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Increases in Business Investment Rates in OECD Countries in the 1990s: How Much Can be Explained by Fundamentals?

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INCREASES IN BUSINESS INVESTMENT RATES IN OECD COUNTRIES IN THE 1990s: HOW MUCH CAN BE EXPLAINED BY FUNDAMENTALS?

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by
Florian Pelgrin, Sebastian Schich and Alain de Serres

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ABSTRACT/RÉSUMÉ

Increases in business investment rates in OECD countries in the 1990s: How much can be explained by fundamentals?

In several OECD countries, investment rates in the business sector grew strongly in the second half of the 1990s. In some cases, the strength of private investment relative to output growth had raised concerns about the risk of capital overhang and the prospect of a prolonged period of slow capital formation in order to bring investment levels back to more sustainable levels. It is possible that the stock market boom has contributed to a rise of investment demand to an excessive level, not only in the United States, but also in the United Kingdom, Canada, Scandinavia and Greece. The purpose of this paper is to assess the contribution of fundamental determinants to the change in investment in the second half of the 1990s, based on the estimation of panel cointegration equations for gross business investment for 18 OECD countries from 1970 to 1999. In addition to the levels of real GDP and a measure of the cost of capital, the set of explanatory variables includes four alternative proxies for financial market development. The inclusion of the latter variables helps to identify a coefficient for output that is close to one as well as a coefficient for the cost of capital that is both negative and significant. Based on these estimation results, the rise in the volume of business investment observed in a number of countries during the second half of the 1990s can only be partly explained by the set of basic determinants. On that basis, the empirical analysis would tend to support the view that investment had exceeded its steady-state level, not least in the United States. However, as suggested by the recent pick-up in investment, the size of the capital overhang in the United States might turn out to be smaller than feared, especially once the increases in trend output growth and depreciation rates are taken into account.

JEL classification: O16, E22, C33.
*Keywords: Financial development, investment, non-stationary panel*s

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Dans quelle mesure la hausse des taux d’investissement dans les pays de l’OCDE durant les années 90 peut-elle être expliquée par les fondamentaux?

Dans plusieurs pays de l’OCDE, les taux d’investissement du secteur des entreprises ont connu une forte croissance durant la deuxième moitié des années 90. Dans certains cas, la croissance rapide de l’investissement privé comparativement à celle de la production globale avait soulevé certaines inquiétudes concernant le risque d’une sur-accumulation de capital et la perspective d’une période prolongée de faible formation de capital nécessaire pour ramener le taux d’investissement à un niveau plus soutenable. Il est possible que la bulle sur les marchés boursiers ait entraîné un sur-investissement non-seulement aux États-Unis mais aussi au Royaume-Uni, au Canada, en Scandinavie et en Grèce. L’objectif de cette étude est d’évaluer la contribution des déterminants fondamentaux au changement dans l’investissement durant la deuxième moitié des années 90, à partir de l’estimation d’équations de panel pour l’investissement brut du secteur des entreprises dans 18 pays de l’OCDE sur la période allant de 1970 à 1999. En plus des variables habituelles, soit le niveau du PIB réel et une mesure du coût du capital, l’ensemble des déterminants inclut quatre mesures alternatives de développement des systèmes financiers. L’inclusion de ces dernières contribue à l’obtention d’un coefficient sur la production rélle qui soit très proche de l’unité de même que celle d’un coefficient sur le coût du capital qui soit négatif et significatif. Selon les résultats d’estimations, la hausse de l’investissement réel observée dans plusieurs pays durant la deuxième moitié des années 90 peut seulement être partiellement expliquée par l’ensemble des déterminants. Ainsi, l’analyse empirique tendrait à confirmer les craintes que l’investissement a augmenté au-delà de son niveau d’équilibre de long terme, particulièrement aux États-Unis. Toutefois, comme le suggère la récente reprise de l’investissement aux États-Unis, l’importance du sur-investissement pourrait s’avérer malgré tout plus modeste que craint au départ, surtout une fois pris en compte la hausse du taux de croissance du PIB potentiel ainsi que l’augmentaiton du taux de dépreciation.

