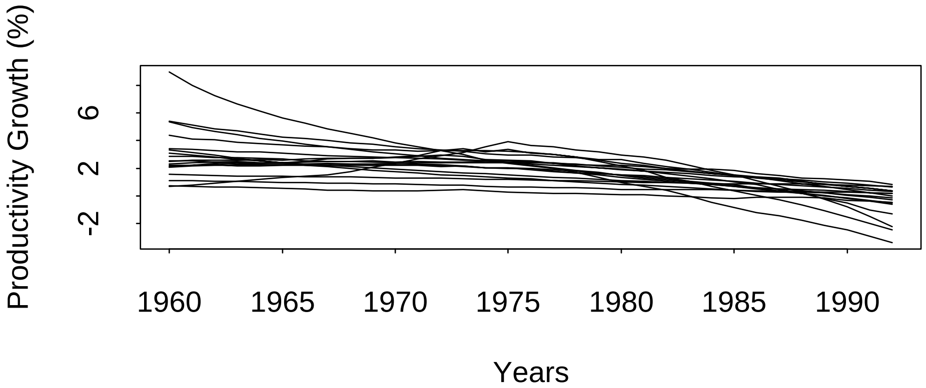

Figure 2: Technical Progress Bias: Consumption

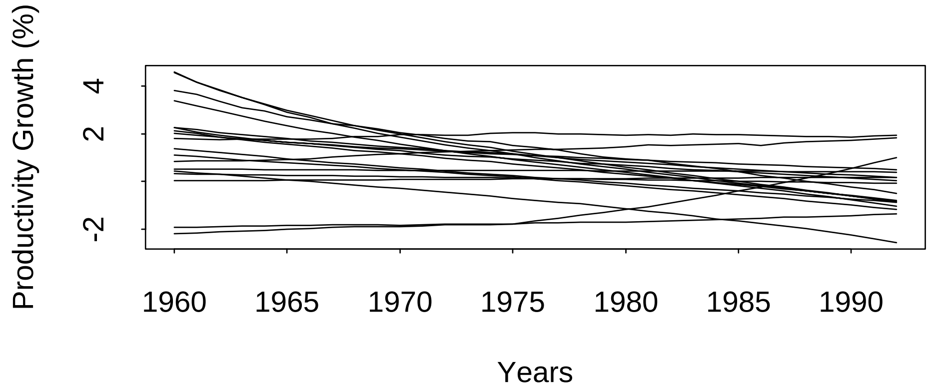

Figure 3: Technical Progress Bias: Investment

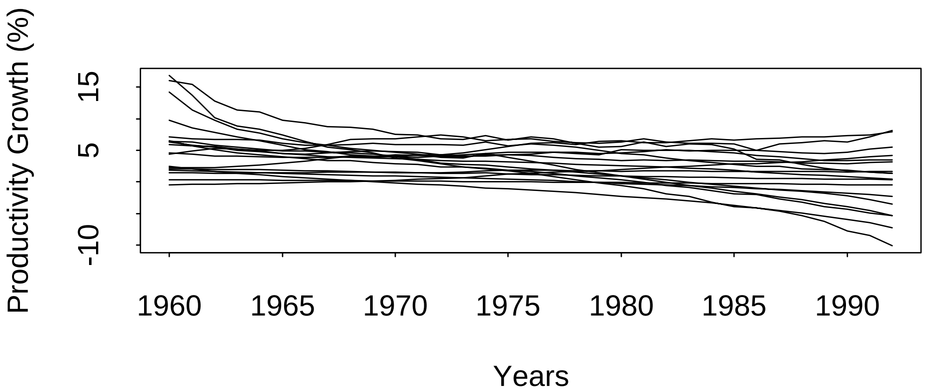

Figure 4: Technical Progress Bias: Exports

