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INTERNATIONAL MONETARY FUND

UNITED KINGDOM

Selected Issues

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Approved by European I Department

February 12, 2003

Contents Page

Tables

United Kingdom: Basic Data

Demographic and other data:

Area	94,247 square miles (244,100 sq. km.)
Population (mid-2001)	60.2 million
Infant mortality (per 1,000 live births)	6.1
Doctors per 1,000 inhabitants	0.5
GDP per capita (2002)	SDR 19,927

Composition of GDP in 2001, at current prices	In billions of Pounds	Distribution in Percent
Private consumption	586.8	59.2
Public consumption	153.9	15.5
Total investment (including stockbuilding)	163.0	16.4
Total domestic demand	896.7	90.5
Exports of goods and services	287.7	29.0
Imports of goods and services	339.1	34.2
GDP at market prices	990.9	100

Selected economic data	2000	2001	2002 Est.	2003 Proj.
	(Annual percentage change)			
Output and unemployment:				
Real GDP (at market prices, average estimate)	3.1	2.0	1.7	2.2
Manufacturing production	2.0	-2.4	0.9 /1	...
Unemployment (in percent of labor force)	5.5	5.1	5.2	5.4
Earnings and prices:				
Average earnings in manufacturing	4.6	4.3	3.5	4.1
Retail price index, excluding mortgage interest	2.1	2.1	2.2	2.6
Money and interest rates:				
M0 (end of period)	4.3	8.3	5.1	...
M4 (end of period)	8.3	6.6	7.0	...
3-month Interbank rate	6.1	5.0	4.0	...
10-year government bond yield	4.8	5.0	4.4	...
Fiscal accounts (In percent of GDP): 2/				
General government balance	4.0 3/	0.0	-1.9	-2.5
Public sector balance	4.0 3/	0.1	-2.1	-2.5
Public sector net debt	31.2	30.3	31.0	32.3
	(In billions of pounds sterling)			
Balance of payments:				
Current account balance	-19.2	-16.4	-18.0	23.0
(In percent of GDP)	-2.0	-1.7	-1.8	-2.2
Trade balance	-18.5	-22.3	-17.8	-22.2
Exports	265	268	269	279
Imports	284	290	287	301
Direct investment (net)	-89.4	-1.0	-21.9 4/	...
Portfolio investment (net)	99.0	-49.0	45.0 4/	...
Reserve assets (US$ billion,eop)	48.2	40.4	42.8	...

Sources: National Statistics; HM Treasury; IFS; and IMF staff estimates.

1/ Year-on-year change as of Noverber 2003.

2/ For example, fiscal balance data for 2002 refers to FY2002/03. The fiscal year begins in April. Debt stock data refers to the end of the fiscal year.

3/ Includes 2.4 percentage points of GDP in 2000/01 corresponding to the auction proceeds of spectrum licenses.

4/ Up to third quarter of 2002.

I. AN ANALYSIS OF HOUSE PRICES IN THE UNITED KINGDOM[1]

A. Introduction

1. **The United Kingdom has experienced three major episodes of house price booms since 1970 and large recent increases in house prices have raised concerns about a new housing market bubble**. U.K. house prices have increased by close to 50 percent over the last three years, with the annual increase in December 2002 amounting to about 25 percent. This chapter examines the factors determining house prices in the United Kingdom and, based on econometric evidence, assesses whether recent house price increases can be explained by fundamentals or whether they represent a temporary overshooting of house prices, characteristic of a bubble. Building on observations on the U.K. housing market in the recent literature, we estimate a simple error-correction model that describes the dynamics of real house prices since the 1970s. Estimation results suggest that (i) earnings and interest rates are the key determinants of house prices; (ii) changes in real house prices exhibit a large degree of persistence, which can contribute to price overshooting; and, (iii) actual house price increases in the first half of 2002 have significantly deviated from those implied by long-run fundamentals, even taking short-run adjustments into account.

B. Characteristics of the U.K. Housing Market

2. **Theoretically, equilibrium house prices are determined by the interaction of supply and demand**. Empirically, this would translate into a simultaneous model of demand and supply equations, where demand for houses would be affected by house prices, income and mortgage interest rates, and supply would respond to house prices and construction costs. Often, U.K. house price models in the literature contain no explicit supply side on the assumption that supply is rigid due to restrictive planning policies. This section briefly reviews the literature to assess the validity of this assumption and goes on to discuss factors characterizing the demand for housing. It provides a context and a guide to the specification of the empirical model estimated in the next section.

Supply Conditions

3. **There appears to be empirical support for a relatively rigid housing supply function**. Meen (1996) summarizes that all empirical studies on the United Kingdom find that the price elasticity of housing supply is very small and falling over time, implying that house prices are determined almost exclusively by demand factors. Bramley's (1993) micro-level study corroborates the lack of responsiveness of housing supply to house prices, and points out that an examination of net flows of housing units supplied at a national level in 1987 reveals that price-responsive supply, such as new construction and conversions, represents only 26–30 percent of all such units supplied.[2] Price-responsive supply has been

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[1] Prepared by Ivanna R. Vladkova Hollar.

[2] The other net supply components are demographics-driven, such as household dissolution due to death, migration, etc.

particularly subdued in this latest episode of house price increases, as evidence suggests that the pace of new house-building has remained roughly the same since 1994/1995.[3]

4. **The rigidity of the housing supply function does appear to be related to planning restrictions**. Bramley's (1993) comprehensive study of the U.K. housing market not only reveals low supply elasticities, but also addresses the gap in the literature, which lacks a quantification of the impact of planning policies on output and prices. In a cross-sectional model of new housing completions across 90 districts in the United Kingdom, Bramley finds that planning policy and general constraints on development in an area have a large and significant impact on output. Planning itself (proxied by the annual flow of new planning permissions) does not appear very responsive to market forces, which suggests that large increases in housing prices do not lead to significant increases in land available for development.

Demand Conditions

5. **The U.K. housing market is characterized by a high income elasticity of housing prices**. Estimated long-run income elasticities of housing prices range from 1.7 to 3.0 (see evidence summarized in Meen, 1996). A recent study by PricewaterhouseCoopers finds a long-run income elasticity of 0.9. It is difficult to assess whether the high sensitivity of house prices to income places the United Kingdom in a unique position, as studies differ in their estimates of income elasticities across other European housing markets.[4] However, cross-country studies have linked high income sensitivity of house prices to high Loan to Value (LTV) ratios. Almeida, and others (2002) show that in countries with high LTV ratios such as the United Kingdom, house prices increase by 1.2 percent for a 1 percent increase in per capita GDP in contrast to countries with low LTV ratios like Italy, where a 1 percent increase in per capita GDP produces a 0.8 percent increase in house prices.

6. **The high LTV ratios in the United Kingdom may also be behind the speculative elements of house price dynamics**. Muellbauer (1994), contrasting the evolution of German and U.K. house prices, suggests that the LTV ratios observed in the United Kingdom during the late 1980s (in excess of 85 percent), combined with persistent house price inflation, amplified the rates of return on equity, producing returns significantly greater than the returns on saving in liquid form.[5] These consistently large rates of return could fuel what the author

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[3] While there have been suggestions of hoarding behavior on the part of developers (leaving land undeveloped while waiting to capitalize on the house price boom), developers themselves blame the slow and restrictive planning system.

[4] A HM Treasury (2000) study estimates long-run income elasticities of house prices for Germany, Italy, Netherlands, Spain and Finland well below the 0.9 income elasticity for the United Kingdom. In contrast, PwC (2002) estimates income elasticities for the Netherlands and Italy which are comparable to those in the United Kingdom.

[5] Indeed, home ownership in the United Kingdom is often a form of retirement saving which is not supplemented by any sizeable liquid financial assets. A Bank of England (2002c) study on financial pressures in the U.K. household sector shows that household average liquid financial assets fell

(continued)

calls the "explicitly speculative" characteristic of U.K. homeownership. Indeed, a survey across European mortgage markets provides a sound basis for that hypothesis: average LTV ratios for new conventional mortgage loans over 1981–90 in the United Kingdom, at 87 percent, were significantly higher than LTV ratios in Germany (65 percent), Italy (56 percent), and the Netherlands (75 percent).[6, 7] Current LTV ratios in the United Kingdom, while on a pronounced declining trend, remain high: the majority of new mortgages have LTV ratios between 75 and 90 percent, although some 4–7 percent of new mortgages have LTV ratios of 100 percent and higher.[8]

7. **While the high LTV ratios observed in the U.K. mortgage market may provide relatively more scope for speculation in house prices than in some other European countries, regional dynamics may also play a role**. A more in-depth analysis of regional housing markets, which is outside the scope of this paper, may reveal further insights into the dynamics of house prices in the United Kingdom. Some studies show a rippling effect from the South East (Meen, 1996), suggesting a role for speculative forces in subsequent price increases elsewhere. However, a recent assessment of the evidence by analysts at Goldman Sachs[9] does not substantiate the claim that the London market leads prices elsewhere.

8. **Short-term interest rates are likely to be more important determinants of housing demand in the United Kingdom than long term rates**. Most mortgage contracts in the United Kingdom are variable rate mortgages. In contrast to the U.S. market where the majority of mortgages are fixed-term at long time horizons, fixed-term mortgage contracts in the United Kingdom represent only about 35 percent of total mortgage loans,[10] and usually imply a fixed term of 5 years or less. Hence, mortgages and house prices are relatively more sensitive to short-term interest rates.

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between 1995 and 2000 for mortgage holders with higher levels of indebtedness, who also were found to hold the largest amount of total assets (own more expensive houses).

[6] Source: Almeida, and others (2002).

[7] Arguably, the down payment ratio cannot be examined independently of the degree of development and efficiency of the mortgage market. While Germany's mortgage market is generally thinner than the United Kingdoms's, the Netherlands has a highly developed mortgage market. Abstracting from explaining institutional features which determine the characteristics of the mortgage market, this paper focuses on modeling price movements *resulting* from such characteristics.

[8] Bank of England (2002b), and Council of Mortgage Lenders.

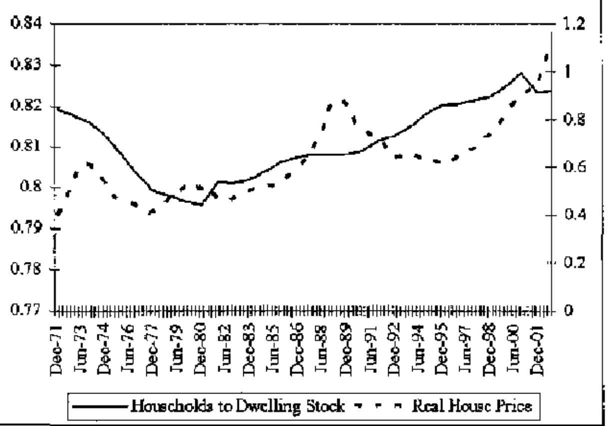
[9] Goldman Sachs, European Daily Comment, 17 January 2003, "Where London Goes, Does the Rest of the UK Follow?"

[10] This figure represents an average over 1996–2002. Conversations with private sector financial analysts suggest that fixed rate mortgages have tended to become more popular after episodes of interest rates spikes.

9. **However, whether housing demand responds to real or nominal interest rates is an empirical question**. Decreases in the real cost of mortgage financing should result in an higher equilibrium housing price. However, nominal rates may also matter. High nominal rates (stemming from high inflation) shift the burden of mortgage prices to the early years of the mortgage, while lower nominal rates (driven by lower inflation with unchanged real rates) reduce the initial burden of mortgage payments. The decline in nominal rates may have resulted in increased demand by bringing more first-time buyers into the market—buyers who might otherwise have been liquidity constrained.

10. **In summary, the U.K. experience with house price inflation is quite unique.** While there has been a dramatic increase in the number of households, the supply of new houses has been severely constrained (Figure 1)—mostly due to restrictive planning policies—and notably unresponsive to house price changes. Conventional determinants of housing supply, such as construction costs and house prices themselves, are unlikely to play a significant role in the United Kingdom, and house prices appear to be determined predominantly by demand factors. Thus, our model focuses on demand-driven dynamics, incorporating factors such as real earnings per household and short-term interest rates.

Figure 1: U.K. House Prices and Structural Factors



C. The Empirical Model

11. **We employ an error-correction model, where real house prices adjust to their long-run equilibrium while responding to short-run movements in house prices in previous quarters, interest rates, and real income per household.** Real house prices are calculated by deflating the ODPM house price index by the Retail Price Index (RPI). Nominal interest rates are short-term, inter-bank 3 month interest rates, and are converted to real interest rates using a 8-quarter moving average of RPI. Real income per household is calculated by deflating total nominal household resources by the consumer expenditure deflator and dividing by the number of households.[11] The model is estimated over 1972 Q4 through 2001 Q3. We then forecast real house prices three quarters out, through 2002 Q2, and compare the actual house price increases to those predicted by the model.

[11] All data series were provided by the Bank of England. Data on the number of households are available on an annual frequency and were interpolated into quarterly data by converting the annual growth rates to constant quarterly growth rates within each year.

12. **All series are I(1), i.e., contain a unit root[12], and real house prices, real income, and interest rates co-integrate**. The Augmented Dickey-Fuller unit root tests for the prices, income, and interest rates over the estimation period are shown in Appendix Table A1. The selected lag length for the model is 3 lags (Table A2). Both the model with nominal interest rates and the model with real interest rates co-integrate, although the evidence of one co-integrating vector is weaker for the model with nominal interest rates (Table A3).

13. **While both models show a long-run income elasticity of house prices consistent with results from the literature, only the real interest rate, and not the nominal interest rate, enters the long-run relationship at standard significance levels**. The model with real interest rates is presented below[13], while the two models are compared in Table 1:

$$\Delta p = \underset{(4.46)}{0.434} * \Delta p_{t-1} + \underset{(2.84)}{0.296} * \Delta p_{t-2} + \underset{(1.70)}{0.173} * \Delta p_{t-3} - \underset{(-2.56)}{0.004} * \Delta r_{t-1} - \underset{(-0.91)}{0.002} * \Delta r_{t-2} + \underset{(0.43)}{0.001} * \Delta r_{t-3}$$

$$+ \underset{(1.93)}{0.235} * \Delta y_{t-1} + \underset{(0.26)}{0.033} * \Delta y_{t-2} + \underset{(0.76)}{0.092} * \Delta y_{t-3} - \underset{(-3.60)}{0.043} * (p + \underset{(1.80)}{0.017} * r - \underset{(-5.55)}{1.328} * y + 12.0)_{t-1}$$

Noteworthy in both models is the high degree of persistence in real house price changes, as measured by the coefficients on lagged house prices, which are large and significant as far as three quarters back. This type of persistence is consistent with a tendency of prices to overshoot. Interestingly, while higher real interest rates reduce equilibrium real house prices, nominal interest rates do not appear to have a long-run effect on real house prices. In the short-run, however, real house prices do respond to changes in nominal interest rates (see Table 1).

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[12] While in theory real interest rates are expected to be I(0), the non-stationarity of the real interest rate in the U.K. over the 1972–2002 period is an empirical characteristic of the data, most probably due to the fact that the real interest rate series was constructed from a deflated nominal interest rate series, and thus heavily influenced by the periods of high inflation and subsequent disinflation.

[13] T-statistics in parenthesis. All variables except interest rates are in logs, Δ denotes first differences, p represents real house prices, r represents real short-term interest rates, and y represents real income per household.

14. **The dynamics of house price inflation, as captured by the empirical model shown above, predict house price increases significantly below actual house price increases in the first half of 2002.** We fit the model[14] through the last three quarters of available data (2001 Q4-2002 Q2). Figure 2 shows the deviation of real house prices from long-run equilibrium.[15] While actual house prices continue their strong upward trend, equilibrium house prices level off in the first half of 2002, consistent with an observed slowdown in earnings growth. Figure 3a compares the actual changes in real house prices with the estimated changes given by the Vector Error Correction (VEC) model which incorporates both short-run movements and adjustments to long-run equilibrium. Figure 3b confirms that the actual price change lies more than one standard error above the price predicted by the model. Evidence from both panels of Figure 3 suggests that the magnitude of recent house price increases over their equilibrium value cannot be explained by short-term developments in real income and interest rates.