Classification JEL: *O16, E22, C33*
Mots-clés: développement financières, investissement, panels non-stationnaires

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INCREASES IN BUSINESS INVESTMENT RATES IN OECD COUNTRIES IN THE 1990s: HOW MUCH CAN BE EXPLAINED BY FUNDAMENTALS?

by

Florian Pelgrin, Sebastian Schich and Alain de Serres[1]

1. Introduction

1. In several OECD countries, investment rates in the business sector grew strongly in the second half of the 1990s, reflecting mostly a rapid acceleration in the purchase of machinery and equipment, notably in volume terms. In some cases, the strength of private investment relative to output growth had raised concerns about the risk of a capital overhang and the prospect of a prolonged period of slow capital formation in order to bring investment levels back to more sustainable levels. While it is possible - even likely - that the stock market boom combined with the rapid decline in computer prices has fuelled investment demand to an excessive level, in particular in the United States, the size of the overhang and the required correction is more difficult to evaluate. The concern was that a large capital overhang could have limited the effectiveness of monetary policy and could thereby have influenced the timing and speed of recovery in the United States and elsewhere. While the recent numbers indicate that the worst fears are unlikely to materialise, investment may rebound less sharply than during previous recoveries. The purpose of this paper is to assess the contribution of fundamental determinants to the change in investment in the second half of the 1990s, based on the estimation of a system of panel cointegration equations for gross business investment.

2. Besides the level of output, the determinants include a measure of the cost of capital and an indicator of financial market development. While the former is a key driver of investment in the neo-classical model pioneered by Jorgensen (1971), its role in both cross-country and time-series empirical work has often proved difficult to capture, owing in part to measurement and identification problems. In contrast, the inclusion of a variable intending to capture the influence of financial market development is not derived directly from the basic neo-classical model. It follows instead from the contribution of recent studies suggesting that financial intermediation affects growth through various channels, including its effects on saving and investment rates as well as on the efficiency of capital allocation (Levine, 1997, 1999, Pagano, 1993; King and Levine, 1993; Leahy *et. al.*, 2001). Following a methodology similar to that found in Benhabib and Spiegel (2000), the present paper takes this simple neo-classical investment model as a base model for the empirical analysis and then adds indicators of financial development to examine whether they contain any further explanatory power.

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1. Florian Pelgrin is an economist in the OFCE International Economics Department, as well as a member of EUREQua, Université de Paris I and was a consultant to the OECD Economics Department. Sebastian Schich and Alain de Serres are senior economists in the OECD Directorate for Financial, Fiscal and Enterprise Affairs and Economics Department, respectively. The authors are grateful for helpful comments from Jorgen Elmeskov, Michael Feiner, Mike Kennedy, Michael Kiley, Mike Leahy, Alain Trognon and Ignazio Visco. They also thank Veronica Humi and Paula Simonin for excellent secretarial and editorial assistance.

3. The present paper uses relatively recent panel cointegration techniques that exploit more fully the information available in the variation of the variables over time compared with methods used in other studies, generally based on a pure cross-section of long-run averages and thus ignoring the time-series dimension (Levine, 1997; Wachtel, 2001).[2] As shown by Arestis and Demetriades (1996, 1997) and Arestis *et al.* (2001), exploiting the time series variations in financial development measures could be important and may yield noticeably different results from cross-section analysis. Using time series analysis for five industrialised countries, Arestis *et al.* (2001) find a much smaller coefficient estimate for stock market capitalisation than previous (cross-section) studies and conclude that the role of stock market capitalisation is probably overestimated in cross-section studies. To exploit the time-series variation, we apply the panel cointegration tests suggested by Kao (1999) and Pedroni (1995), and use four different panel estimators (OLS, bias-corrected OLS, FMOLS and DOLS).