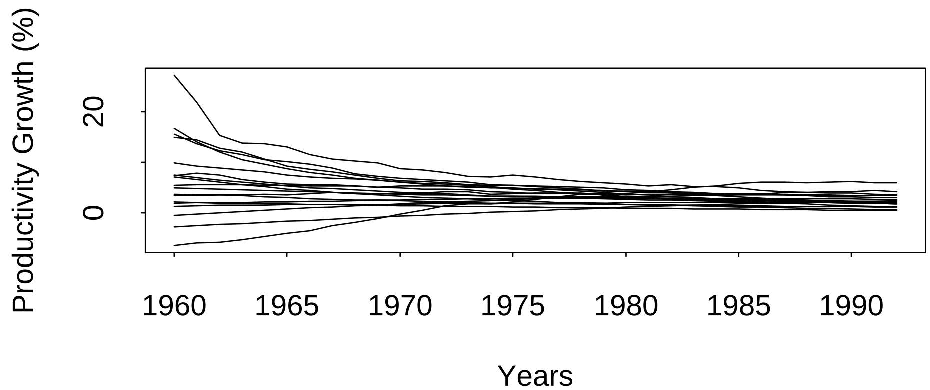

Figure 5: Technical Progress Bias: Imports

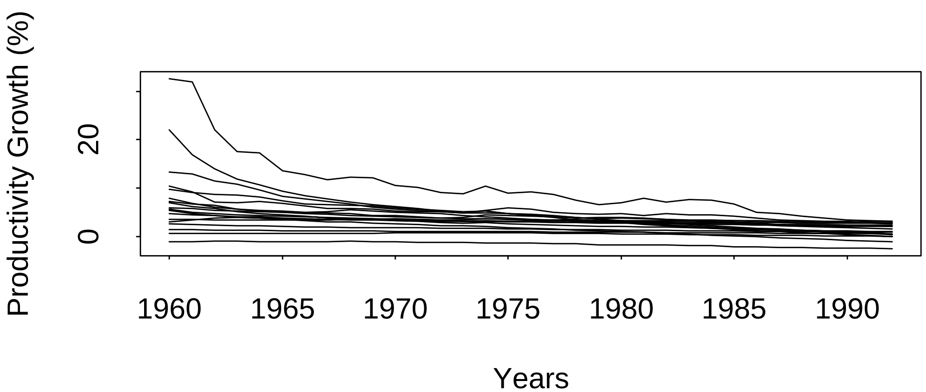

Figure 6: Technical Progress Bias: Labour

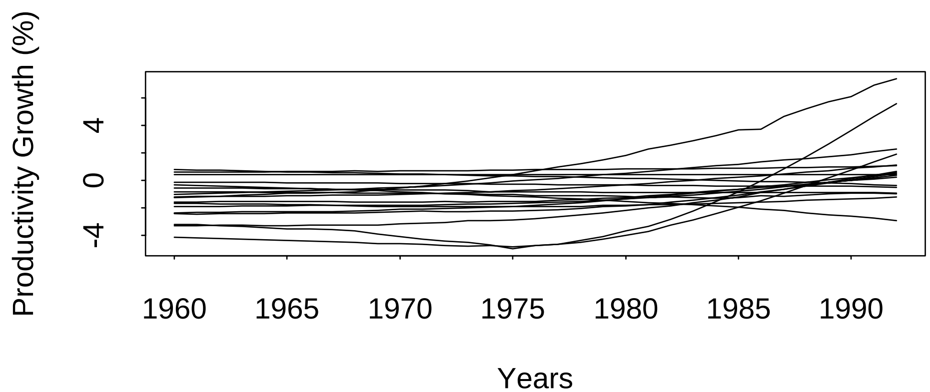

Figure 7: Own Price Elasticity: Consumption

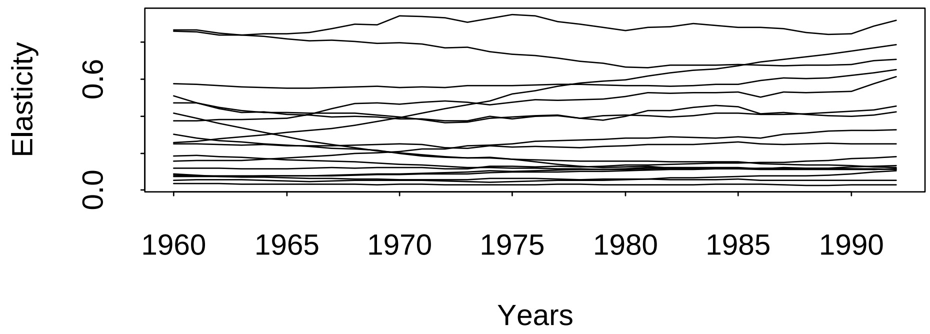