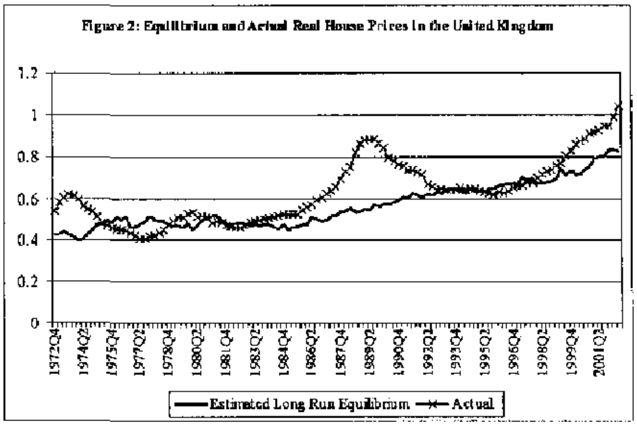

Figure 2: Equilibrium and Actual Real House Prices in the United Kingdom

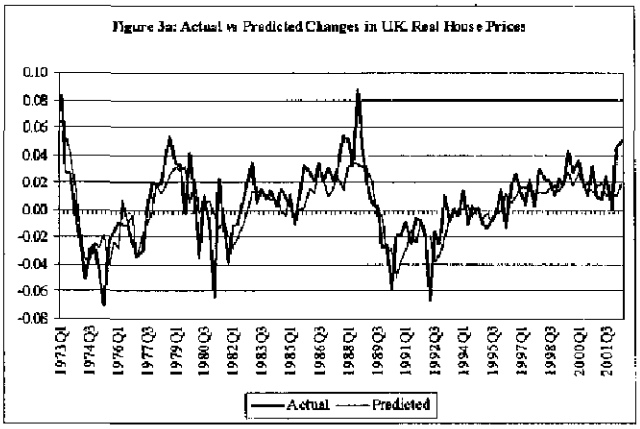

Figure 3a: Actual vs Predicted Changes in UK Real House Prices

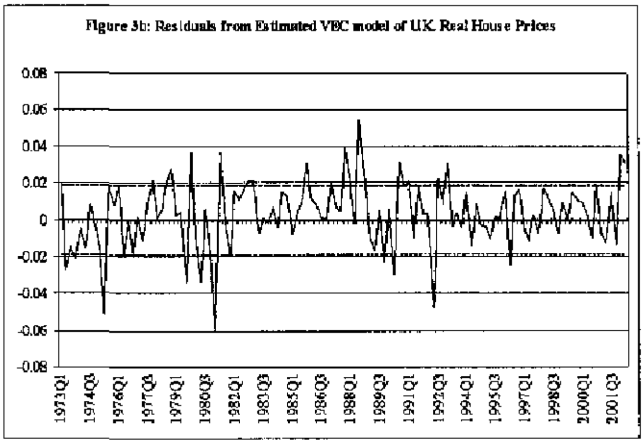

Figure 3b: Residuals from Estimated VEC model of UK Real House Prices

15. **Despite the apparent gap between actual and estimated equilibrium prices as early as 2000, it is only in 2002 that increases in real house prices appear significantly out of line with movements in their determinants.** The residuals of the estimated ECM lie

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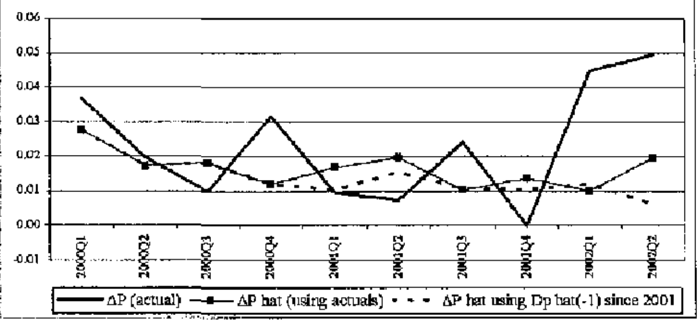
[14] We use the model with real rather than nominal interest rates, as the long-run relationship obtained by this model is not only a better fit for the data but is also theoretically more appealing.

[15] The estimated long-run equilibrium is given by the cointegrating vector for the model with real interest rates in Table 1.

within the 1 standard deviation band up until Q1 2002 (suggesting that the predicted values are reasonably close to the actual house price changes). However, the estimated prices themselves could reflect a possible bubble because they are computed using the lagged actual house prices. Thus, the existence of a bubble could go undetected. To address this concern, we estimate the predicted values for Δp using lagged predicted—rather than actual—values for the 2001–02 period. The results are shown in Figure 4, which compares the actual price increases to the predicted price increases, including those predicted values generated using the method outlined above. This exercise clearly confirms that it is indeed only in the first two quarters of 2002 that the real price increases have been significantly larger than can be explained by adjustments to equilibrium or responses to short-run movements in interest rates nd income.

Figure 4. Actual House Price Changes and Simulation of Model Dynamics, 2001–02



ΔP (actual) refers to the change in real house prices.
ΔP hat (using actual) refers to the predicted value of the change in real house prices using lagged actuals.
ΔP hat using Dp hat (-1) since 2001 refers to the predicted value of the change in real house prices at time t using predicted values of the change in real house prices at t-1.

D. Concluding Remarks

16. **The empirical model of U.K. house prices presented in this chapter focuses on demand-side factors** (income and interest rates) in explaining the type of house price dynamics that we observe in the United Kingdom, as supply is notably unresponsive to price changes. Yet, clearly the rigidity of supply amplifies the price effects of shifts in demand. The empirical model of house prices presented in this chapter shows a 26 percent positive deviation of actual real house prices from their estimated long-run equilibrium in the second quarter of 2002, a relative overvaluation that is nonetheless smaller than that at the peak of the last housing boom in the late 1980s.[16] An error correction specification of changes in real house prices shows that real house prices adjust to their long-run equilibrium while responding to short-run movements in house prices in previous quarters, interest rates, and real income per household. Results show that only in the first half of 2002 did actual house price increases rise significantly above than the price increases predicted by the model, raising the likelihood that recent price increases are unsustainable and can lead to a sharp correction.

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[16] According to the estimated model, at the peak of the housing price boom in the late 1980s the deviation of actual real house prices over their estimated long-run equilibrium was roughly 60 percent.

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Table 1. United Kingdom: House Price Model, Estimation Results, 1972:4 - 2001:3

	Model with Real Interest Rates	Model with Nominal Interest Rates
Cointegrating Vector		
Interest Rate	-0.017	-0.003
	[-1.805]	[-0.150]
Real Income per Household	1.329	0.979
	[5.555]	[2.836]
Error Correction:		
Lagged Deviation from Equilibrium	-0.043	-0.020
	[-3.604]	[-2.194]
Δp (t-1)	0.434	0.399
	[4.461]	[4.204]
Δp (t-2)	0.296	0.267
	[2.837]	[2.654]
Δp (t-3)	0.173	0.231
	[1.698]	[2.334]
Δr (t-1)	-0.004	-0.006
	[-2.562]	[-3.723]
Δr (t-2)	-0.002	-0.003
	[-0.915]	[-1.917]
Δr (t-3)	0.001	-0.002
	[0.431]	[-1.217]
Δy (t-1)	0.235	0.152
	[1.932]	[1.221]
Δy (t-2)	0.033	0.023
	[0.260]	[0.178]
Δy (t-3)	0.092	0.113
	[0.761]	[0.942]
Number of Observations	116	116
Adj. R-squared	0.54	0.56

Constant omited from table
t-statistics in [ ]
All variables except interest rates are in logs. Δ denotes first differences.
p represents real house prices, r represents short-term interest rates, and y represents real income per household.

Table A1: Unit Root Tests, 1972:4 - 2001:3

Variable	*Test Specification*	*Lag*	*ADF t-statistic*
Real House Prices	Levels	2	-1.033
	1st Differences	1	-4.142 **
Real Income Per Household	Levels	1	0.511
	1st Differences	0	-13.933 **
Real 3m Interest Rate	Levels	1	-2.306
	1st Differences	0	-7.726 **
Nominal 3m Interest Rate	Levels	1	-2.310
	1st Differences	0	-8.863 **
Null Hypothesis: Series has a unit root			
Test critical values:	1% level		-3.488
	5% level		-2.887
	10% level		-2.580

*,** Denote rejection of null hypothesis at 5% and 1% significance level, respectively
Lag length is chosen using the Schwartz Information Criterion

Table A2: Lag Order Selection Criteria

The lag length of the VAR system used to perform cointegration analysis was selected using the criteria presented below.

Lag	LogL	FPE	AIC	SC	HQ
0	-155.550	3.09E-03	2.734	2.805	2.763
1	397.146	2.62E-07	-6.640	-6.356	-6.525
2	454.994	1.13E-07	-7.483	-6.984 *	-7.280
3	469.567	1.03E-07 *	-7.579 *	-6.867	-7.290 *
4	476.342	1.07E-07	-7.540	-6.615	-7.165

* indicates lag order selected by the criterion
FPE: Final prediction error
AIC: Akaike information criterion
SC: Schwarz information criterion
HQ: Hannan-Quinn information criterion

Table A3: Cointegration Rank Test

Hypothesized Number of Cointegrating Vectors	Eigenvalue	Trace Statistic	5 Percent Critical Value	1 Percent Critical Value
A. Model with Real Interest Rates				
None **	0.210	47.092	34.91	41.07
At most 1	0.102	19.813	19.96	24.6
At most 2	0.062	7.364	9.24	12.97
B. Model with Nominal Interest Rates				
None *	0.162	40.194	34.91	41.07
At most 1	0.101	19.675	19.96	24.6
At most 2	0.062	7.384	9.24	12.97

*(**) denotes rejection of the hypothesis at the 5%(1%) level

II. Cross-Country Overview of Growth Patterns 1970–2000[1]

A. Introduction

1. **This chapter examines the comparative growth performance of the United Kingdom in relation to a peer group of economies.** In this context, the United Kingdom shows a significant gap in labor productivity. Improving the U.K. productivity performance is one of the main economic objectives of the authorities, as laid out, *inter alia,* in HM Treasury (2000). The sources of this productivity gap and the appropriate policies to close it have been the subject of public debate and lively academic research in recent times.

2. **We study the United Kingdom within a sample of eighteen industrialized countries during the last 30–40 years and discuss the findings in the context of the ongoing public policy debate.** We apply standard growth accounting to a dataset primarily based on the Annual Macroeconomic Database (AMECO) and to a country sample considerably wider than that of other recent research on the subject.[2] Still, the picture that emerges broadly confirms the conclusions of most of the recent academic research: Although the U.K.'s lag in GDP per working-age person is minor with respect to most countries in the sample, except the United States, this largely reflects higher employment rates and hours worked in the United Kingdom than in most other European countries. When output per hour worked is considered, the United Kingdom lags behind most countries in the sample by considerable amounts. In turn, this lag corresponds to differences in total factor productivity (TFP) and, to a lesser extent, a lower capital-labor ratio.

3. The paper is structured as follows. Section B presents the main evidence that can be inferred from observable variables—including the existence of a persistent differential in labor productivity between the United Kingdom and most economies in the sample—and discusses the evolution of these variables over time. Section C introduces the growth accounting methodology used to attribute the productivity gap to its components: TFP and, broadly speaking, capital intensity. It discusses the relative advantages of different decompositions of the productivity gap and the results from these decompositions. Sections D and E discuss the possible factors underpinning the TFP and capital stock gaps respectively. And finally, Section F offers some conclusions.

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[1] Prepared by Julio Escolano.

[2] The AMECO database is maintained by the Directorate General for Economic and Financial Affairs of the European Commission. The countries included in the sample are Australia, Belgium, Canada, Denmark, Finland, France, Germany, Iceland, Ireland, Italy, Japan, the Netherlands, New Zealand, Norway, Spain, Sweden, the United Kingdom, and the United States. To allow cross-country comparability, data are in 1995 US dollars, based on Eurostat's purchasing parity standard exchange rates. Hours worked are obtained from the OECD database. As a matter of convention throughout this paper, for the purposes of numerical calculations and their presentation in figures and tables, one labor unit is defined as 2,088 hours of work (one year of 40-hour weeks).

B. The Output and Productivity Gaps

4. **GDP per working-age person** is perhaps the most immediate measure of an economy's productivity in the use of its endowment of non-reproducible resources—the most important of which is labor in modern economies. The related magnitude GDP per capita is more directly associated to welfare considerations—arguably the ultimate goal of efficiency in the use of resources—but it depends on factors, such as the age composition of the population, which are considered beyond the reach of economic policies, at least in the short to medium term. GDP per working-age person is also the observable magnitude most closely related to the output measure typically modeled in growth theory, where all the labor endowment is assumed to be potentially available for market production and is used to normalize total output.[3]

5. **In the second half of the 1990's,** the U.K.'s level of GDP per working-age person was only slightly below most other countries in the sample, although the gap with respect to some countries such as the United States was significant (about 50 percent, see Table 1). The gap with respect to France and Germany was about 5 percent and slightly negative vis-à-vis Italy.[4] Over time, the gap has declined with respect to the majority of countries in the sample since the early 1980's. Over **the whole 1960-2001 sample period,** the United States maintained a wide lead in GDP per working-age person with respect to all countries in the sample (Figure 1).[5] The

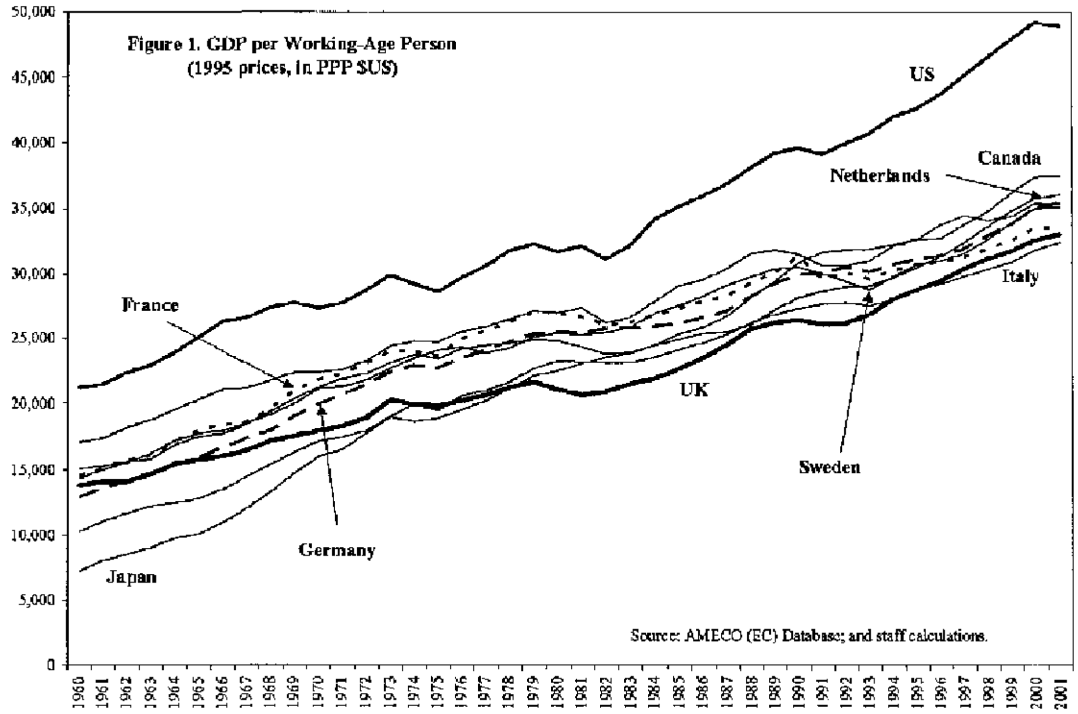

Figure 1. GDP per Working-Age Person (1995 prices, in PPP $US)

[3] See Kehoe and Prescott (2002).

[4] The narrow gap relative to Germany partly reflects the effects of German unification.

[5] For readability, Figures 1–6 do not show all countries in the actual sample. Tables 1–7, however, report the results for all countries in the sample.

lead vis-à-vis the United Kingdom was little changed at about 50 percent of the U.K.'s level. Most other European countries, including France, Germany, and Italy, started in 1960 at a level similar to the United Kingdom. These countries, however, experienced substantial growth in GDP per working-age person over the 1960–1980 period (see Table 3) and narrowed the gap with the United States while leaving the United Kingdom behind. Subsequently, since early in the 1980's, the growth of continental-European countries in output per working-age person declined below that of the United States and the United Kingdom, resulting on a partial reversion towards the U.K. level and a reduction of the U.K. gap with respect to these countries.

6. **This evolution of the GDP per working-age person reflects, in turn, the combined dynamics of labor productivity and average labor input per working-age person.** The broad picture on **labor productivity** (measured as output per hour worked) is that the United Kingdom lost ground with respect to most European countries until well into the 1980's as these countries caught up with the United States; and since then, the United Kingdom maintained its relative position and in some cases regained some ground (Figure 2). Since 1970 to the mid-1990's, the United Kingdom narrowed its gap with the United States, albeit generally at a lower pace than other European countries. Finally, since about 1995, labor productivity in the United States grew at a faster pace than in the United Kingdom and most other large economies in the sample. Thus, the United States appears to be pulling ahead for the first time since the beginning of the sample period (1970) and possibly since much earlier—although this acceleration has taken place only for a few years and it is still too early to consider it a trend.[6]

7. Regarding **average annual hours worked per working-age person**, by the end of the sample period (in 1996–2001), the United Kingdom belongs in a high labor input group with Japan, the United States, Canada, Australia, Iceland and New Zealand (Figure 3). The high labor input in the United Kingdom corresponds primarily to high employment rates—currently about 75 percent, one of the highest in the sample—and also to relatively high hours worked per employee, at least compared with other European countries. In most continental European countries, including France, Germany and Italy, labor input per working-age person is relatively low (roughly ¾ of U.K. and U.S. levels), whereas Nordic-European countries are somewhere in the middle. This is, of course, why continental European countries with high levels of labor productivity (such as France, Belgium, Germany, and the Netherlands) do not exhibit a significant lead with respect to the United Kingdom in GDP per working-age person; while the United States—a high labor productivity and high labor input economy—has a large lead in GDP per working-age person over the United Kingdom and other countries in the sample. Specifically, the U.K.'s catch-up to continental European levels of GDP per working-age person (or per capita) since the early

[6] In particular, the most recent data from the U.K. Office for National Statistics, based on OECD data, do not show this widening of the U.K. productivity differential with respect to the United States.