4. Section 2 briefly reviews the recent stylised facts on investment and presents the empirical model. The choice of data is discussed in Section 3, which also presents the results of panel unit root and cointegration tests. The main results from the estimation of the investment equations corresponding to four panel cointegration techniques are discussed in Section 4. Overall, they largely conform to the prediction of the basic neo-classical model; while the long-run parameter on the level of real output is very close to unity, the cost of capital measure is found to have a significant negative long-term impact on investment, with a parameter size close to one in some cases. The results also confirm earlier evidence concerning the existence of a long-run relationship between financial development and investment. The relationship is stronger when financial development is measured by private credit issued by deposit money banks than stock market capitalisation or total value traded. Section 5 examines the contribution from the main determinants to the change in investment in the second half of the 1990s. Conclusions follow in Section 4.

2. Development in investment rates

5. Several OECD countries experienced a robust increase in both total and private investment during the second half of the 1990s, the main exceptions being Japan and Norway. The rebound in gross fixed capital formation, following several years of weak growth, was mainly driven by business investment, with public investment remaining flat (Table 1). In fact, over that period, real business investment has risen even more strongly relative to real GDP than suggested by the ratio of nominal investment spending to nominal GDP, owing to the drop in the relative price of capital goods. After moving more or less in line with real output throughout the 1980s and early 1990s, real investment has pulled away in the following years, most notably in the United States, the United Kingdom, Canada, Sweden, Denmark and Greece, despite a particularly strong output performance (Figure 1). While investment is typically more volatile than output, such a large and persistent gap between the two series is difficult to explain by traditional multiplier effects alone. This has raised the issue of sustainability, lest other determinants can account for the buoyancy of investment in the late 1990s observed in many countries.

6. To examine this issue, a set of panel equations for gross business investment in volumes is estimated using a cointegration technique. The specification of the equations and the set of determinants are based on the neo-classical theory of investment (Annex 1). Based on this simple conceptual framework, gross investment can be determined in the long run by a small set of variables, which includes the level of

2. Another traditional approach in the literature is to aggregate data over a time period of five years or ten years in a panel framework. The temporal aggregation may bias the results and induce an apparent relationship even if no relationship is present. Instrumental variables and GMM estimators do not necessarily solve this problem.

output, the real interest rate, the relative price of capital goods and the depreciation rate. The limited set of determinants mostly reflects the large number of simplifying assumptions unlikely to be met in the real world. Relaxing some of these assumptions would lead to an extension of the set of determinants in several directions. For instance, properly taking into account the effect of taxation in the cash-flow relationship (see equation A1-1) would lead to a specification of the user cost of capital which would include terms reflecting the corporate tax rate, the rate of investment tax credit and the discounted value of tax depreciation allowances. Tax factors can vary substantially both over time and across countries and such changes can be important for investment but also complicated to capture empirically, especially in a cross-country set-up.[3] Furthermore, allowing for taxation and uncertainty implies that the financial cost of capital (or the rate used to discount future revenues) is unlikely to be independent from the choice of financial mix by the firm and should therefore be measured as some combination of the cost of debt and equity. In practice, such a measure would also be difficult to construct for a large pool of countries.

7. However, one empirical feature that the neo-classical model seems to share with alternative models of investment such as Tobin's Q or variants of the Euler-equation approach, is the difficulty of identifying significant and robust relative price effects on the rate of capital formation at the aggregate level, regardless of how much sophistication goes into the construction of the cost of capital (Chirinko, 1993; Hassett and Hubbard, 1997).[4] Stated differently, it has become almost a stylised fact in empirical work on investment that the latter is much more correlated with output than it is with the cost of capital, even though, as pointed out many years ago by Shapiro (1986), "neo-classical theories of investment view output as the consequences of firms' choice of capital stock and other factors, not the cause".[5] In fact, empirical research over the past several years has increasingly turned to industry or firm-level data in order to find significant cost-of-capital effects on investment, especially at medium to high frequencies.[6]

8. One possible reason for the difficulty encountered in capturing a significant cost of capital effect relates to measurement problems, especially at the aggregate level. Such problems may even have worsened recently as a result of the shifting composition of capital towards information and communication technology (ICT) equipment -- a trend not confined to the United States (Colecchia and Schreyer, 2001). [7] Given the difficulty of properly quantifying rapid quality improvements, measuring the price of ICT equipment has become particularly problematic and has called into question the assumption

3. For example, the boom/bust cycle in non-residential structure investment observed in the United States in the 1980s has been related to the Tax Reform Act of 1986.