Figure 8: Own Price Elasticity: Investment

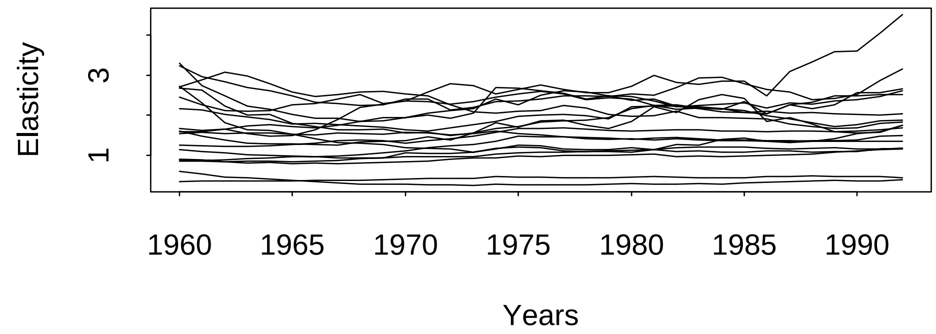

Figure 9: Own Price Elasticity: Exports

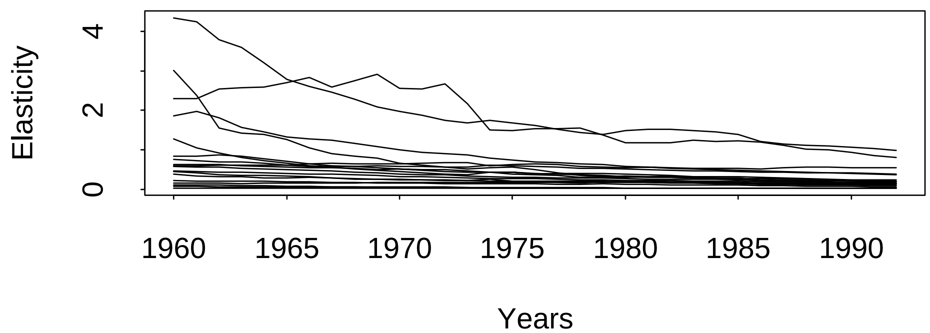

Figure 10: Own Price Elastcity: Imports

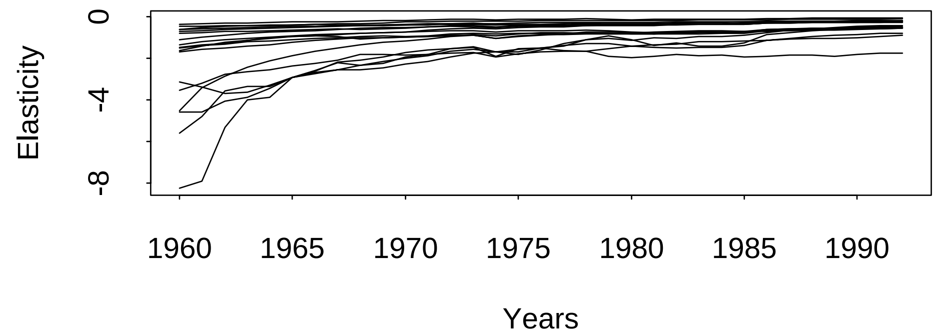

Figure 11: Own Price Elasticity: Labour