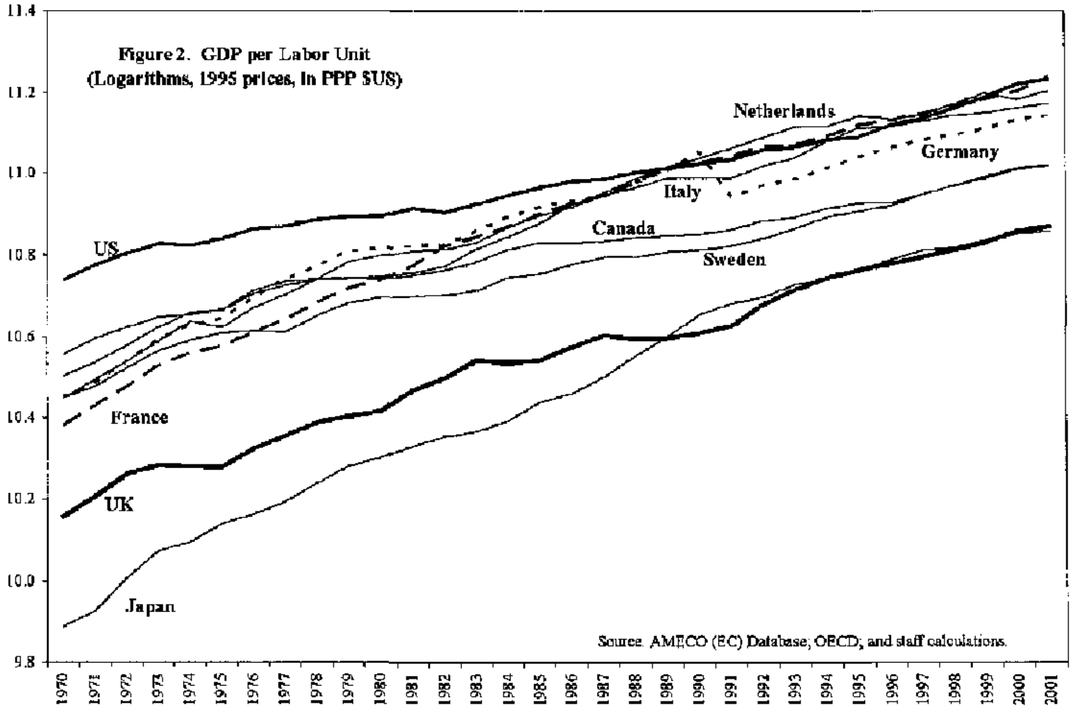
Figure 2. GDP per Labor Unit
(Logarithms, 1995 prices, in PPP $US)
Netherlands
Germany
Italy
Canada
Sweden
US
France
UK
Japan
Source: AMECO (EC) Database; OECD; and staff calculations.
11.4
11.2
11.0
10.8
10.6
10.4
10.2
10.0
9.8

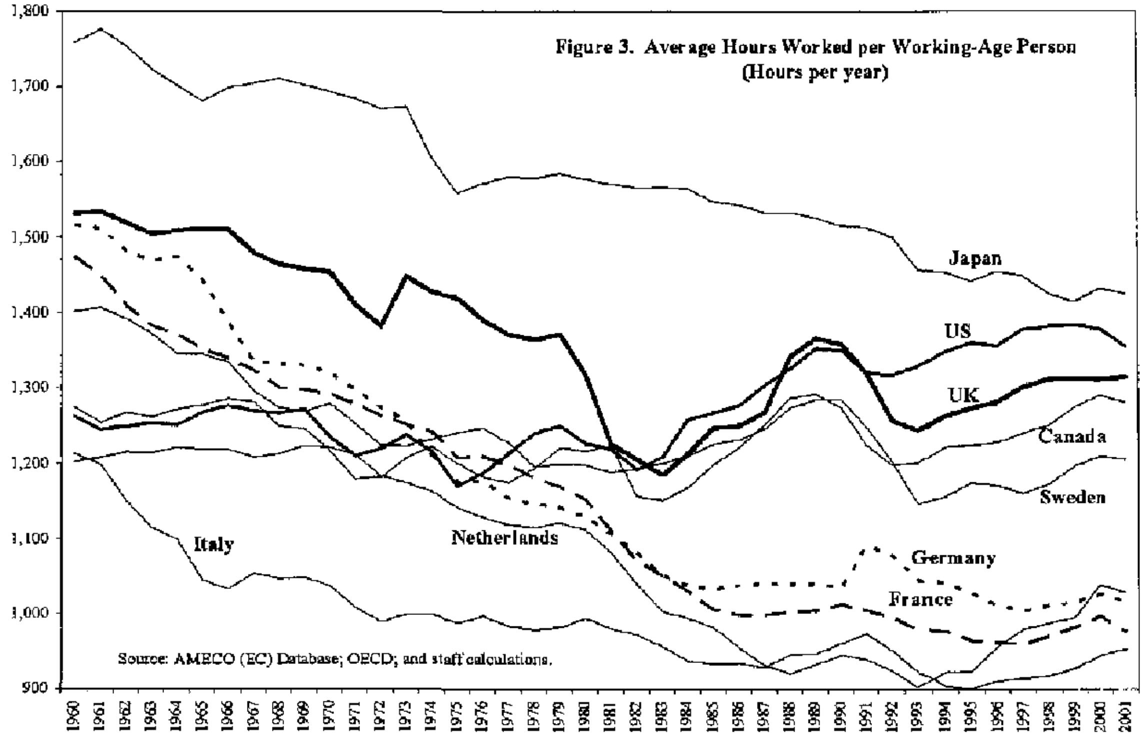
Figure 3. Average Hours Worked per Working-Age Person
(Hours per year)
Japan
US
UK
Canada
Sweden
Italy
Netherlands
Germany
France
Source: AMECO (EC) Database; OECD; and staff calculations.
1,800
1,700
1,600
1,500
1,400
1,300
1,200
1,100
1,000
900

1980's was mainly due to increases in average labor input per person (which was declining in the continent), while productivity growth was broadly similar.[7]

8. **Thus, the evidence indicates that the U. K. economy has a significant deficit in terms of labor productivity levels relative to most peer economies, although this may not be apparent through comparisons of GDP per working-age person (or GDP per capita).** This conclusion is supported by recent research, despite somewhat different methodologies and data sources.[8] The literature indicates that there was already a major U.S. productivity lead over the United Kingdom before World War II, particularly in manufacturing. On the other hand, Germany's and France's overtaking of the United Kingdom in terms of productivity levels is a more recent phenomenon that probably took place in 1950–1970.[9] At the start of the post-war period, the United Kingdom's labor productivity was about 55 percent of U.S. labor productivity, compared with about 40 percent for French and German labor productivity (O'Mahony (1999)). Thus, catch-up and technological imitation could have spurred part of the faster productivity growth in continental Europe vis-à-vis the United Kingdom in the early post-war period. Nevertheless, Crafts (1991) estimates that even when the "catch-up and reconstruction bonus" is discounted, U.K. productivity growth lagged behind continental European countries through the 1970's—a "growth gap" that did not close until the 1980's, when many continental European countries had reached a productivity level similar to the United States. Since the 1980's, although the deterioration of the U.K. relative labor productivity performance was halted (with some catching up in the 1990's), the level gap has remained wide.

9. **Many factors seemed to have contributed to the opening of the U.K. productivity gap during the period under review.** Although an exhaustive survey of these factors is beyond the scope of this paper, the following are among those that have elicited some measure of consensus and attracted most research efforts.[10] Crafts (1996) argues that supply-side policies during the 1950's through the 1970's, while sidestepping necessary structural reforms, focused on poorly-targeted subsidies to investment—which, in turn, was mainly physical fixed investment with little positive externalities and where the social returns were not likely to exceed private returns (Oulton and O'Mahony (1994)). Blundell and others

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[7] The same conclusion is reached, for example, in Card and Freeman (2002).

[8] See Crafts and O'Mahony (2001), O'Mahony and de Boer (2002), HM Treasury (2000), and Hall and Jones (1999).

[9] See Crafts (1991), and Crafts and O'Mahony (2001).

[10] The literature covering this field is too abundant to attempt any comprehensive enumeration of sources. Recent overviews include, among others, Blundell and others (2003), Card and Freeman (2002), Crafts and O'Mahony (2001), MacKinsey Global Institute (1998), Nickell (2002), and O'Mahony (2002).

(2003) and Crafts (1996) point out that a turbulent and confrontational industrial relations environment from the 1950's through the 1980's and macroeconomic instability also contributed to deter investment and technological innovation.[11] Based on a sample of U.K. companies, Nickell and others (1997) finds that the structure of firm ownership in the United Kingdom, with dispersed shareholders and weak constraints on management has militated against better productivity performance. Nickell and others (1997) and Nickell (1996) also find that weak competition was also a factor in the poor productivity performance.

C. Some Growth Accounting

10. **In order to discuss further the U.K. productivity performance, it is useful to allocate productivity levels among constituent factors.**[12] Following standard growth accounting methodologies, we postulate a Cobb-Douglas production function

$$Y_t = A_t K_t^{\alpha} L_t^{(1-\alpha)} \tag{1}$$

where Y_t, K_t and L_t denote output, capital, and labor input respectively in year t. As before, labor input is measured in hours worked. That is, $L = Eh$, the product of the number of employees by (an index of) average hours worked per employee. The factor A_t represents total factor productivity (TFP), an index of the efficiency with which labor and capital are combined in the production of output. Under this formulation, since A_t is calculated as a residual, the contribution from human capital (e.g., workforce skills) is implicitly subsumed into TFP. The parameter α represents the output elasticity with respect to capital and is set to 0.3.[13]

[11] For example, Bean and Crafts (1996) estimates that during 1945–1979, the U.K. framework of industrial relations reduced total factor productivity growth by 0.75–1.1 percent per year.

[12] A summary of the results of the growth accounting calculations is presented in Tables 1–7.

[13] This is the value generally used in the growth accounting literature and is adopted here to facilitate international comparisons. Although α is a technology parameter, under standard equilibrium assumptions it equals the remuneration of capital as a share of total income, which is typically used to calibrate its value. Golling (2002) presents evidence that, when self-employed income is apportioned according to the reported shares for corporate income, 0.3 is a focal value for most countries. In particular, this value is very close to the capital income share in the United Kingdom and the United States. In continental-European countries, it appears that the capital income share as reported in the national accounts is somewhat above 0.3. This however, may reflect market imperfections (e.g., labor market rigidities, non-wage labor costs, etc.) rather than different available technologies, which

(continued)

11. Under these assumptions, labor productivity can be expressed as the product of TFP and a function of the capital-labor ratio.

Decomposition I: $$Y_t / L_t = A_t (K_t / L_t)^{\alpha} \quad (2)$$

When comparing productivity levels across countries, this decomposition allows splitting the productivity differential into the part that is due to the use of more capital per hour worked and the part that is due to more efficient use of given resources (i.e., TFP)—implicitly considering these two magnitudes independent of each other. Specifically, when comparing the United Kingdom to another country, the TFP contribution to the labor productivity differential represents the part of the labor productivity gap that would be closed if TFP levels were equalized between the two countries while keeping constant the capital stock per hour worked in each of them. This decomposition of labor productivity (referred here as Decomposition I) has received the most attention in the current U.K. debate on the causes of economic performance (see O'Mahony and de Boer (2002)).

12. The empirical **results of Decomposition I** are reported in Table 7 for the initial decade of the sample period (1971–1980) and for 1996–2000. They show that a deficit in TFP is the major cause of the U.K. productivity gap relative to other sample countries. The gap in capital stock per hour worked is also positive with respect to all countries except New Zealand, but it is relatively minor with respect to the United States (with which nevertheless a large labor productivity gap exists) and Canada. A low capital-labor ratio in the United Kingdom plays a more significant role in relation to continental European economies such as France, Germany, Italy, and the Netherlands. Over the sample period, the United Kingdom has generally achieved some modest catch-up in labor productivity with respect to other European countries, mainly by narrowing the TFP gap, whereas the relative productivity deficit that can be attributed to a low capital-labor ratio has generally increased somewhat, except with respect to Sweden (see Figures 4 and 5).

13. An alternative decomposition of the sources of the U.K. labor productivity gap can be obtained by expressing it as a function of TFP and the capital-output ratio.

Decomposition II: $$Y_t / L_t = A_t^{1/(1-\alpha)} (K_t / Y_t)^{\alpha/(1-\alpha)} \quad (3)$$

Under Decomposition II, the fraction of the labor productivity gap allocated to TFP represents the increase in labor productivity that would follow from closing the TFP gap, *if the capital-output ratio remained constant.* To see why this measure is useful, consider an economy that increases its TFP, and hence output, while the investment ratio (investment as a proportion of GDP) remains unchanged. Since the increase in output will lead to a larger stock of capital, the capital-labor ratio will increase. Thus, Decomposition I will allocate part

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appears implausible. If the true value of α were above 0.3 in some countries, the calculations presented here would underestimate TFP in those countries.

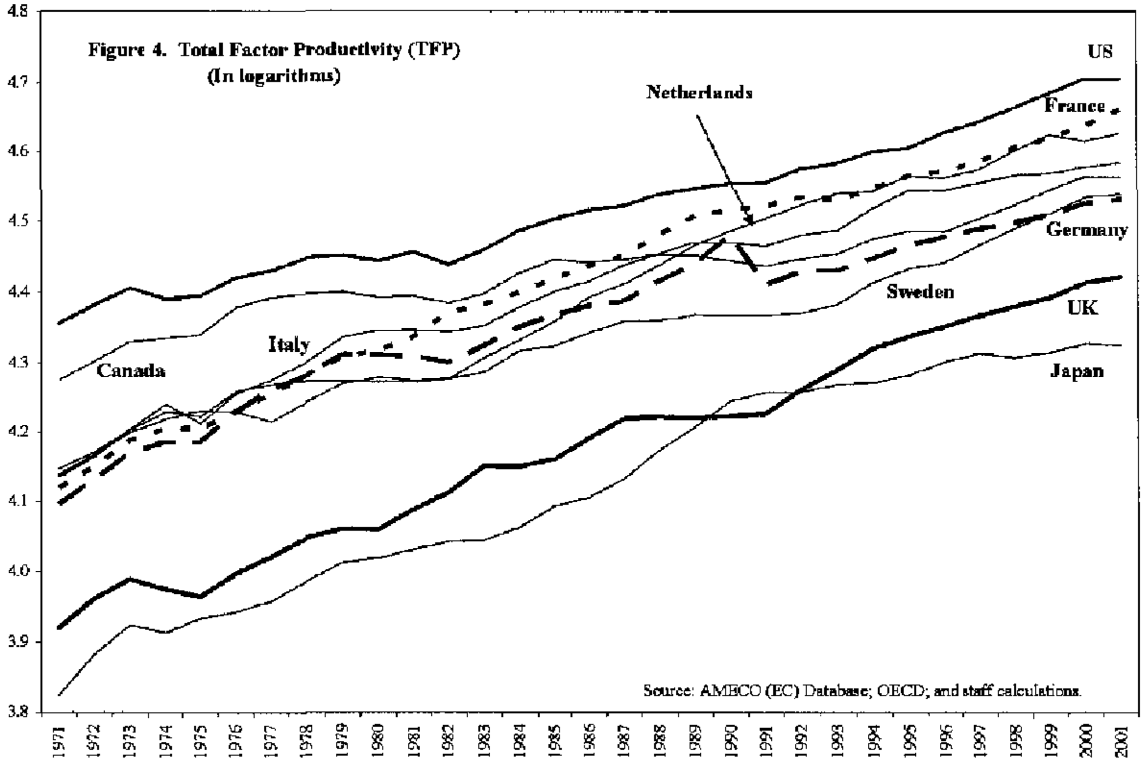


Figure 4. Total Factor Productivity (TFP)
(In logarithms)
US
Netherlands
France
Germany
Sweden
UK
Italy
Canada
Japan
Source: AMECO (EC) Database; OECD; and staff calculations.
4.8
4.7
4.6
4.5
4.4
4.3
4.2
4.1
4.0
3.9
3.8
1971 1972 1973 1974 1975 1976 1977 1978 1979 1980 1981 1982 1983 1984 1985 1986 1987 1988 1989 1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000 2001

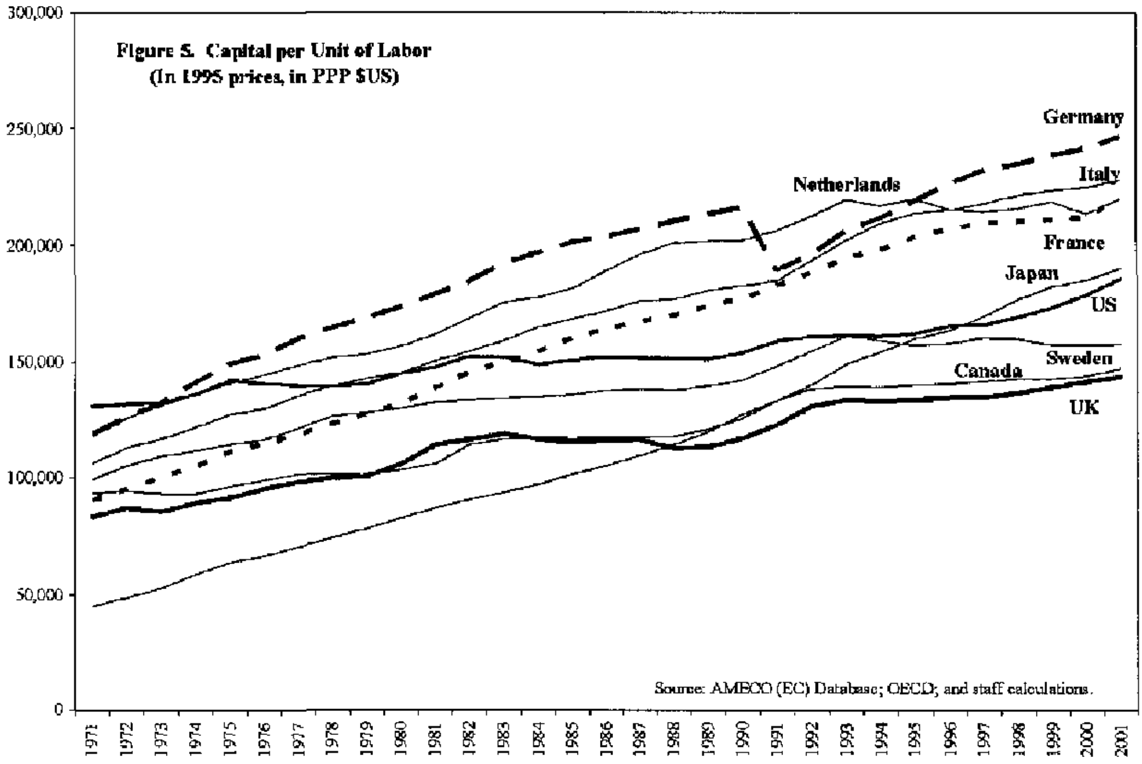


Figure 5. Capital per Unit of Labor
(In 1995 prices, in PPP $US)
Germany
Italy
Netherlands
France
Japan
US
Sweden
Canada
UK
Source: AMECO (EC) Database; OECD; and staff calculations.
300,000
250,000
200,000
150,000
100,000
50,000
0
1971 1972 1973 1974 1975 1976 1977 1978 1979 1980 1981 1982 1983 1984 1985 1986 1987 1988 1989 1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000 2001