4. Evidently, exceptions to this general finding exist. For example, Ashworth and Davis (2001), using time series analysis on G-7 country data, identify a significant role for the user cost only in the case of Germany. See also Caballero (1999) for a number of other exceptions. They are found especially in the case of studies focusing on machinery and equipment as well as on low frequency correlations between the key variables.

5. This general finding has recently been confirmed even in the context of panel data (*e.g*. Schich and Pelgrin, 2001 and In't Veld, 2001). Both studies found that quantity variables (output, profits) dominate empirically price variables (real interest rate, relative prices or taxes).

6. For example, Mojon *et al.* (2001) use disaggregated data over 51 "representative" industries to investigate the investment behaviour and find significant negative effects from industry-specific user cost measures in Germany, France, Italy and Spain, with a long-run coefficient which is not significantly different from one. This confirms earlier findings reported in Hassett and Hubbard (1997) that the consensus emerging from studies based on US micro data suggested an elasticity of investment to the user cost of capital of between - 0.5 and -1.0.

7. The rapid increase in computer power and quality of telecommunication equipment have made the measured relative price of ICT equipment fall quite rapidly in the growing number of countries using hedonic price measurement.

that different types of capital goods can be aggregated into one homogeneous capital good with a representative cost.[8] Another explanation for the weak correlation between investment and the cost of capital effect is the classic identification problem that plagues the empirical results based on reduced-form estimates of a specification that include endogenous regressors. A third explanation is found in the literature on capital market imperfections.[9] In a world of imperfect competition and asymmetric information, the nature of the access to credit may vary both across firms and time - with some firms being liquidity constrained - implying that investment decisions may not be independent from internal cash flow or profitability even in the long run. In such a case, the real interest rate and the cost of capital may not reflect the true cost of borrowing faced by firms, especially the smaller ones more likely to be dependent on specific sources of credit such as bank lending.

9. In this context, financial markets perform several functions that may help reduce the effect of such imperfections. They facilitate the trading, hedging, diversifying and pooling of risk, the efficient allocation of resources, the monitoring of the allocation of funds of managers and the mobilising of savings. Measures of financial system developments can thus have an independent impact on investment. While constructing measures of the user cost of capital that take into account the main features of corporate taxation in a large set of countries is beyond the scope of this paper, the set of long-run determinants of investment is extended to include proxies for financial system developments.

10. Building on previous empirical work showing that the extent of financial market development can provide a significant contribution to output growth via its impact on investment, four alternative proxies for financial market developments have been introduced to capture these influences. First, *liquid liabilities*, which consist of currency and interest-bearing liabilities of bank and non-bank financial intermediaries, are used as a proxy for the overall size of the financial intermediary system. Second, the *private credit* provided to the private sector by deposit money banks, which consists of the total claims of deposit money banks on the private sector is intended to measure the degree of financial intermediation. Third, the ratio of *stock market capitalisation to GDP*, which consists of the value of shares listed, aims at capturing the ease with which funds can be raised in the equity market. Fourth, the *value traded* corresponds to the value of domestic shares traded on domestic exchanges divided by GDP. Each of these proxies has shortcomings. Since they include deposits by one financial intermediary in another, liquid liabilities suffer from a double-counting problem. Private credit only captures the financing intermediated banks and thus ignores the growing importance of the financing through other institutions or the securities market. More generally, these two variables better represent the size of the banking system than financial system development *per se*. This limitation applies particularly to liquid liabilities which could be high even in places where financial assets are not widely available. As for the two stock market variables, they suffer from the fact that by measuring values rather than volumes they are affected by equity price movements, as shown by their strong rise in the 1990s (Figure 2). As a result, they may also capture the effect of the cost of equity on investment, which is not taken into account in the measure of the cost of capital.[10]

8 . One alternative would consist in estimating a system of disaggregated investment equations consistent with a flexible approximation to the production function. Kiley (2001) estimates such a system for the United States.

9. See in particular Bernanke *et al*. (1999) Friedman and Kuttner (1993) and Stiglitz (1992) for earlier surveys on the relevance of the quantity channel as a determinant of investment independent from the price channel.

10. Indeed, the link between investment decisions and stock market valuation is at the heart of the Tobin's Q model according to which investment increases when firms' market value is higher than their replacement cost.

11. So far empirical evidence on the finance-investment link for the sample of developed countries has been mixed with several studies failing to identify a significant role of finance for economic development. King and Levine (1993) found that excluding OECD countries from their full sample of developed and developing countries did not affect the significance of the relationship between financial development and investment. This is consistent with the view that the links are significant for non-OECD, but not for OECD countries. Fernandez and Galetovic (1994) confirmed the weak relationship of financial development and investment in a direct test of this relationship for OECD countries. More recently, however, Leahy *et al.* (2001) and Beck and Levine (2001) both identified a significant link for OECD countries, on the basis of different methodologies.

12. In order to assess the possible influence of financial market development on investment levels across countries or over time, the basic neo-classical specification derived in Annex 1 is thus augmented to incorporate one of the suggested proxies:

$$i_{i,t} = \beta_{1,i} y_{i,t} + \beta_{2,i}(c_{i,t} - p_{i,t}) + \beta_{3,i} f_{i,t} + u_{i,t} \quad (1)$$

where $f_{i,t}$ is a proxy of financial development and $u_{i,t} = \alpha_i^{'} + \varepsilon_{i,t}$, $\alpha_i^{'}$ is an individual fixed effect and $\varepsilon_{i,t}$ is a random error term.

3. Data and empirical results

3.1 Data

13. The empirical analysis uses data on investment, output, a crude measure of the cost of capital and four measures of financial development for a panel of 18 OECD countries from 1970 to 1999.[11] Gross investment is measured by the log level of real private business sector fixed capital formation. The output variable is the real private gross domestic product. The cost of capital is measured as $\log\left(1 + {P_I}/{P} \cdot r\right)$, where r is a real long-term interest rate (derived from government securities) and ${P_I}/{P}$ is the ratio of a deflator of private non-residential fixed capital formation to an output price deflator (to adjust for relative price changes between capital goods and output). As shown on Figure 3, the trend decline in the relative price of capital goods throughout the 1980s and 1990s has contributed to put downward pressures on the cost of capital. As mentioned above, a set of four financial development indicators - liquid liabilities, private credit of deposit money banks, stock market capitalisation and total value traded as a share of GDP - is used. The data source for these four indicators' variables is the World Bank's financial development database (Beck *et al.*, 1999), where the data are only available until 1996 or 1997, in the case of OECD countries. For the purpose of the current study, the base has been up-dated to 1999 using the same methodology and data sources as in (Beck *et al*., 1999).

11. The sample includes: Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Greece, Italy, Japan, Netherlands, New Zealand, Norway, Spain, Sweden, United Kingdom and United States. In cases where less than 20 observations were available for a country, it was eliminated from the regression specification. For example, in the specifications where financial development is measured by data on stock market capitalisation, Finland, New Zealand and Norway (with 15, 13 and 17 observations, respectively) were excluded.

3.2 Panel unit root tests

14. Before proceeding with cointegration analysis it is necessary to verify whether or not the variables are actually integrated with the same order. The approach taken is that suggested by Im, Pesaran and Shin (1997), henceforth IPS, and is essentially the standard ADF-test in a panel context:

$$\Delta y_{i,t} = \mu_i + \beta_i t + \rho_i y_{i,t-1} + \sum_{j=1}^{p} \varphi_{ij} \Delta y_{i,t-j} + \varepsilon_{i,t} \tag{2}$$

where $y_{i,t}$ stands for each of the variables presented in Section 3.1. The null hypothesis is $\mathrm{H}_0 : \rho_\mathrm{i} = 0$ for all *i* and the alternative hypothesis $\mathrm{H}_1 : \rho_\mathrm{i} < 0$ for at least one i.