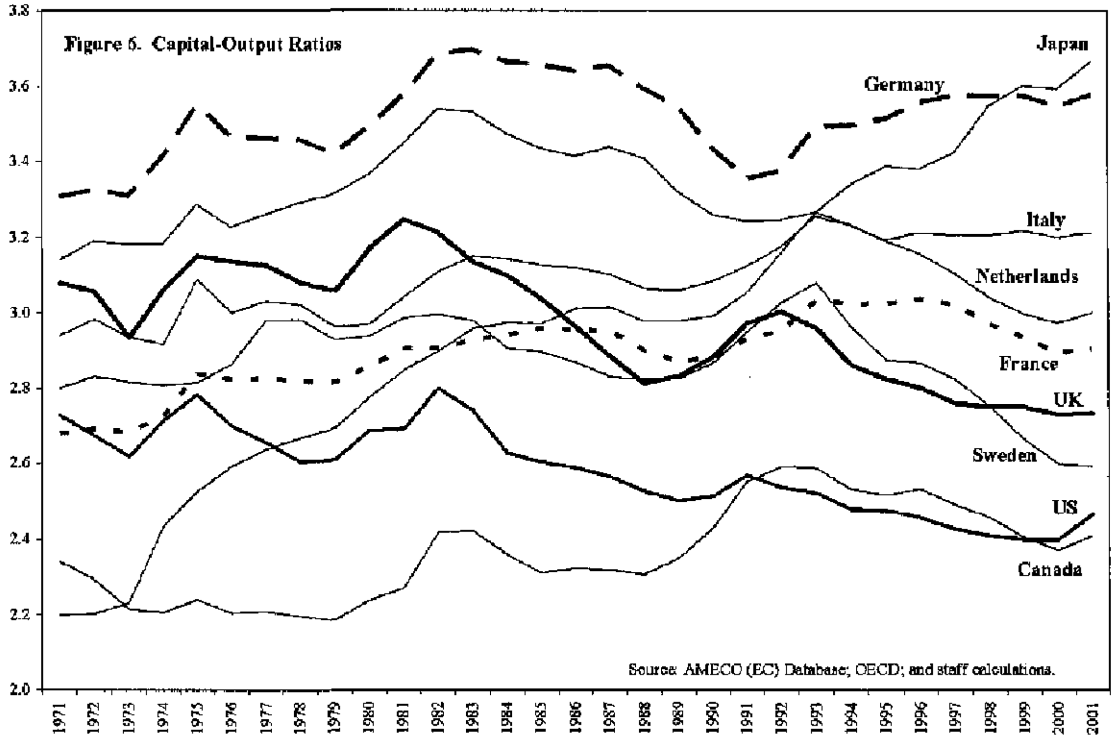
of the increase in output per hour worked to an increase in the capital-labor ratio. In contrast, Decomposition II will allocate the full increase in labor productivity (after the transition period) to the original increase in TFP that triggered the process. Of course, Decomposition I is more useful when increases in the capital-labor ratio (and hence in the capital stock) are considered independent from exogenous increases in TFP and output—even if only for analytical purposes. Decomposition II is more relevant if capital-output ratios tend to remain roughly constant when TFP and output increase—with capital-labor ratios increasing accordingly.[14] Indeed, growth theory does suggest that capital-output ratios should be stable, at least along the balanced-growth path. Also empirically, capital-output ratios do not present an identifiable trend for most countries, although some countries in the sample experienced shifts and oscillations in this ratio during the sample period.

14. Table 7 also reports **the results of performing Decomposition II** for the countries in the sample (see also Figure 6). As it could be expected, even a larger proportion of the U.K. labor productivity gap is allocated to insufficient TFP levels. In 1996–2000, lower capital stock is a relevant factor (say, above 5 percentage points of the productivity gap) only vis-à-vis Germany, Japan, Italy, and the Netherlands; whereas the capital-output ratio gap is negative with respect to Australia, Belgium, Canada, Ireland, Norway, and the United States. In the case of the United States, for example, the labor productivity gap is 42 percent, of which 50 percentage points are due to a comparative deficit in TFP, while a negative -8 percentage points are due to a capital-output ratio gap. This should be interpreted as indicating that if TFP in the United Kingdom reached the levels of the United States while the capital-output ratio remained at its current value, labor productivity in the United Kingdom would exceed the United States by 8 percent—or, alternatively, the United Kingdom could reduce its capital-output and investment ratios while staying at U.S. labor productivity levels.

D. The Gap in TFP

15. **Increasing the level of TFP in the United Kingdom is ultimately the key component in raising labor productivity.** The empirical evidence presented here as well as in other studies indicates that the major source of the U.K.'s low labor productivity levels is a correspondingly low level of TFP. Closing the TFP gap with the United States would raise labor productivity between 33 percent and 50 percent depending of the associated response of investment rates (Table 7). Despite the larger capital stock gap, the TFP gap is also the major cause of U.K. labor productivity differentials with other European economies. Studies based on methodologies that do not rely on growth accounting or an aggregate production function—such as those based on firm-level microeconomic evidence, or sectoral analyses—

[14] Hall and Jones (1999) argues this point. For the opposite viewpoint, see O'Mahony and de Boer (2002). Decomposition II is widely used in the growth literature (see, for example, Mankiw et al. (1992), Hall and Jones (1999), and Kehoe and Prescott (2002)).



confirm the importance of TFP in explaining U.K. productivity differentials.[15] Moreover, TFP growth constitutes the most direct means to improve welfare—presumably the ultimate goal—as it entails expanding the output that can be obtained from any given level of resources. Thus, higher output per capita could be obtained (or more leisure could be afforded) without sacrificing consumption to maintain permanently higher investment ratios.

16. **Although the specific factors underpinning TFP growth and TFP differentials are notoriously difficult to identify, there is mounting evidence of the critical role played by some of them.** The problem is that growth theory and growth accounting analyses based on an aggregate production, while emphasizing the role played by TFP, throw little light on the underlying causes of TFP differentials. This is because TFP is computed (and, in effect defined) as a residual from equation (1) and thus, implicitly encompasses all factors that influence output other than physical capital and labor. Beyond the traditional interpretation as technological knowledge, it also includes many intangibles such as

[15] For example, Crafts and Mills (2001) uses econometric methods to analyze the manufacturing sector while relaxing some standard assumptions in aggregate growth theory (e.g., perfect competition). It concludes that there is no reason to reject the benchmark rankings of British and German TFP performance estimated by conventional growth accounting. See also Baily and Solow (2001) and MacKinsey Global Institute (1998).

economic policies, the quality of labor and management, business practices, and institutional and legal features.[16] Studies of the U.K. productivity performance, trying to see through this TFP "black box," have singled out and underscored the importance of a number of factors influencing U.K. TFP, including its differential vis-à-vis other countries.

17. ***Research and development (R&D).*** There is wide agreement that R&D activity is crucial in raising productivity. Even for economies that are not at the technological frontier, imitation and catch up is not costless, as existing technologies need to be assimilated and adapted to the specific characteristics of markets and economic conditions. Using R&D spending as an indicator, Crafts and O'Mahony (2001) conclude that the United Kingdom shows a significant gap with respect to the United States and Germany, and less so with respect to Japan and France. The gap with the United States is particularly pronounced in manufacturing. HM Treasury (2000), based on OECD data, also argues that the U.K. economy has an important deficit in this area with respect to the United States, France, and Germany and that the differential widened over the 1990's. Crafts and O'Mahony (2001), using estimated elasticities of output with respect to R&D spending, conclude that virtually all the U.K. gap in TFP with respect to the United States can be ascribed to the differential in R&D spending between the two countries. A related issue is whether R&D spending results in productivity spillovers beyond the firm that undertakes the expenditure. This, in turn, would imply that, in the absence of remedial measures, R&D is likely to be undersupplied, as the social return would exceed the private, appropriable return. Although the debate on the existence of spillovers is far from closed, a substantial number of empirical studies find corroborative evidence.[17] By combining company accounts data and industry information in five countries (France, Germany, Japan, United Kingdom, and United States), O'Mahony and Vecchi (2002) find evidence of both a relation between output growth and R&D spending (except in Japan) and of productivity spillovers of R&D spending.

18. ***Human capital.*** Differentials in the stock of human capital appear to underpin TFP differentials between the United Kingdom and other European countries, but less so with respect to the United States. Based on the workforce composition by educational attainment, Crafts and O'Mahony (2001) considers that most of the TFP gap with respect to Germany and France can be attributed to a

Table 8. Workforce Qualifications, 1998

(As percent of the workforce, total economy)

	UK	USA	Germany	France
High	16.6	24.1	13.5	16.4
Intermediate	34.6	18.1	63.8	51.2
Low or none	48.8	57.8	22.7	32.4

Source: Crafts and O'Mahony (2001).

[16] Hall and Jones (1999) and Prescott (1997).

[17] See Griliches (1992) and Jones and Williams (1998). The latter finds that, owing to spillovers, optimal R&D investment is at least two to four times actual investment. OECD (2002) reports evidence that R&D has a large long-term effect on TFP.

deficit of intermediate skills in the United Kingdom (Table 8). Other studies also show a significant contribution of workforce skills to productivity growth in the United Kingdom. For example, Lau and Vaze (2002) estimates that increases in labor force skill contributed with about 26 percent of total labor productivity growth in 1995–2000; and Haskel and Pereira (2002), using matched establishment and worker data, finds a strong association between the position of a business in the productivity distribution and use of employees with high human capital—which in turn, appears more related to education than to work experience.

19. ***Competition environment.*** Although from a theoretical standpoint the effect of competition on TFP is ambiguous, factual evidence for the United Kingdom points strongly to a positive effect.[18] Based on a sample of U.K. firms, Nickell (1996) finds that competition, as measured by increased number of competitors or by lower levels of rents, is associated with a significantly higher TFP growth.[19] Based on U.K. firm-level data as well, Nickell and others (1997) finds further evidence of positive effects of competition on TFP growth. It also finds a positive effect on TFP from the existence of a dominant shareholder and financial market pressures, suggesting that competition acts as a substitute for shareholder control and lenders' oversight in spurring and focusing management efforts at improving efficiency and innovation—thus, mitigating agency (principal-agent) costs, considered one of the causes of the U.K. sluggish productivity performance.[20] These results are consistent with evidence that innovations tend to occur more frequently in firms with larger market share. Blundell and others (1999) reports evidence that, within an industry, the number of innovations and patents is strongly correlated with market share but also that less competitive industries (lower import penetration or higher concentration) had fewer innovations in the aggregate. It argues that competition prompts pre-emptive innovation among market-share leaders to retain their position. In addition, the direction of causality between innovation and market share could plausibly be that innovative firms capture market share displacing more conservative ones and, at any point in time, this "competitive selection" results in a larger market share of innovative firms. In other words, in addition to causing incumbent's pre-emptive innovation, competition also contributes significantly to TFP growth by the exit of

[18] This ambiguity is well conveyed by the Schumpeterian idea of "creative destruction." While market power offers entrepreneurs the possibility of reaping the rents from innovation, competition—including fluid entry and exit of firms—provides a sharper incentive to innovate and is necessary for the innovations to prevail and spread, contributing to generalized growth and renewal of the innovation cycle (Nickell (1996), Blundell and others (1999)).

[19] OECD (2002) discusses the effect of product market competition. Based on existing evidence for OECD countries, it argues that competition has positive and sizable effects on TFP through innovation and technology diffusion.

[20] Nickell (2002), Crafts and O'Mahony (2001).

inefficient firms, their replacement by more innovative entrants, and the expansion of the latter's market share. Micro-data studies indicate that the entry and exit of firms and the expansion of more efficient establishments accounted for between one third and half of the productivity growth in the United Kingdom during the 1990's and an even larger share of TFP growth.[21]

20. ***Spillovers from new physical capital.*** A possible source of TFP is that investment in certain types of capital may enhance the productivity of labor above and beyond what is implied by their measured contribution to the capital stock. This could occur if investment in some types of capital produced efficiency gains in the use of other resources or positive spillovers in other firms (e.g., through network externalities). The most obvious candidate for these effects in recent years is investment in ICT equipment. However, the evidence on the contribution to U.K. TFP from ICT capital investment (i.e., ICT usage as opposed to ICT production) is mixed and tends to point to a modest, if any, increase in TFP.[22] Investment in ICT equipment has probably contributed significantly to overall labor productivity—specially when deflators are corrected for possible mismeasurement. But until now, the contribution of ICT in the United Kingdom seems to have been almost exclusively through capital deepening (higher capital-labor ratios) and higher productivity in ICT-producing industries, rather than by enhancing TFP economy-wide.

E. The Gap in Capital Stock

21. **The current public and academic debate on the causes of U.K. low labor productivity has emphasized the role of the U.K.'s low capital stock.**[23] There are a number of factors supporting this view. First, the United Kingdom lags behind comparable economies in terms of its capital-labor ratio. Although this lag appears quantitatively less important than the lag in TFP, it is still significant. Table 2 and Figure 5 show that, in the 1990's, the U.K. capital-labor ratio was below all other countries in the sample except Australia and New Zealand. And Table 7 shows that according to the Decomposition I of labor productivity, the low U.K. capital-labor ratio accounts for a substantial part of the productivity gap (although less than the TFP gap, as discussed above). Second, even if the primary goal were to increase TFP, this would still imply investment in new capital equipment. Although some theoretical analysis may model TFP as "manna from heaven," there is abundant evidence that increasing TFP involves associated increases in the capital stock. This new capital may be required, for example, to take advantage of new technologies and higher skills or to permit the reorganization of work and management practices.

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[21] See Disney and others (2000) and Barnes and Haskel (2000, 2001, and 2002).

[22] See Oulton (2002) and Kodres (2001).

[23] See HM Treasury (2000) and Crafts and O'Mahony (2001).

22. **Some considerations, however, argue for tempering the emphasis on the U.K. capital gap.** Most of the evidence of the U.K. relative shortfall in capital stock is based on comparisons with continental European countries (which also dominate our sample) and Japan. These countries appear to have followed a path to higher productivity driven to a large extent by high capital intensity. Japan and some continental European countries—notably Germany, Italy, and the Netherlands—exhibit particularly high capital-output ratios, even when compared to countries that have higher productivity. In fact, the capital-output ratios of Australia, Belgium, Canada, Ireland, Norway, Sweden, and the United States are all below that of the United Kingdom despite large productivity leads in the case of many of these countries (Tables 1–2). Thus, a cross-country comparison offers no evidence that closing the U.K. productivity gap will require a higher capital-output ratio. As discussed above, increasing TFP and output per hour worked while keeping the capital-output ratio close to its current value would entail a higher capital-labor ratio. But the latter does not need to reach the high levels prevailing, for example, in Germany or Italy. Further, it is unclear that the high capital-output and capital-labor ratios prevailing in many continental European countries are an efficient technological response to economic conditions rather than a result of labor market rigidities or other distortions.[24]

23. **The evidence suggests that a large part of the U.K.'s capital-labor ratio gap reflects a low stock of government capital.** The paucity of data in this area (particularly cross-country) is still a serious obstacle in reaching conclusions. Nevertheless, O'Mahony and de Voer (2002) and O'Mahony (1999) estimate that U.K. capital-labor ratios in market sectors (defined to exclude the general government) show a smaller gap than in the overall economy. They conclude that the overall capital gap is particularly pronounced in the government sector. This is consistent with other studies, including the companion paper "U.K. Investment: Is There a Puzzle?" in this *Selected Issues* volume. This raises the question of how much of a boost in productivity can be expected from closing the U.K. gap in public capital. An increase in the government capital stock would presumably increase productivity in the public sector—in the activities and delivery of public services where the new capital is used. But the extent to which higher public investment results in higher private sector productivity is hardly a matter of consensus among economists. Although few observers would argue against productivity spillovers from, for example, well-targeted public investment in transportation infrastructure,

[24] The conjecture is that that labor market distortions may lead to higher capital intensity than would otherwise be dictated by efficiency considerations. Chapter III, ("U.K. Investment: Is There a Puzzle?") finds a significant positive effect of employment protection practices on investment rates in a panel of countries. Blanchard (1997) argues that, in continental Europe, as real wages failed to adjust to the productivity slowdown and supply shocks of the 1970's, firms reacted by moving away from labor. This eventually led to increases in unemployment and adoption of capital intensive technologies. Caballero and Hammour (1998) also finds evidence in this direction—for example, a strong positive correlation between the increase in dismissal restrictions and the increase in the capital-labor ratio.

the empirical evidence of spillovers from general public capital is inconclusive. On the one hand, based on U.S. data, Lynde and Richmond (1992), for example, finds that public capital is a significant input in reducing private sector costs and that private and public capital are complements rather than substitutes. Among studies that find positive effects, the elasticity of private-sector TFP with respect to public capital is often found to be about ⅓. On the other hand, other studies find no significant (and on occasion negative) effects. For instance, with U.S. and Netherlands data, Sturm and Haan (1995) finds no evidence of spillovers when first differences are employed—which it argues, ought to be employed since the relevant variables are neither stationary nor cointegrated.[25]

F. Conclusions

24. **We have examined the growth performance of the United Kingdom against a wide sample of 18 advanced economies.** The results indicate that, in terms of **GDP per working-age person**, the United Kingdom lags with respect to most economies in the sample—although the differential is not large, except with respect to the United States. When controlling for the high employment rates and per-employee hours worked, however, the resulting U.K. gap in **output per hour worked (labor productivity)** is substantial with respect to most countries in the sample and has remained so over time. While other large European economies achieved labor productivity levels similar to the United States during the 1980's, the United Kingdom has maintained a gap of about 40 percent.

25. **Growth accounting techniques used to decompose the labor productivity gap indicate that the main element behind the U.K. lag is low levels of TFP.** From a policy standpoint, although the TFP measure encompasses a multiplicity of factors, a number of them appear to be crucial in fostering a catch up with comparable economies. Increasing R&D activity and enhancing competition would have a significant positive effect on entrepreneurship and innovation. These factors alone could explained most of the U.K. TFP lag with respect to the United States. In addition, the skill composition of the U.K. workforce is tilted towards the low end in comparison with other European countries, where intermediate skills are stronger—which, in turn, could explain a large part of the differential with respect to these economies.

26. **U.K. capital stocks also show a comparative deficit with respect to some countries—although it is not very pronounced and the evidence is less conclusive.** The capital-labor ratio of the United Kingdom is below most other countries in the sample. In contrast, the U.K. capital-output ratio is higher than in many other countries with higher labor productivity, including the United States. Thus, the evidence does not support the need to increase substantially the current investment rates (and consequently the capital-output ratio).