15. Instead of pooling and assuming that ρ_i is the same for all countries (Levin and Lin, 1993), the IPS methodology uses separate unit root tests for the N countries. The test statistic (denoted IPS t-bar statistic) is then calculated as the average of the individual ADF statistics, $\bar{t}_{N,T} = \left(1/N\right)\sum_{i=1}^{N} t_i$, where t_i is the ADF t-statistic for the OLS estimate in equation (2) for the *i*-th country. This statistic has the following interesting property. Assuming no cross-country correlation among the errors and T to be the same for all countries, the normalised statistic converges in distribution to a standard normal one, $\sqrt{N}\left(\frac{\bar{t}_{N,T} - E\left[\bar{t}_{N,T}\right]}{\sqrt{Var\left[\bar{t}_{N,T}\right]}}\right) \Rightarrow N(0,1)$, where $\Rightarrow$ denotes convergence in distribution $E\left[\bar{t}_{N,T}\right] = \mu$ and $Var\left[\bar{t}_{N,T}\right] = \sigma^2$ are tabulated on the basis of Monte-Carlo simulations (IPS, 1997). Applying this test to the seven variables under consideration, the null of non-stationarity can not be rejected for any variable (Table 2).[12] This result is robust to the choice of lag orders (up to three were considered here), as well as to the inclusion of time trend. To see how robust the results are to the specific aggregation used, a test for the existence of a unit root is also made for each variable in each country individually. Using ADF and Phillips-Perron tests, we find that for almost all countries the presence of a unit root for investment and GDP is not rejected. Results are somewhat more mixed in the case of financial development variables and the user cost of capital, though the null hypothesis of a unit root is not rejected in the majority of countries. Overall the results indicate that the variables have a unit root, *i.e.* that they are stationary in first differences, allowing to proceed with tests for cointegration.

3.3 Panel cointegration tests

16. Before conducting panel cointegration tests, individual cointegration tests are applied for the variables in each country, using the trace and max-eigen value statistic from the Johansen test. The results are consistent with the existence of one cointegrating relationship in most countries, with the evidence for a cointegration relationship being slightly stronger for the augmented as compared to the base model.[13]

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12. We also applied the unit root test suggested by Harris and Tzavalis (1999). The results were broadly similar, except when a time trend is included. In this case, the null hypothesis of non-stationary was rejected for the financial development variables. However, it has been shown on the basis of Monte-Carlo simulations (IPS, 1997) that the inclusion of a trend makes the tests less powerful.

13. Without inclusion of a trend (both with and without a constant), the null hypothesis of no cointegrating relationship could be rejected for most countries (and the null hypothesis of at most one could not be

Nevertheless, it should be borne in mind that these tests have low power in small samples (such as ours), which is one of the original motivations for applying panel cointegration tests.

17. The next step consists of applying the panel cointegration tests suggested by Pedroni (1995) and Kao (1999). They assume that the slope coefficients are the same across countries ("homogenous cointegration tests"). To see whether this is consistent with the data, we apply a Wald test comparing the $\beta_i = \beta$ for all i with unrestricted β_i 's (Pedroni, 2000) and a joint Hausman test. The Wald test rejects the null hypothesis of identical coefficients at conventional significance levels. However, Pesaran *et al*. (1998) argue that it typically rejects the null hypothesis in most applied examples and suggest using a joint Hausman test instead. On the basis of this test, the null of homogeneity can not be rejected in most cases. Specifically, homogeneity can not be rejected in the case of the model without financial development (a statistic of 3.17 with p-value 0.17) as well as when financial development is proxied either by private credit (2.82 with p-value 0.42), stock market capitalisation (1.21 with p-value 0.75) or total value traded (1.14 with p-value 0.78). While the results are different when financial development is proxied by liquid liabilities (15.06 with p-value 0.00), taking all the evidence together, we conclude that the homogeneity assumption is justified overall.[14] It appears to be a reasonable hypothesis as regards the long-run relationship for a sample of a relatively homogenous group such as the OECD countries. This may reflect, *inter alia*, arbitrage conditions or common technologies influencing all countries in a similar way.