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[25] Other studies have focused on government size, finding a negative effect on growth (e.g., Dar and AmirKhalkhali (2002)). This strain of the literature, however, highlights the distortive effects of higher taxes or deficits associated with higher government spending (see Tanzi and Zee (1997)) rather than the direct effect of public capital on the private production possibility frontier.

In fact, the higher capital-output ratios of some countries in the sample could reflect inefficiencies in the use of resources. The U.K. capital stock and capital-labor ratio, however, will need to increase in parallel with and as part of the process of increasing TFP. Much of the U.K.'s gap with regard capital-labor ratios appears to be concentrated in the public sector. Thus, it is critical that higher public investment be efficient, if it is to help close the U.K.'s productivity gap.

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Table 1. Growth Accounting: International Comparison of Levels (I)
(UK=100, 1995 US dollars at 1995 PPP exchange rates)

	1961–70	1971–80	1981–90	1991–2000	1996–2000
GDP per working-age person					
Australia	118.8	114.8	112.3	108.0	108.4
Belgium	100.1	114.1	114.8	113.7	112.3
Canada	127.5	124.5	124.7	113.9	112.6
Denmark	127.3	129.7	125.2	116.1	115.3
Finland	85.9	96.7	109.6	100.5	102.5
France	103.4	115.4	115.4	109.1	106.3
Germany	114.0	122.6	119.6	106.5	103.1
Iceland	113.3	126.7	139.8	121.6	120.8
Ireland	70.9	78.3	84.8	102.6	111.4
Italy	86.1	100.5	105.8	100.2	97.9
Japan	70.7	97.1	111.6	114.0	110.8
Netherlands	111.9	117.5	108.4	108.1	108.1
New Zealand	132.6	115.1	102.5	87.8	86.4
Norway	93.7	106.9	121.4	125.0	127.3
Spain	67.4	81.8	78.5	78.2	77.6
Sweden	112.1	116.9	119.2	107.3	105.6
United Kingdom	*100.0*	*100.0*	*100.0*	*100.0*	*100.0*
United States	157.7	148.4	151.5	150.1	149.8
GDP per unit of labor 1/					
Australia	136.3	123.8	114.4	109.0	109.0
Belgium	126.5	149.1	155.9	161.0	161.0
Canada	151.1	144.3	129.3	118.7	116.8
Denmark	123.1	133.3	133.6	131.7	130.1
Finland	89.5	99.7	105.0	116.9	119.4
France	114.9	132.4	142.6	143.5	142.2
Germany	121.8	143.0	144.4	132.7	132.5
Iceland	110.9	123.6	122.3	115.0	113.5
Ireland	72.4	88.4	103.9	126.7	134.4
Italy	119.5	140.7	141.4	139.4	138.3
Japan	61.7	84.0	91.6	101.1	100.6
Netherlands	137.4	142.5	141.1	145.2	142.0
New Zealand	142.7	115.6	100.4	90.4	87.3
Norway	111.0	129.5	138.1	149.5	151.5
Spain	77.7	95.3	108.1	104.6	102.4
Sweden	126.3	132.7	122.5	116.8	116.4
United Kingdom	100.0	100.0	100.0	100.0	100.0
United States	187.1	169.4	150.4	142.5	141.9
Labor input per working-age person 1/			(Index)		
Australia	86.9	92.7	98.3	99.0	99.5
Belgium	79.3	76.8	73.8	70.7	69.8
Canada	84.3	86.2	96.5	96.0	96.4
Denmark	103.7	97.5	94.0	88.1	88.6
Finland	96.2	97.0	104.6	86.0	85.8
France	90.4	87.4	81.3	76.1	74.7
Germany	94.2	86.0	83.0	80.5	77.8
Iceland	102.1	102.7	114.6	105.8	106.4
Ireland	98.3	88.9	81.9	80.5	82.7
Italy	72.5	71.3	75.0	72.0	70.8
Japan	114.7	115.7	122.2	113.0	110.2
Netherlands	81.3	82.5	77.3	74.3	76.1
New Zealand	92.7	99.4	102.4	97.1	99.0
Norway	84.7	82.6	88.1	83.5	84.0
Spain	86.8	86.4	72.9	74.7	75.7
Sweden	89.0	88.0	97.4	92.0	90.7
United Kingdom	100.0	100.0	100.0	100.0	100.0
United States	84.1	87.5	100.7	105.3	105.6

Sources: AMECO database; OECD; and staff calculations.

1/ One unit of labor is defined as 2,088 hours of work (one year of 5-day weeks, 8-hour days).

Table 2. Growth Accounting: International Comparison of Levels (II)
(UK=100)

	1961–70	1971–80	1981–90	1991–2000	1996–2000
TFP			(Index)		
Australia	127.6	122.4	113.3	109.3	109.3
Belgium	121.1	140.3	142.6	142.8	141.5
Canada	139.5	142.5	128.8	117.1	115.5
Denmark	117.1	122.0	120.6	119.3	118.5
Finland	91.0	97.7	100.7	107.7	111.4
France	112.7	125.5	129.2	126.8	125.1
Germany	112.2	124.4	122.3	114.3	112.7
Iceland	108.3	118.3	117.3	109.9	109.1
Ireland	79.1	90.0	97.4	118.1	125.9
Italy	113.7	128.2	126.2	121.7	119.9
Japan	76.1	94.2	94.3	95.6	93.4
Netherlands	123.8	126.2	122.3	126.0	124.0
New Zealand	132.1	115.6	100.3	91.4	89.0
Norway	107.5	119.7	122.6	132.2	134.2
Spain	89.4	103.8	108.5	102.3	99.7
Sweden	119.8	124.5	116.5	111.3	111.5
United Kingdom	100.0	100.0	100.0	100.0	100.0
United States	158.8	151.0	138.8	133.7	132.9
Capital per unit of labor 1/	(1995 US dollars at 1995 PPP exchange rates)				
Australia	124.7	103.9	103.1	99.0	98.9
Belgium	115.0	122.2	134.2	149.1	153.7
Canada	130.5	104.3	101.1	104.6	103.8
Denmark	117.5	134.3	140.7	139.3	136.7
Finland	94.5	107.1	114.6	131.8	126.2
France	105.8	119.3	138.6	150.9	153.2
Germany	130.8	158.8	173.6	164.2	171.3
Iceland	108.6	115.0	114.8	116.3	114.1
Ireland	74.1	93.8	123.8	126.7	124.0
Italy	117.3	136.1	145.9	157.5	160.9
Japan	48.8	68.5	90.4	120.6	128.1
Netherlands	141.5	149.9	160.7	160.9	157.3
New Zealand	129.7	100.5	100.5	96.4	93.8
Norway	110.9	129.7	148.2	150.6	149.8
Spain	62.1	75.3	98.7	107.6	109.4
Sweden	119.0	123.8	118.0	117.5	115.6
United Kingdom	100.0	100.0	100.0	100.0	100.0
United States	172.8	146.8	130.8	123.9	124.4
Capital-output ratio					
Australia	91.9	83.9	90.0	90.8	90.8
Belgium	91.4	81.9	86.0	92.4	95.5
Canada	87.0	72.3	78.1	88.1	88.9
Denmark	95.6	100.5	105.2	105.7	105.1
Finland	105.4	107.1	109.1	113.6	106.0
France	92.5	90.0	97.0	105.0	107.8
Germany	107.1	110.9	120.1	123.4	129.3
Iceland	98.0	93.3	93.8	101.2	100.5
Ireland	102.2	105.9	119.0	101.4	92.8
Italy	98.4	96.7	103.0	112.7	116.3
Japan	80.9	80.9	98.4	118.8	127.2
Netherlands	102.9	105.2	113.8	110.7	110.8
New Zealand	91.1	87.1	99.8	106.6	107.4
Norway	100.0	99.9	107.1	100.9	98.8
Spain	80.6	78.5	91.2	102.6	106.7
Sweden	94.4	93.2	96.3	100.7	99.4
United Kingdom	100.0	100.0	100.0	100.0	100.0
United States	92.7	86.7	86.9	86.8	87.7

Sources: AMECO database; OECD; and staff calculations.
1/ One unit of labor is defined as 2,088 hours of work (one year of 5-day weeks, 8-hour days).

Table 3. Growth Accounting: International Comparison of Growth Rates (I)
(In percent)

	1961–70	1971–80	1981–90	1991–2000	1996–2000
GDP per working-age person					
Australia	3.1	1.2	1.2	2.3	2.5
Belgium	4.6	2.7	1.7	2.1	2.7
Canada	2.7	1.9	1.6	1.8	2.8
Denmark	3.9	1.5	1.1	2.0	2.5
Finland	3.8	3.0	2.7	1.9	4.8
France	4.4	2.5	1.6	1.6	2.4
Germany 1/	4.2	2.1	1.5	1.7	1.8
Iceland	2.8	4.5	1.3	1.5	3.6
Ireland	3.9	3.0	2.8	5.4	7.7
Italy	5.2	3.1	1.6	1.5	2.0
Japan	8.2	3.5	3.2	1.4	1.6
Netherlands	3.5	1.5	1.3	2.4	3.3
New Zealand	1.5	0.1	0.8	1.5	1.5
Norway	3.5	4.1	1.7	3.0	2.8
Spain	6.6	2.4	2.0	2.1	3.4
Sweden	3.9	1.8	1.8	1.4	2.7
United Kingdom	2.6	1.6	2.3	2.1	2.5
United States	2.5	1.5	2.3	2.2	2.9
GDP per unit of labor 2/					
Australia	2.7	1.9	1.0	2.0	2.2
Belgium	5.3	4.3	2.1	2.6	2.8
Canada	3.2	1.9	1.1	1.6	1.8
Denmark	4.9	3.1	2.2	1.7	1.4
Finland	4.6	3.5	3.1	3.3	3.4
France	5.8	3.6	2.9	1.8	1.7
Germany 1/	5.6	3.7	2.4	2.5	1.8
Iceland	3.1	5.1	1.2	1.2	1.8
Ireland	5.0	4.7	3.9	4.6	5.6
Italy	6.9	3.6	2.0	1.7	1.0
Japan	8.6	4.2	3.6	2.0	1.8
Netherlands	3.3	2.5	2.9	1.5	0.8
New Zealand	1.6	0.3	1.9	0.9	1.4
Norway	4.8	4.6	2.4	2.8	2.3
Spain	6.9	4.6	2.7	1.5	1.0
Sweden	4.9	2.5	1.2	2.0	2.0
United Kingdom	3.2	2.6	2.0	2.5	1.9
United States	2.8	1.6	1.3	2.0	2.6
Labor input per working-age person 2/					
Australia	0.4	-0.7	0.2	0.3	0.3
Belgium	-0.7	-1.5	-0.4	-0.5	-0.1
Canada	-0.5	0.0	0.5	0.1	1.1
Denmark	-1.0	-1.6	-1.1	0.3	1.0
Finland	-0.8	-0.4	-0.3	-1.3	1.4
France	-1.3	-1.1	-1.3	-0.2	0.7
Germany 1/	-1.4	-1.5	-0.9	-0.8	0.0
Iceland	-0.3	-0.6	0.1	0.3	1.8
Ireland	-1.0	-1.6	-1.1	0.8	2.0
Italy	-1.6	-0.4	-0.3	-0.2	1.0
Japan	-0.4	-0.7	-0.4	-0.6	-0.1
Netherlands	0.1	-0.9	-1.6	0.9	2.4
New Zealand	0.0	-0.3	-1.1	0.6	0.1
Norway	-1.3	-0.5	-0.6	0.2	0.5
Spain	-0.3	-2.0	-0.7	0.6	2.4
Sweden	-0.9	-0.6	0.7	-0.6	0.6
United Kingdom	-0.5	-1.0	0.3	-0.4	0.6
United States	-0.2	-0.1	1.0	0.2	0.3

Sources: AMECO database; OECD; and staff calculations.

1/ Growth rates are spliced to avoid a discontinuity at the time of unification. Growth rates are West Germany for 1960–1991 and for unified Germany thereafter.

2/ One unit of labor is defined as 2,088 hours of work (one year of 5-day weeks, 8-hour days).

Table 4. Growth Accounting: International Comparison of Growth Rates (II)
(In percent)

	1961–70	1971–80	1981–90	1991–2000	1996–2000
TFP					
Australia	2.4	1.2	0.6	1.7	1.8
Belgium	4.2	2.9	1.5	1.8	2.1
Canada	2.9	1.5	0.5	1.2	1.6
Denmark	3.6	1.8	1.6	1.6	1.3
Finland	3.1	2.2	2.2	2.9	3.7
France	4.4	2.3	2.0	1.2	1.4
Germany 1/	3.7	2.4	1.7	1.6	1.2
Iceland	2.1	3.9	0.8	1.0	1.7
Ireland	3.4	3.0	2.8	4.3	5.4
Italy	4.9	2.4	1.2	1.1	0.7
Japan	7.1	2.1	2.3	0.8	0.9
Netherlands	2.2	1.5	2.1	1.3	1.0
New Zealand	1.5	-0.1	1.1	0.9	1.0
Norway	3.3	3.1	1.5	2.5	1.8
Spain	5.6	2.7	1.9	0.8	0.8
Sweden	3.7	1.5	0.9	1.7	2.0
United Kingdom	2.2	1.7	1.7	1.9	1.5
United States	2.2	1.1	1.1	1.5	2.0
Capital per unit of labor 2/					
Australia	1.1	2.3	1.3	1.1	1.4
Belgium	3.6	4.3	1.9	2.9	2.6
Canada	0.9	1.2	1.9	1.4	0.6
Denmark	4.4	4.4	2.0	0.6	0.4
Finland	5.1	4.0	2.9	1.2	-1.1
France	4.6	4.3	3.0	1.8	0.8
Germany 1/	6.5	4.5	2.2	2.8	2.0
Iceland	3.4	4.0	1.5	0.8	0.2
Ireland	5.5	5.5	3.7	1.0	0.7
Italy	6.3	4.0	2.3	2.1	1.0
Japan	4.9	7.1	4.4	3.9	3.0
Netherlands	3.7	3.3	2.6	0.5	-0.6
New Zealand	0.3	1.5	2.6	0.1	1.3
Norway	4.8	5.0	2.8	1.1	1.5
Spain	4.1	6.1	2.8	2.3	0.7
Sweden	3.9	3.2	0.9	1.0	0.0
United Kingdom	3.3	3.0	1.0	1.9	1.2
United States	1.8	1.4	0.6	1.5	2.0
Capital-output ratio					
Australia	-1.6	0.4	0.3	-0.9	-0.7
Belgium	-1.6	0.1	-0.2	0.3	-0.3
Canada	-2.2	-0.7	0.8	-0.2	-1.2
Denmark	-0.5	1.3	-0.2	-1.1	-1.0
Finland	0.4	0.6	-0.2	-2.0	-4.3
France	-1.1	0.7	0.1	0.0	-0.9
Germany 1/	0.8	0.7	-0.2	0.3	0.2
Iceland	0.3	-1.0	0.3	-0.5	-1.6
Ireland	0.4	0.8	-0.2	-3.5	-4.6
Italy	-0.5	0.4	0.4	0.4	0.0
Japan	-3.4	2.8	0.8	1.8	1.2
Netherlands	0.4	0.8	-0.3	-0.9	-1.4
New Zealand	-1.3	1.2	0.7	-0.8	-0.1
Norway	0.0	0.4	0.4	-1.7	-0.8
Spain	-2.6	1.5	0.1	0.8	-0.3
Sweden	-0.9	0.7	-0.2	-1.0	-2.0
United Kingdom	0.2	0.4	-0.9	-0.5	-0.7
United States	-0.9	-0.2	-0.7	-0.5	-0.6

Sources: AMECO database; OECD; and staff calculations.

1/ Growth rates are spliced to avoid a discontinuity at the time of unification. Growth rates are West Germany for 1960–1991 and for unified Germany thereafter.

2/ One unit of labor is defined as 2,088 hours of work (one year of 5-day weeks, 8-hour days).

Table 5. Growth Accounting: International Comparison of Levels (I)
(1995 US dollars at 1995 PPP exchange rates)

	1961–70	1971–80	1981–90	1991–2000	1996–2000
GDP per working-age person					
Australia	18,913	23,189	26,250	31,440	33,659
Belgium	15,942	23,036	26,841	33,097	34,862
Canada	20,306	25,145	29,143	33,163	34,973
Denmark	20,274	26,195	29,273	33,801	35,801
Finland	13,679	19,535	25,611	29,249	31,828
France	16,474	23,312	26,984	31,748	33,001
Germany	18,155	24,758	27,949	31,017	32,010
Iceland	18,043	25,579	32,685	35,403	37,496
Ireland	11,286	15,803	19,817	29,880	34,577
Italy	13,717	20,287	24,724	29,171	30,397
Japan	11,258	19,609	26,084	33,200	34,400
Netherlands	17,826	23,722	25,340	31,455	33,563
New Zealand	21,112	23,243	23,962	25,546	26,842
Norway	14,929	21,586	28,370	36,393	39,537
Spain	10,738	16,525	18,359	22,752	24,093
Sweden	17,857	23,602	27,867	31,250	32,791
United Kingdom	15,926	20,196	23,374	29,111	31,050
United States	25,123	29,974	35,415	43,703	46,520
GDP per unit of labor 1/					
Australia	30,375	37,605	44,034	51,454	54,224
Belgium	28,196	45,278	59,995	76,024	80,079
Canada	33,667	43,830	49,755	56,029	58,122
Denmark	27,430	40,488	51,434	62,196	64,720
Finland	19,946	30,287	40,411	55,187	59,415
France	25,600	40,200	54,887	67,741	70,743
Germany	27,139	43,438	55,595	62,640	65,921
Iceland	24,714	37,535	47,054	54,276	56,458
Ireland	16,130	26,860	40,009	59,842	66,842
Italy	26,645	42,735	54,419	65,831	68,818
Japan	13,744	25,521	35,259	47,711	50,049
Netherlands	30,617	43,268	54,318	68,570	70,665
New Zealand	31,804	35,113	38,655	42,659	43,442
Norway	24,731	39,340	53,145	70,588	75,391
Spain	17,319	28,944	41,614	49,366	50,964
Sweden	28,158	40,315	47,132	55,140	57,910
United Kingdom	22,289	30,372	38,489	47,215	49,750
United States	41,705	51,443	57,897	67,284	70,606
Labor input per working-age person 1/		(Index, US 1995 = 100)			
Australia	95.5	94.8	91.5	93.7	95.3
Belgium	87.2	78.5	68.7	66.9	66.9
Canada	92.7	88.1	89.9	90.8	92.4
Denmark	114.0	99.7	87.5	83.4	84.9
Finland	105.7	99.2	97.4	81.4	82.2
France	99.4	89.3	75.7	72.0	71.6
Germany	103.6	88.0	77.3	76.1	74.6
Iceland	112.2	105.1	106.7	100.1	102.0
Ireland	108.0	90.9	76.3	76.2	79.3
Italy	79.6	72.9	69.8	68.1	67.8
Japan	126.1	118.3	113.7	107.0	105.6
Netherlands	89.4	84.4	72.0	70.4	72.9
New Zealand	101.9	101.6	95.3	91.9	94.9
Norway	93.2	84.4	82.0	79.1	80.5
Spain	95.4	88.3	67.8	70.7	72.6
Sweden	97.9	90.0	90.7	87.1	86.9
United Kingdom	109.9	102.2	93.1	94.6	95.8
United States	92.5	89.5	93.8	99.7	101.2

Sources: AMECO database; OECD; and staff calculations.

1/ One unit of labor is defined as 2,088 hours of work (one year of 5-day weeks, 8-hour days).

Table 6. Growth Accounting: International Comparison of Levels (II)

	1961–70	1971–80	1981–90	1991–2000	1996–2000
TFP		(Index, US 1995 = 100)			
Australia	56.6	66.9	73.7	83.4	87.3
Belgium	53.7	76.6	92.7	109.0	113.0
Canada	61.9	77.8	83.8	89.3	92.2
Denmark	51.9	66.6	78.4	91.0	94.6
Finland	40.4	53.4	65.5	82.2	88.9
France	50.0	68.5	84.0	96.8	99.9
Germany	49.8	68.0	79.5	87.2	90.0
Iceland	48.0	64.6	76.2	83.8	87.1
Ireland	35.1	49.2	63.3	90.1	100.5
Italy	50.4	70.0	82.0	92.8	95.8
Japan	33.8	51.5	61.3	72.9	74.6
Netherlands	54.9	68.9	79.5	96.1	99.0
New Zealand	58.6	63.1	65.2	69.7	71.1
Norway	47.7	65.4	79.7	100.9	107.2
Spain	39.7	56.7	70.5	78.1	79.6
Sweden	53.1	68.0	75.7	84.9	89.0
United Kingdom	44.4	54.6	65.0	76.3	79.8
United States	70.5	82.5	90.2	102.0	106.1
Capital per unit of labor 1/		(1995 US dollars at 1995 PPP exchange rates)			
Australia	83,210	97,439	119,231	132,506	135,694
Belgium	76,754	114,530	155,192	199,604	210,761
Canada	87,099	97,763	116,924	140,054	142,327
Denmark	78,433	125,951	162,638	186,443	187,478
Finland	63,087	100,368	132,553	176,434	173,113
France	70,598	111,807	160,216	202,001	210,144
Germany	87,315	148,849	200,722	219,852	234,993
Iceland	72,469	107,862	132,732	155,733	156,460
Ireland	49,425	87,941	143,148	169,554	170,032
Italy	78,280	127,611	168,685	210,810	220,728
Japan	32,568	64,242	104,573	161,448	175,658
Netherlands	94,425	140,580	185,783	215,398	215,712
New Zealand	86,564	94,181	116,232	129,086	128,624
Norway	74,010	121,579	171,336	201,540	205,402
Spain	41,422	70,562	114,170	144,046	149,988
Sweden	79,443	116,073	136,465	157,260	158,545
United Kingdom	66,739	93,757	115,631	133,855	137,153
United States	115,354	137,638	151,197	165,786	170,679
Capital-output ratio					
Australia	2.8	2.6	2.7	2.6	2.5
Belgium	2.7	2.5	2.6	2.6	2.6
Canada	2.6	2.2	2.4	2.5	2.5
Denmark	2.9	3.1	3.2	3.0	2.9
Finland	3.2	3.3	3.3	3.2	2.9
France	2.8	2.8	2.9	3.0	3.0
Germany	3.2	3.4	3.6	3.5	3.6
Iceland	2.9	2.9	2.8	2.9	2.8
Ireland	3.1	3.3	3.6	2.9	2.6
Italy	2.9	3.0	3.1	3.2	3.2
Japan	2.4	2.5	3.0	3.4	3.5
Netherlands	3.1	3.2	3.4	3.1	3.1
New Zealand	2.7	2.7	3.0	3.0	3.0
Norway	3.0	3.1	3.2	2.9	2.7
Spain	2.4	2.4	2.7	2.9	2.9
Sweden	2.8	2.9	2.9	2.9	2.7
United Kingdom	3.0	3.1	3.0	2.8	2.8
United States	2.8	2.7	2.6	2.5	2.4

Sources: AMECO database; OECD; and staff calculations.

1/ One unit of labor is defined as 2,088 hours of work (one year of 5-day weeks, 8-hour days).

Table 7. U.K. Labor Productivity Gap and Its Components
(Gap with respect to the UK, in percent of UK level)

	Total Labor Productivity Gap	Decomposition I $Y/L = A(K/L)^{\alpha}$		Decomposition II $Y/L = A^{1/(1-\alpha)}(K/Y)^{\alpha/(1-\alpha)}$	
		Due to TFP gap	Due to capital-labor ratio gap	Due to TFP gap	Due to capital-output ratio gap
Average 1996–2000					
Australia	9	9	0	14	-5
Belgium	61	41	19	64	-3
Canada	17	16	1	23	-6
Denmark	30	18	12	27	3
Finland	19	11	8	17	3
France	42	25	17	38	4
Germany	33	13	20	19	14
Iceland	13	9	4	13	0
Ireland	34	26	8	39	-5
Italy	38	20	18	30	9
Japan	1	-7	7	-9	10
Netherlands	42	24	18	36	6
New Zealand	-13	-11	-2	-15	3
Norway	52	34	17	52	-1
Spain	2	0	3	0	3
Sweden	16	11	5	17	0
United States	42	33	9	50	-8
Average 1971–1980					
Australia	24	22	1	33	-10
Belgium	49	40	9	62	-13
Canada	44	43	2	66	-22
Denmark	33	22	11	33	0
Finland	0	-2	2	-3	3
France	32	26	7	38	-6
Germany	43	24	19	37	6
Iceland	24	18	5	27	-4
Ireland	-12	-10	-2	-14	2
Italy	41	28	12	43	-2
Japan	-16	-6	-10	-8	-8
Netherlands	42	26	16	39	3
New Zealand	16	16	0	23	-7
Norway	30	20	10	29	0
Spain	-5	4	-8	5	-10
Sweden	33	25	8	37	-4
United States	69	51	18	80	-11

Sources: AMECO database; OECD; and staff calculations.

III. U.K. INVESTMENT: IS THERE A PUZZLE?[1]

A. Introduction

1. **The United Kingdom's low level of labor productivity compared with other major economies has been associated with a low stock of physical capital.**[2] The low physical capital stock, in turn, has mostly reflected low investment flows over the past several decades. Indeed, a comparison of the United Kingdom's total physical investment in relation to GDP within a sample of OECD countries reveals a ratio that is consistently among the lowest over the past four decades (Figure 1).[3]

2. **Why has the United Kingdom's investment been so low?** An extensive academic literature has addressed this issue, focusing on possible explanatory factors—such as differences in capital market structures, managerial incentives, human capital, macroeconomic environment—that could account for the low level of U.K. investment.[4] However, conclusively identifying the factors that could explain the investment gap has so far proved difficult and a puzzle remains.[5]

3. **This paper examines the United Kingdom's investment in relation to a comparable group of OECD countries in an attempt to see if approaching the issue from a somewhat more disaggregated perspective could shed light on the puzzle.** Data availability on the components of investment are a significant obstacle. Nevertheless, combining two international data sets, we decompose the investment data in two ways: broadly speaking, by ownership (public/private) and by type of asset (equipment/structures). Based on an analysis of this disaggregated data, the paper draws two broad conclusions:

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[1] Prepared by Petya Koeva.

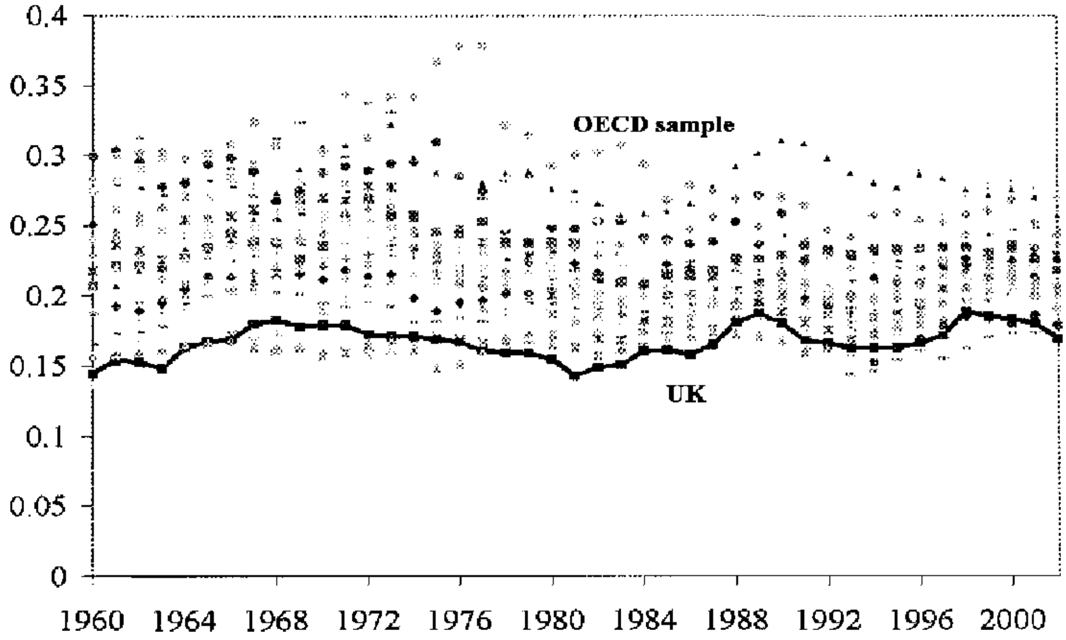
[2] See, for instance, O'Mahony (1999). For a further discussion of the United Kingdom's comparative productivity performance, see Chapter II on "Cross-country Overview of Growth Patterns."

[3] Based on OECD data, December 2002 (data for 2002 are preliminary estimates). The results are similar if investment-to-GDP ratios are computed at current prices. The sample group for Figures 1, 3 and 4 includes (other than the United Kingdom) 20 OECD countries: Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Japan, Netherlands, New Zealand, Norway, Portugal, Spain, Sweden, Switzerland, and the United States.

[4] See Franks and Mayer (1990), Bond and Jenkinson (1996), Driver and Soteri (1999), Corbett and Jenkinson (1996), Bond, Elston, Mairesse, and Mulkay (1997), for example.

[5] See Bond (2000) and Ashworth, Hubet, Pain, and Riley (2001) for an overview of the empirical findings in the literature.

Figure 1. Aggregate Investment as a Share of GDP
(In constant prices)



Source: OECD

- **First, compared with other countries, the United Kingdom does not appear to have a shortfall in equipment investment—the component of investment that the literature suggests would be most closely associated with productivity.**[6] Much of the investment gap appears to be associated with substantially lower investment in structures ("construction investment"), including lower residential investment.

- **Second, econometric analysis suggests that the difficulty in explaining cross-country differences in private non-residential investment (the category that corresponds most closely to "business fixed investment") appears to be due mainly to difficulties in explaining cross-country differences in non-residential construction investment.** A substantial part of the cross-country differences in equipment investment can be captured by variables that represent differences in labor market rigidities and the user cost of capital. (Other variables may be important as well—only a small number of variables could be included in the analysis given data limitations).

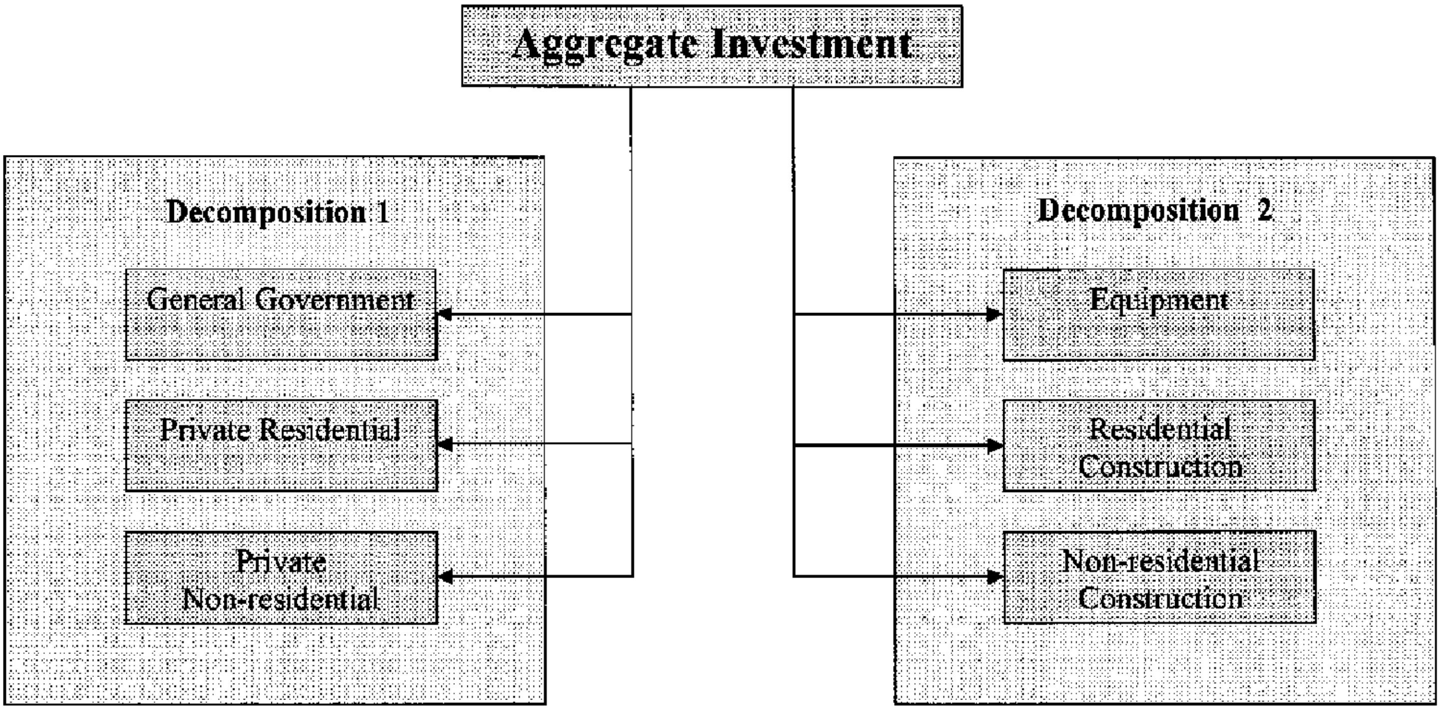
[6] See Hulten (1992), De Long and Summers (1991), Greenwood and Hercowitz (1997).

4. The rest of the paper is organized as follows. Section B discusses the various decompositions of aggregate investment that are permitted by the data and identifies three investment components for further analysis. Section C analyzes empirically the relationship between these investment components and determinants suggested by theory, in order to explain the observed differences in investment-to-GDP ratios between the United Kingdom and a sample of other OECD countries. Section D concludes.

B. Investment Trends: Decomposing the U.K.'s Shortfall in Aggregate Investment

5. **The available data allows aggregate investment to be decomposed in two different ways** (Figure 2). In the first decomposition, using OECD data, aggregate investment is split into general government, residential private, and non-residential private investment.[7] In the second decomposition, using European Commission data, aggregate investment is split by asset type into equipment, residential construction, and non-residential construction.[8]

Figure 2. Aggregate Investment Data: Two Available Decompositions



Sources: OECD and AMECO.

[7] OECD database, December 2002.

[8] AMECO database, December 2002.

6. **A closer look at the U.K.'s investment gap on the basis of the first decomposition suggests the following** (Figure 3):

- *General government investment* in the United Kingdom was comparable to other OECD countries during the 1960s and mid-1970s—a period when the United Kingdom fell behind other European countries in terms of productivity growth.[9] However, general government investment declined steadily in relation to GDP to relatively low levels in the subsequent period. Others have noted that this fall in general government investment since the mid 1970s largely reflected a decline in housing investment by local authorities, although investment in other sectors—such as education and health—weakened as well.[10]

- *Residential private investment* in the United Kingdom was consistently lower than in other countries during the entire period, possibly reflecting a better stock of housing at the start of the period—especially compared to post-war Europe—as well as supply constraints in the latter period.[11]

- The United Kingdom's *non-residential private investment* was among the lowest in the sample until the late-1980s and reached levels broadly comparable to other countries in the late 1990s. However, for the past four decades as a whole, the United Kingdom's average ratio of non-residential private investment to GDP was 9.8 percent—well below the sample average of 12.4 percent.[12]

7. **The asset decomposition of aggregate investment reveals the following patterns** (see Figure 4):

- *Equipment investment* in the United Kingdom, notably, has been comparable to equipment investment in other countries during the last four decades.[13] The U.K. ratio of equipment investment to GDP averages 7.6 percent for the entire period—same as the sample average.

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[9] See Chapter II, "Cross-Country Overview of Growth Patterns."

[10] See Clark, Elsby and Love (2002).