18. The two suggested tests by Pedroni and Kao are based on the null of no cointegration. On the other hand, Kao (1999) presents a based test in the spirit of the Dickey-Fuller (DF) and the Augmented Dickey-Fuller (ADF) residual statistics. Each test uses OLS estimated residuals $\hat{u}_{i,t}$ from the estimated equation (1). The DF-type test consists of estimating ρ in the following form:

$$\hat{u}_{i,t} = \rho\hat{u}_{i,t-1} + v_{i,t} \tag{3}$$

and testing the null $H_0 : \rho = 1$. In this context, four different statistics are derived (see also Kao, 1999). They differ with regard to the assumptions regarding exogeneity of regressors with respect to the errors and possible cointegration with endogenous regressors. The ADF-type test is based on the following regression:

$$\hat{u}_{i,t} = \rho\hat{u}_{i,t-1} + \sum_{j=1}^{p}\psi_j \Delta\hat{u}_{i,t-j} + v_{i,t} \tag{4}$$

and the null $H_0 : \rho = 1$. On the other hand, the test suggested by Pedroni (1995) involves a non-parametric correction and is based on two statistics from a pooled Phillips and Perron-type test.

19. The results of the cointegration tests for the variables in equation (1), as well as for a sub-group that excludes the indicator of financial market development, are shown in Table 3. Almost all statistics reject the null of no cointegration.[15] An exception is the DF-t statistics. However, as shown in Kao (1996),

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rejected). However, when additional lags are included, the evidence becomes weaker in the case of some countries. Nevertheless, the null of no cointegration is still rejected for most countries.

14. We also experimented with heterogeneous panel cointegration tests (Pedroni, 1997 and 2000). The results obtained were broadly similar to those described here.

15. An alternative test is that for the null of cointegration, as suggested by McCoskey and Kao (1998*a* and *b*) and discussed in Banerjee (1999) and Baltagi and Kao (2000). Applying this type of test gives weaker results in favour of cointegration. However, these tests are quite new and the small size properties not as

when the cross-section and time series dimensions are comparable and the estimated variance is small (as is the case here), the DF-rho* and DF-t* tests have size and power properties superior to the DF_t statistics. This leads to the conclusion that the variables are co-integrated. This holds both for the variables in (1) and the sub-group consistent with the basic neo-classical model. If anything, the evidence for cointegration is slightly stronger when the financial development variables are included. Specifically, the DF-t* test rejects the null of no cointegration at a higher level of significance in the case of the model augmented by financial development variables than in the case of the base-investment model. The results from the test suggested by Pedroni are similar, also rejecting the null hypothesis of no cointegration.

4. Estimation results

20. Four different homogenous estimation approaches are used, the standard OLS, BCOLS (bias-corrected OLS), FMOLS (fully modified OLS) and DOLS (dynamic OLS) estimators described in Kao and Chiang (2000) and summarised in Annex 2. The results are reported in Table 4. The main findings are the following:

- In most cases, the coefficient on real GDP is significant and very close to unity, in conformity with theoretical priors. Exceptions are found in the case of the OLS estimator and in one instance when the BCOLS estimator is used.

- Second, the measure of the cost of capital (adjusted real interest rate) is almost always negative as predicted. Moreover, it is almost always significant when private credit, stock market capitalisation or value-traded are added to the basic specification. In the latter two cases, the coefficient on the cost of capital is close to unity when the DOLS method is used, consistent with the Cobb-Douglas production function specification.

- Third, the alternative proxies for financial market development are systematically significant, irrespective of the specific indicator and estimator chosen.

21. Given the traditional difficulties in identifying any significant cost of capital effect in empirical aggregate investment equations, the finding of relatively high coefficients on the adjusted real interest rate is an important result especially as, in the case of the FMOLS and DOLS methods, this is obtained jointly with the finding of a unit coefficient on output.[16] The higher parameter values for the cost of capital obtained under the FOMLS and DOLS are consistent with earlier findings by Caballero (1994) for US data. Applying the Stock and Watson (1993) procedure similar to the DOLS approach used in this paper, the author found a coefficient on the cost of capital close to minus one in a regression for US capital equipment, where the unit coefficient on output is imposed.