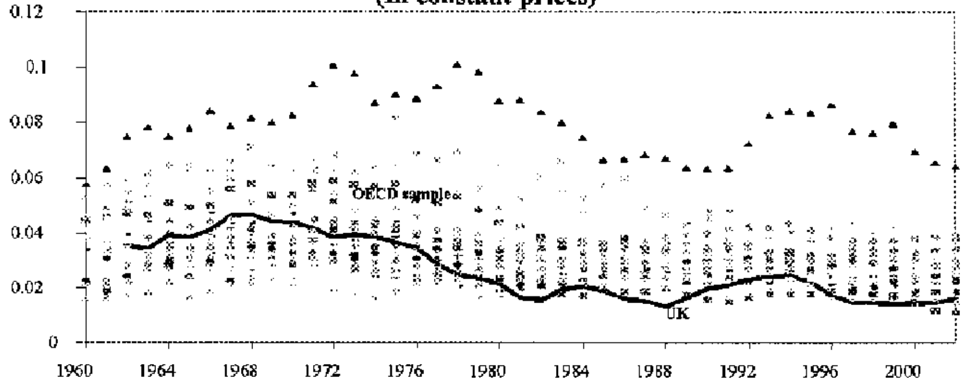
[11] See Chapter I, "An Analysis of House Prices in the United Kingdom."

[12] The rise in the United Kingdom's non-residential-to-GDP ratio is less evident on the basis of current prices. See Bloom and Bond (2001) for a further discussion.

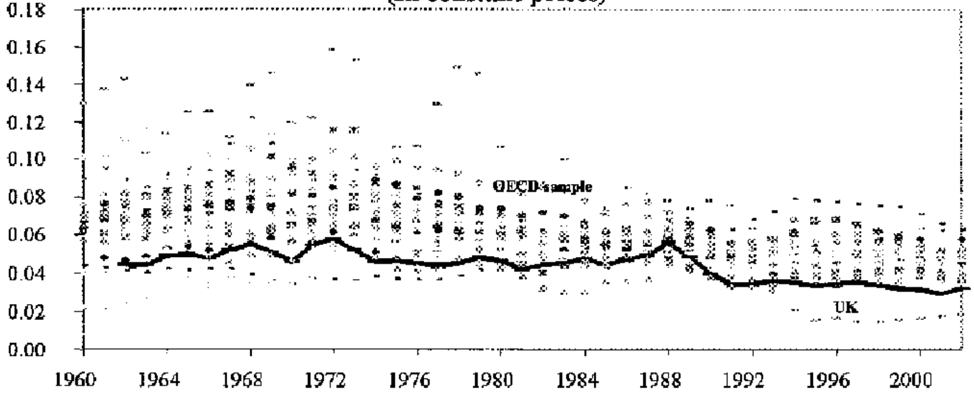
[13] This similarly holds even if the equipment-to-GDP ratio is computed in current prices.

Figure 3. Components of Aggregate Investment: Decomposition 1 1/

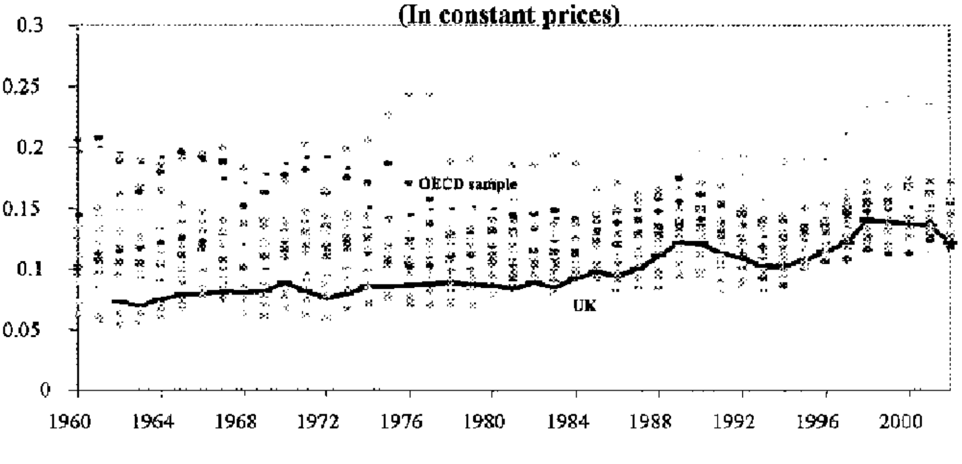
General Government Investment as a Share of GDP
(In constant prices)



Residential Private Investment as a Share of GDP
(In constant prices)

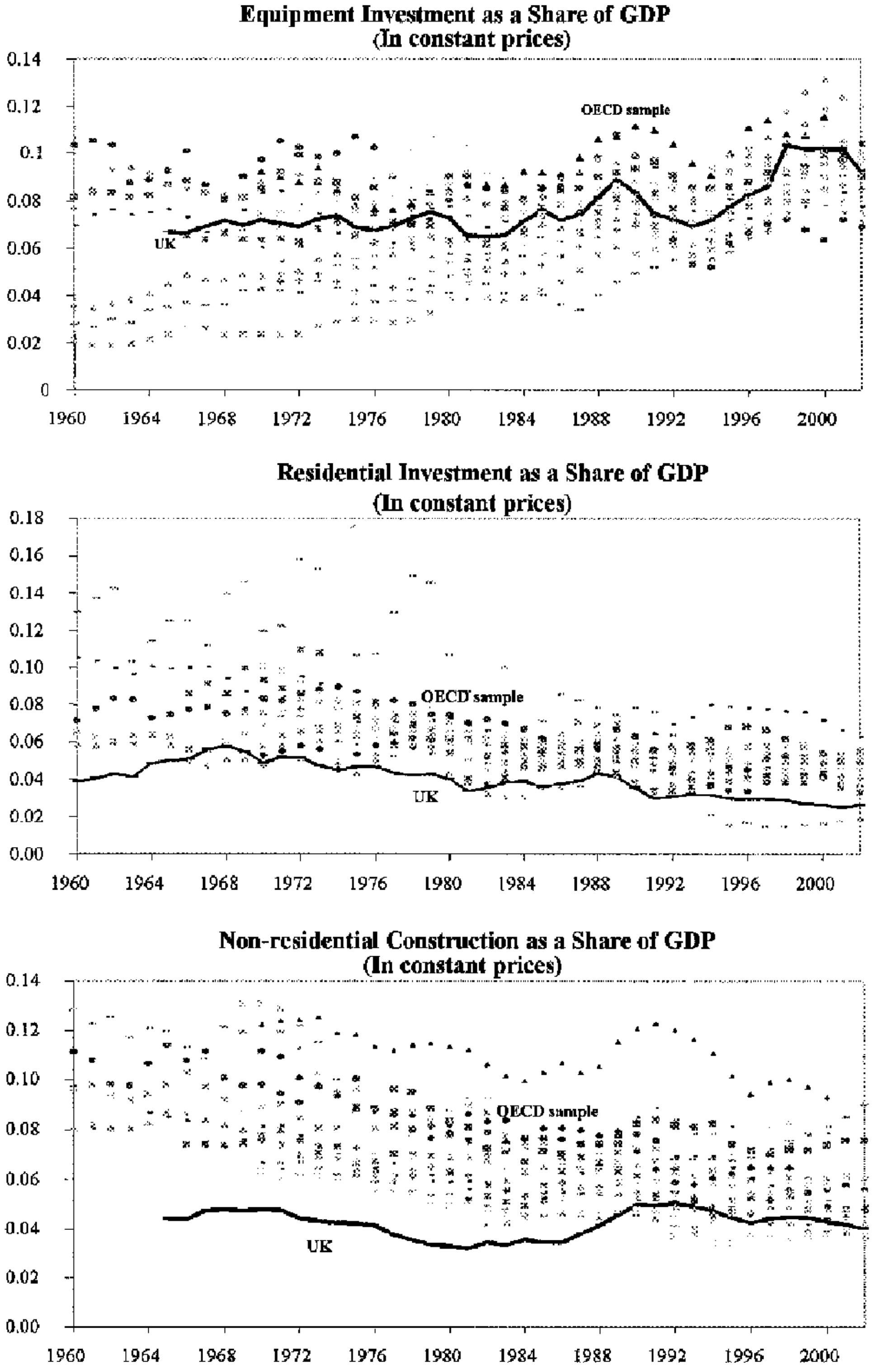


Non-residential Private Investment as a Share of GDP
(In constant prices)



Source: OECD.
1/ Countries comprising the sample are given in footnote 2 of the text.

Figure 4. Components of Aggregate Investment: Decomposition 2 1/



Source: AMECO.

1/ Countries comprising the sample are given in footnote 2 of the text.

- *Residential construction investment* in the United Kingdom has been among the lowest in sample, mostly reflecting a low level of residential private investment (as also noted in the second bullet in paragraph 5).

- The United Kingdom had a large and persistent gap in *non-residential construction investment* during the entire sample period.

8. **The remaining part of the paper focuses on explaining the United Kingdom's relative performance with regard to the component of aggregate investment that is most relevant from a productivity perspective—non-residential private investment—as well as the asset decomposition of this component, to the extent permitted by the data.** Non-residential private investment corresponds closely to the concept of "business fixed investment"—the standard variable used in economic analyses of investment.[14] However, a decomposition of this variable into private equipment investment and private non-residential construction investment is not available for an adequate sample of countries. Hence, the paper analyzes total equipment investment and total non-residential construction investment as the best available proxies, even though they include general government investment in these assets.[15]

C. What Explains the U.K.'s Relative Investment Performance?

Theoretical considerations

9. The theoretical literature points to several factors that may explain the observed pattern of differences between the investment ratios of the United Kingdom and other industrialized countries.

- *User cost of capital (-).*[16] Investment theory predicts that a higher level of the user cost of capital would lead to lower investment. The user cost variable is the product of two components—the real interest rate and the relative price of capital.[17] The real

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[14] As is the standard practice, residential investment is excluded from the analysis in this paper, given that the housing stock does not enter the production function, and hence, does not influence productivity.

[15] For the United Kingdom, at least, equipment investment is mostly private and general government investment tends to be concentrated in construction. This may hold true for other countries in the sample as well.

[16] The direction of the influence of each variable on investment ("+" or "-") as predicted by theory is given in parentheses. Data sources and variable construction are explained further in the appendix.

[17] Using a simplified version of the Jorgenson user cost formula that ignores the effect of taxation.

interest rate depends on the nominal interest rate and expected inflation, which is proxied in this analysis by current GDP deflator inflation. The relative price of capital is measured as the ratio of the gross fixed capital formation deflator to the GDP deflator. The constructed variable used in the empirical analysis is denoted by *USER*.

- *Macroeconomic instability (-).* An increased level of macroeconomic uncertainty is likely to make firms less willing to undertake investment for a given level of expected return, reflecting the impact of risk aversion and/or irreversibility in investment decisions.[18,19] In this paper, the level of macroeconomic instability is proxied by inflation uncertainty as measured by the conditional variance of monthly CPI inflation, estimated for each country in the sample. The constructed variable is called *INSTAB*.

- *Human capital/skills (+).* Higher levels of human capital and better skill composition of the labor force are likely to be associated with higher investment, assuming that human capital and physical capital are complements in production. Capturing human capital and skills by a single variable is admittedly difficult. Following examples in the literature, this paper uses two proxies for human capital—the average years of schooling (*EDYR*) and the percentage of the population without any schooling (*NOSCH*).

- *R&D spending (−).* Higher levels of R&D spending would tend to be related to higher investment, if spending on R&D is assumed to be complementary to physical or human capital. Constructed as the ratio of nominal R&D spending to nominal GDP, the research and development spending variable is denoted by *R&D*.

- *Labor market rigidity (+).* A more rigid labor market is likely to be associated with higher investment, if firms respond to labor market distortions by moving away from labor-intensive to capital-intensive technologies in the medium run. The degree of labor market rigidity (*LRIGID*) is proxied by an index of employment protection, with a range from 0 to 2, increasing in the strictness of employment protection.[20]

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[18] For instance, the impact of macroeconomic instability on investment is explored in Pindyck and Solimano (1993)

[19] See Abel and Eberly (1994), Abel, Dixit, Eberly, and Pindyck (1996) and Dixit and Pindyck (1994) for a discussion of the impact of uncertainty on investment in the presence of irreversibility. Note that in this context, the effect of uncertainty on the *magnitude* of investment—as opposed to its timing—is ambiguous on theoretical grounds (see Caballero (1991)).

[20] See Nickell and Nunziata (2001) and Blanchard and Wolfers (2000).

Empirical analysis

10. **Our objective is to examine the relationship between the investment variables and their theoretical determinants, in order to explain U.K.'s relative investment performance.** Based on the discussion in paragraph 8, the dependent variables used in the empirical analysis are: (i) non-residential private investment (*NRPRI*); (ii) equipment investment (*EQUIP*); (iii) non-residential construction investment (*CON*). The explanatory variables are as outlined above—the user cost of capital (*USER*), macroeconomic instability (*INSTAB*), human capital (*NOSCH* and *EDYR*), research and development spending (*R&D)*, and labor market rigidity (*LRIGID*).[21]

11. **An examination of the sample means of the dependent and explanatory variables reveals the following** (Table 1):

- The United Kingdom's equipment investment (*EQUIP*) is very close to the sample mean, while non-residential construction (*CON*) and non-residential private investment (*NRPRI*) are about 2.5 percentage points of GDP lower than the corresponding sample means.

- Compared to the sample mean, the United Kingdom had: (i) a lower user cost of capital (*USER*); (ii) a more uncertain macroeconomic environment, as measured by inflation uncertainty (*INSTAB*); (iii) better human capital (*EDYR* and *NOSCH*);[22] (iv) higher research and development spending (*R&D*); and (v) a smaller degree of labor market rigidity (*LRIGID*).

- The fact that the United Kingdom had, on average, a lower user cost of capital and a higher level of human capital than the sample average suggests that these two factors could not help explain the United Kingdom's relative shortfall in non-residential private investment and non-residential construction investment. On the other hand, the United Kingdom's somewhat greater macro instability and notably lower degree of labor market rigidity may help explain an investment shortfall.

12. **The partial correlations between the investment variables and their potential determinants can be examined in a simple cross-country regression framework.** In particular, for each country in the sample, the average investment-to-GDP ratio (*NRPRI*,

[21] Since not all variables were available for all countries, a few countries from the original sample of 21 countries (see footnote 2) had to be dropped from the various regressions reported in this section.

[22] These variables do not capture the United Kingdom's deficiencies in intermediate skills (vis-à-vis countries like Germany and France) that have been identified in the literature as significant in explaining productivity differentials.

Table 1. Variable Definitions and Mean Values

Variable	Definition	Mean value	
Dependent variables		UK	Sample
NRPRI	Private nonresidential investment as a share of GDP	0.0976	0.1239
EQUIP	Equipment investment as a share of GDP	0.0756	0.0761
CON	Nonresidential construction investment as a share of GDP	0.0421	0.0689
Explanatory variables			
USER	User cost (=Real interest rate times the relative price of capital)	0.0255	0.0316
INSTAB	Inflation uncertainty	0.0037	0.0025
LRIGID	Employment protection index (0 to 2)	0.2900	1.0238
EDYR	Average years of schooling of total population aged 25 and over	8.2489	8.0560
NOSCH	Percentage of population aged 25 and over without any schooling	2.4778	4.6238
R&D	R&D spending as a share of GDP	0.0133	0.0124

Sources: OECD; AMECO; IFS; LMIDB; ARBERD; and staff estimates.

Table 2. Coefficient Estimates from Cross-Country Regressions

	NRPRI				*EQUIP*				*CON*			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
USER	-0.153	-0.155	-0.266	-0.153	-0.217	-0.526	-0.646	-0.602	-0.087	0.212	0.121	-0.031
	(0.462)	(0.337)	(0.295)	(0.503)	(0.491)	(0.402)	(0.410)	(0.388)	(0.374)	(0.294)	(0.305)	(0.426)
INSTAB	-0.031	0.000	-0.001	-0.035	-0.006	0.017	0.005	-0.120	-0.026	-0.026	-0.014	-0.039
	(0.030)	(0.028)	(0.019)	(0.036)	(0.027)	(0.030)	(0.026)	(0.106)	(0.020)	(0.019)	(0.016)	(0.027)
LRIGID	0.024	0.035	0.034	0.023	0.010	0.036	0.021	0.004	0.002	-0.007	0.004	0.008
	(0.011)**	(0.017)*	(0.010)***	(0.012)*	(0.011)	(0.019)*	(0.013)*	(0.005)	(0.009)	(0.014)	(0.010)	(0.011)
EDYR	-	0.008	-	-	-	0.013	-	-	-	-0.004	-	-
	-	(0.007)	-	-	-	(0.008)	-	-	-	(0.006)	-	-
NOSCH	-	-	-0.005	-	-	-	-0.004	-	-	-	-0.001	-
	-	-	(0.002)**	-	-	-	(0.003)	-	-	-	(0.002)	-
R&D	-	-	-	-0.041	-	-	-	0.059	-	-	-	-0.080
	-	-	-	(0.131)	-	-	-	(0.072)	-	-	-	(0.155)
Constant	0.109	0.027	0.108	0.116	0.073	-0.058	0.081	0.103	0.079	0.112	0.072	0.131
	(0.025)**	(0.082)	(0.018)***	(0.034)***	(0.028)**	(0.093)	(0.027)**	(0.028)***	(0.021)**	(0.068)	(0.018)**	(0.058)**
Obs.	17	17	17	16	15	15	15	14	15	15	15	14
R-squared	0.33	0.38	0.54	0.34	0.12	0.37	0.36	0.53	0.14	0.28	0.29	0.20

Notes: 1. Robust standard errors. 2. Significance levels of 1 percent, 5 percent, and 10 percent are denoted by (***), (**), and (*), respectively. 3. All regressions are estimated with a constant, which is not reported.

Source: Staff estimates.

EQUIP, and *CON*) is regressed on the average values (for each country) of the explanatory variables (*USER*, *INSTAB*, *NOSCH* and *EDYR*, *R&D*, and *LRIGID*). The results are reported in Table 2. These averages can be interpreted as the long-run values for each country, so that the regressions exploit only the cross-sectional variation in the data. The appeal of this simple exercise is that the impact of all the constructed explanatory variables on investment

can be considered.[23] The main drawback is that the sample size—determined by the number of countries in the sample—is very small.

13. **The results from these cross-country regressions can be summarized as follows** (Table 2):

- Countries with more rigid labor markets (*LRIGID*) tend to have significantly higher non-residential private and equipment investment.
- Countries with fewer educated people (*NOSCH*)—as measured by the percentage of the population without any schooling—tend to have significantly higher non-residential private investment.
- All other explanatory variables are statistically insignificant, which is possibly caused by the small sample size. Cross-country differences in non-residential construction investment (*CON*) are particularly difficult to explain (even if one were to attribute the lack of significance of individual variables to the small sample size).

14. **We now turn to examining the United Kingdom's relative investment performance in a panel regression framework, which exploits the variation in the data within countries**. Given data limitations only three explanatory variables (*USER, INSTAB,* and *LRIGID*) can be utilized in this exercise. We adopt a four-step approach, explained further in Box 1. *First*, each investment ratio (*NRPRI, EQUIP, CON*) is regressed on country dummies only, thus capturing in each coefficient estimate the difference in the sample means between the United Kingdom and each country (the United Kingdom is taken to be the reference country). *Second*, year dummies are added to the first specification, representing common shocks that affect the investment ratios of all countries in a particular year. *Third*, three constructed explanatory variables (*USER, INSTAB,* and *LRIGID*) are incorporated in the model, in order to observe the impact on the country dummies. Eliminating the statistical significance of the country dummies would indicate that the bilateral investment-to-GDP differences are being explained by the added exogenous variables. *Fourth*, the country dummies are dropped from the estimation, in order to illustrate their joint importance in explaining investment-to-GDP ratios.

15. **The main findings of this approach are as follows** (Table 3):

- **Model 1.** The country dummies—representing the fixed (unknown) differences between the investment-to-GDP ratios of the United Kingdom and individual countries—are statistically significant for almost all countries and all types of

[23] The human capital and R&D variables are available only for selected years and cannot be used in a panel regression.

Box 1. Empirical Specifications

Model 1. In this specification, the relevant dependent variable y (= *NRPRI, EQUIP* or *CON*) is regressed on country dummies only (D_i), with the United Kingdom taken as a reference (omitted) category:

$$y_{it} = const + \beta_1 D_i + \varepsilon_{it}$$

Therefore, the estimated coefficients of the country dummies represent the differences between the average investment-to-GDP ratios of the individual countries vis-à-vis the United Kingdom, with the standard errors revealing whether these differences are statistically significant.

Model 2. In addition to the country dummies, Model 2 includes year dummies (T_j) in order to control for any common shocks affecting investment-to-GDP ratios across countries in specific years.

$$y_{it} = const + \beta_1 D_i + \beta_2 T_j + \varepsilon_{it}$$

Model 3. This specification adds the constructed explanatory variables (*X* = *USER, INSTAB,* and *LRIGID*) and interactions with the year dummies (*Interact*) to Model 2. The statistical significance of their coefficients reveals if these variables help explain the observed variation in investment-to-GDP ratios. Moreover, one could observe if the coefficients of the country dummies–which capture investment differences vis-à-vis the United Kingdom—become statistically insignificant.

$$y_{it} = const + \beta_1 D_i + \beta_2 T_j + \beta_3 X_{it} + \beta_4 Interact_{it} + \varepsilon_{it}$$

Model 4. The last specification omits the country dummies, in order to demonstrate their role in improving the fit of the empirical model.

$$y_{it} = const + \beta_2 T_j + \beta_3 X_{it} + \beta_4 Interact_{it} + \varepsilon_{it}$$

investment.[24] Consistent with Figures 3 and 4, in the cases of non-residential private investment (*NRPPR*) and non-residential construction (*CON*), most countries had—on average—higher investment ratios during the sample period. Note that in the case of equipment investment (*EQUIP*), the country dummies are all significant even though the U.K. average is close to the sample average (Table 1), indicating significant bilateral differences between individual country means and the U.K. mean.

- **Model 2.** For all investment variables, the overall pattern of the country dummy coefficients remains unchanged when year dummies are added. The overall fit of the model improves somewhat for non-residential construction investment, suggesting

[24] For example, a coefficient estimate 0.01 indicates a 1 percentage point difference between the United Kingdom's investment-to-GDP ratio and the corresponding investment ratio of a given country.

Table 3. Coefficient Estimates from Panel Regressions

	NRPRI				*EQUIP*				*CON*			
	Model 1	Model 2	Model 3	Model 4	Model 1	Model 2	Model 3	Model 4	Model 1	Model 2	Model 3	Model 4
Australia	0.030	0.030	0.039	-	-	-	-	-	0.040	0.043	0.044	-
	(0.003)***	(0.003)***	(0.003)***	-	-	-	-	-	(0.003)***	(0.002)***	(0.003)***	-
Austria	0.033	0.033	0.050	-	0.014	0.015	0.016	-	0.038	0.044	0.047	-
	(0.003)***	(0.003)***	(0.004)***	-	(0.001)***	(0.002)***	(0.007)**	-	(0.002)***	(0.002)***	(0.004)***	-
Belgium	0.028	0.028	0.044	-	-	-	-	-	-	-	-	-
	(0.003)***	(0.003)***	(0.004)***	-	-	-	-	-	-	-	-	-
Canada	-0.006	-0.005	0.000	-	-0.035	-0.034	-0.027	-	0.040	0.038	0.039	-
	(0.004)	(0.004)	(0.003)	-	(0.003)***	(0.003)***	(0.003)***	-	(0.002)***	(0.002)***	(0.003)***	-
Denmark	0.031	0.030	0.040	-	-0.002	-0.002	0.001	-	0.022	0.023	0.026	-
	(0.003)***	(0.003)***	(0.004)***	-	(0.002)	(0.002)	(0.006)	-	(0.002)***	(0.002)***	(0.004)***	-
Finland	0.066	0.067	0.078	-	0.015	0.016	0.007	-	0.044	0.042	0.043	-
	(0.005)***	(0.005)***	(0.006)***	-	(0.003)***	(0.003)***	(0.005)	-	(0.003)***	(0.002)***	(0.004)***	-
France	0.017	0.017	0.030	-	-0.019	-0.020	-0.019	-	0.020	0.023	0.026	-
	(0.003)***	(0.002)***	(0.004)***	-	(0.002)***	(0.003)***	(0.008)**	-	(0.002)***	(0.002)***	(0.004)***	-
Germany	0.067	0.067	0.082	-	0.003	0.003	0.000	-	0.026	0.024	0.029	-
	(0.005)***	(0.005)***	(0.006)***	-	(0.001)*	(0.002)**	(0.002)	-	(0.002)***	(0.002)***	(0.005)***	-
Ireland	0.025	0.025	0.025	-	0.008	0.007	0.005	-	0.021	0.027	0.024	-
	(0.004)***	(0.004)***	(0.004)***	-	(0.003)***	(0.003)**	(0.004)	-	(0.004)***	(0.003)***	(0.003)***	-
Italy	0.029	0.029	0.047	-	0.007	0.006	0.000	-	0.008	0.011	0.017	-
	(0.003)***	(0.003)***	(0.006)***	-	(0.001)***	(0.002)***	(0.004)	-	(0.002)***	(0.002)***	(0.006)***	-
Japan	0.043	0.043	0.063	-	0.020	0.019	0.015	-	0.071	0.074	0.079	-
	(0.005)***	(0.004)***	(0.005)***	-	(0.002)***	(0.003)***	(0.009)	-	(0.002)***	(0.002)***	(0.004)***	-
Netherlands	0.032	0.032	0.044	-	-0.004	-0.005	-0.003	-	0.040	0.042	0.044	-
	(0.003)***	(0.003)***	(0.004)***	-	(0.002)***	(0.002)***	(0.009)	-	(0.005)***	(0.003)***	(0.005)***	-
Norway	0.087	0.087	0.103	-	0.062	0.061	0.058	-	-	-	-	-
	(0.006)***	(0.006)***	(0.008)***	-	(0.018)***	(0.018)***	(0.019)***	-	-	-	-	-
Spain	0.019	0.019	0.040	-	-0.011	-0.012	-0.010	-	0.025	0.028	0.035	-
	(0.004)***	(0.003)***	(0.006)***	-	(0.002)***	(0.002)***	(0.006)	-	(0.002)***	(0.003)***	(0.007)***	-
Sweden	0.007	0.007	0.027	-	-0.012	-0.012	-0.005	-	0.010	0.013	0.020	-
	(0.003)**	(0.002)***	(0.004)***	-	(0.002)***	(0.003)***	(0.003)	-	(0.002)***	(0.002)***	(0.005)***	-
US	-0.005	-0.005	-0.005	-	-0.012	-0.011	-0.008	-	0.025	0.023	0.022	-
	(0.003)*	(0.003)*	(0.002)**	-	(0.003)***	(0.003)***	(0.003)**	-	(0.002)***	(0.002)***	(0.003)***	-
USER	-	-	0.614	-0.147	-	-	-0.883	-0.909	-	-	4.912	0.932
	-	-	(0.534)	(0.386)	-	-	(0.392)**	(0.005)***	-	-	(2.484)**	(0.144)***
INSTAB	-	-	-0.388	0.212	-	-	0.000	-0.001	-	-	-0.160	-0.004
	-	-	(0.275)	(0.168)	-	-	(0.003)	(0.004)	-	-	(0.270)	(0.003)
LRIGID	-	-	0.013	0.041	-	-	0.014	0.027	-	-	0.011	0.045
	-	-	(0.007)*	(0.017)**	-	-	(0.008)*	(0.002)***	-	-	(0.050)**	(0.005)***
Year dummies	no	yes	yes	yes	no	yes	yes	yes	no	yes	yes	yes
Interaction terms	no	no	yes	yes	no	no	yes	yes	no	no	yes	yes
Observations	589	589	589	589	443	443	443	443	418	418	418	418
R-squared	0.65	0.68	0.79	0.26	0.41	0.44	0.57	0.30	0.66	0.85	0.91	0.25

Notes: 1. Robust standard errors. 2. Significance levels of 1 percent, 5 percent, and 10 percent are denoted by (***), (**), and (*), respectively. 3. All regressions are estimated with a constant, which is not reported.

Source: Staff estimates.

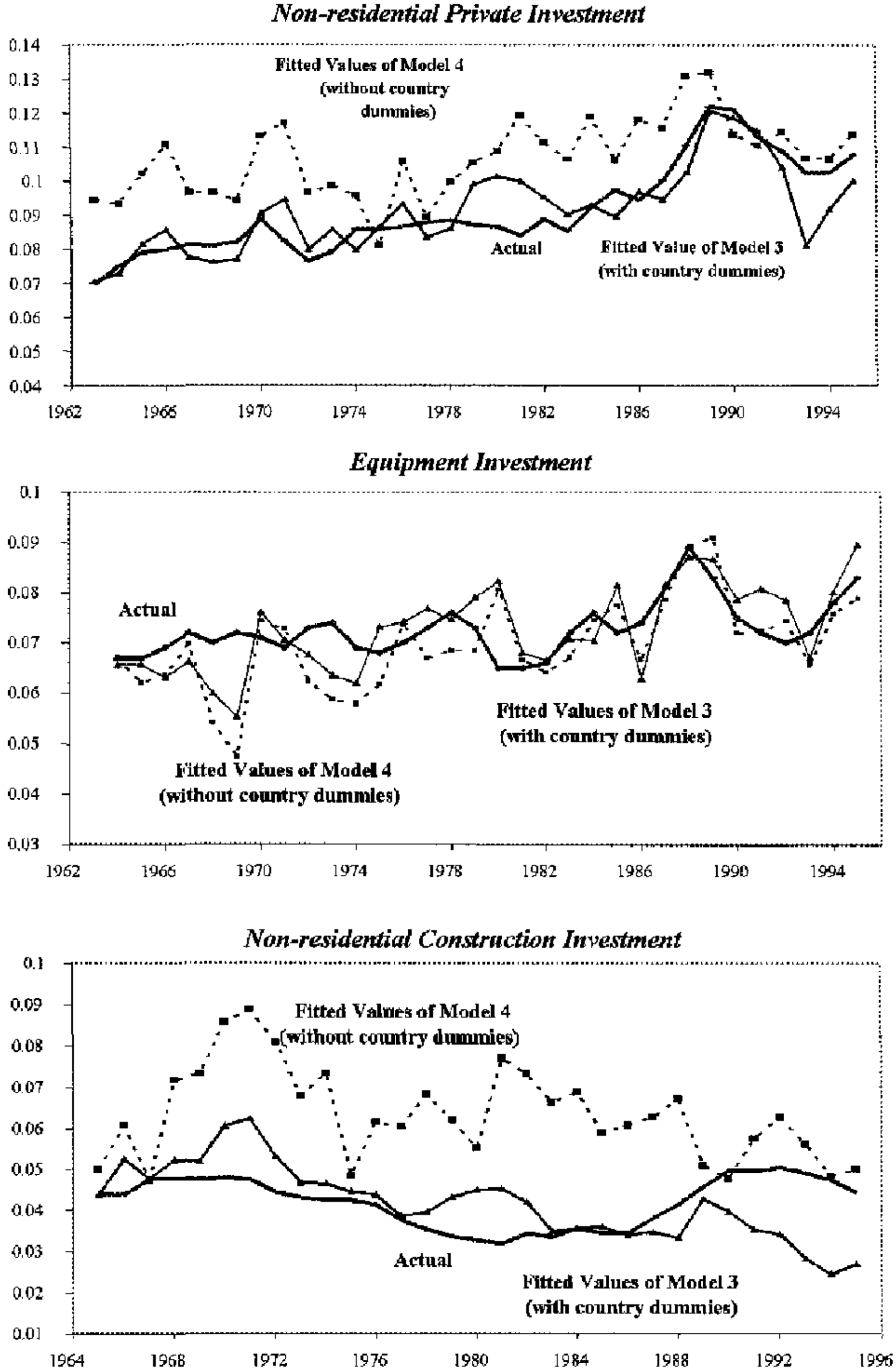
some role for exogenous shocks that may have affected all countries during particular years.

- **Model 3**. When the explanatory variables *USER, INSTAB,* and *LRIGID* are added, the country dummies remain largely significant in the equation for non-residential private investment, confirming the difficulty typically found in the literature in explaining the United Kingdom's low business fixed investment in relation to other countries. However, many of the country dummies become statistically insignificant in the case of equipment investment suggesting that these three explanatory variables as a group help explain the differences between the United Kingdom's equipment investment-to-GDP ratio and those of Finland, Germany, Ireland, Italy, Japan, Netherlands, and Sweden. At the same time, the country dummies remain significant in the regression for non-residential construction investment suggesting difficulty in explaining cross-country differences with regard to this investment component. In all specifications, a higher degree of labor market rigidity is associated with higher investment-to-GDP ratios. The user cost has the expected sign and is statistically significant only in the equipment investment regressions. The impact of macroeconomic instability on investment is found to be negative, but insignificant.

- **Model 4.** When the country dummies are dropped, the explanatory power of the regression (as indicated by the respective R-squares) declines sharply for non-residential private investment and non-residential construction investment. For equipment investment, the drop in explanatory power is less (although still substantial) and labor market rigidities and user cost of capital remain statistically significant.

16. **These findings are demonstrated graphically in Figure 5,** which shows actual and predicted values for the United Kingdom using the coefficients from Model 3 (with country dummies) and Model 4 (without country dummies) for the three types of investment. As in much of the literature, non-residential private investment is difficult to explain without controlling for fixed country effects. However, most of this difficulty appears to arise from the non-residential construction component where the fitted values without country dummies are far above actual values indicating the importance of fixed country effects. By contrast, in the case of equipment, the actual U.K. investment appears broadly similar to the fitted values of the empirical specification (with and) without country dummies, suggesting a lesser role for country-specific effects and a greater role for the three explanatory variables *USER, INSTAB,* and *LRIGID.*

Figure 5. UK Investment-to-GDP Ratios: Actual and Fitted Values



Source: Staff estimates.

D. Conclusions

17. **This paper has examined disaggregated data on investment across a sample of OECD countries, including the United Kingdom; several broad conclusions can be drawn from the analysis.** First, the United Kingdom's performance in *equipment investment*—the part of aggregate investment most likely to affect productivity—is comparable to those of other OECD countries. Moreover, most of the bilateral differences in equipment investment ratios between the United Kingdom and other countries can be attributed to differences in the user cost of capital and labor market rigidity, where lower user cost of capital and higher degree of labor market rigidity are associated with higher equipment-to-GDP investment ratios. Second, the United Kingdom has significantly lower *non-residential construction investment* than other countries and this difference is difficult to explain. These cross-country differences may reflect historical factors (a comparatively large stock of (non-residential) structures at the start of the period, possibly reflecting post-war differences with continental Europe, for example) or different policies (since government investment tends to be more important in this investment component). Third, taken together these factors suggest that the United Kingdom's comparatively low *non-residential private investment* the most commonly examined investment variable in the literature—reflects lower construction, rather than equipment, investment. Moreover, the difficulties in explaining non-residential private investment may reflect the well-known difficulties in explaining investment in structures, rather than a puzzle with regard to equipment investment.

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Data Sources and Variable Construction

The user cost variable (*USER*) is implemented as the product of the long-term real interest rate and the relative price of capital. Nominal long-term interest rate are taken from OECD and IFS. Expected inflation and the relative price of capital (measured as the gross fixed capital deflator divided by the GDP deflator) are constructed using OECD data.

The macroeconomic instability variable (*INSTAB*) is proxied by inflation uncertainty. The uncertainty variable is constructed as the conditional variance of monthly inflation, derived from a GARCH model estimated for each country in the sample. The monthly CPI series are taken from the IFS and miscellaneous country sources.

The two human capital variables—average years of schooling of the total population (*EDYR*) and percentage of population without any schooling (*NOSCH*)—are from the Barro-Lee educational attainment dataset (Barro and Lee, 2000).

The research and development spending variable (*R&D*) is computed as the ratio of R&D spending to GDP, in current prices. The data on R&D spending, which include the private sector only, are available from the OECD's *ARBERD* database (1987–2000).

The labor market rigidity variable (*LRIGID*) is proxied by an index of employment protection, which is available for the period between 1960 and 1995. The data source is the *Labour Market Institutions Database* (Nickell and Nunziata, 2001).