22. In this regard, the smaller coefficients obtained on output and the cost of capital in the cases of OLS and, to a lesser extent, BCOLS are not surprising given that, as pointed out by Chen, McCoskey and Kao (1999) and Caballero (1994), both approaches have a non-negligible bias in small samples. On that account the FMOLS and DOLS are preferable and should be given more weight. In addition, using Monte-Carlo simulation, Kao and Chiang (2000) show that the DOLS estimator performs best among the four estimators both in large and in small samples. However, the latter authors show that one important drawback of DOLS is that the results can be quite sensitive to the exact choice of number of leads and lags.

well analysed as those for the more standard test for the null of *no* cointegration. This is why we have more confidence in the results of the latter.

16. A similar result is obtained when an alternative measure of the cost of capital is used (Pelgrin and Schich, 2002).

To test for robustness of results in that respect, all combinations of up to three leads and lags were considered. As shown in Table 5, the coefficient estimates vary only slightly when the number of leads and lags is changed.

23. The significance of proxies for financial development provides support to the hypothesis that the latter is conducive to investment even in high-income countries, confirming earlier results reported in Leahy *et al.* (2001). It also expands on past work which has failed to identify a significant role for financial development in investment and capital accumulation in OECD countries, based on methods that do not fully exploit both the cross-sections and time dimensions. In this regard, however, the evidence captured by the time series dimension could well reflect factors other than financial development. In particular, the stock market variables may capture elements of the user cost of capital which are missing in the measure used in the specification. Such an omission may in fact bias the results in finding extra effects from financial developments, especially along the time-series dimension.

24. To test for the sensitivity of the results to the developments of the late 1990s, characterised by strong stock market gains and substantial declines in the relative price of capital goods, the equations have been re-estimated over the sample 1970-1995. The results shown in Table 6 are generally similar to the ones obtained over the full sample. While private credit, stock market capitalisation and total value traded are always significantly positive, the estimated coefficients suggest a much stronger role for private credit than for stock market indicators (stock market capitalisation and total value traded). This may reflect the importance of the so-called *bank-lending channel* of transmission of financial shocks to the real economy. In countries where private banks still represent the main source of capital funding for a large number of firms (such as in continental Europe), investment can be quite sensitive to changes in banks' deposits, in particular if the latter can not easily substitute between deposits and other sources of funds such as bonds or equities (Kashyap and Stein, 1994; Ramey, 1993). In such a case, an adverse shock on banks' liabilities, following for instance a tightening of monetary policy can generate a credit crunch and an abrupt retrenchment in investment, over and above the effect from the rise in the cost of capital. The results would thus suggest that despite the growing trends towards securitisation, bank lending remains a predominant source of capital funding in the majority of countries in the sample.

25. To shed further light on this, a "horse-race" exercise was conducted where private credit was included jointly with either stock market capitalisation or total value traded in equation (6). Table 7 shows that in both cases estimates support a much stronger effect of private credit on business investment than the two measures of stock market developments, though both variables remain significant, at least at the 10 per cent margin.[17] This differs from several previous empirical studies, but confirms specifically the hypothesis by Arestidis *et al.* (2001) that standard cross-section analysis tends to overestimate the role of stock market capitalisation. On the other hand, a comparison of the full and shorter sample also shows that the size and significance of the coefficient on private credit has diminished since 1995 relative to that of stock market capitalisation (in particular in the case of DOLS estimates), a factor consistent with the growing importance of sources of financing other than bank loans.

17. In principle, given that one of the financial market indicators is sufficient to yield a cointegration relationship, one would have to test for whether more than one cointegration vector can be found to make the results of Table 4 strictly comparable to those from Table 3. However, the application of a multiple-equation test akin to the *Johansen-Juselius* test in a time-series is cumbersome to apply in a panel setting and therefore beyond the scope of this paper.

5. The investment boom of the late 1990s: How much can be explained?

26. In order to see whether the general rise in investment rates in the second half of the 1990s in OECD countries could be largely explained by the set of determinants, the contributions of the variables to the change in the level of investment has been calculated. The results, which are based on the estimates from the specification using stock market capitalisation and on the DOLS method, are presented in Table 8. They show that the change in business investment between 1995 and 1999 can be largely explained by the determinants in the cases of Germany, France, Italy, Belgium and Spain. In contrast, only between about one-third and one-half of the increase in business investment over the same period in the United States, Japan, the United Kingdom, Canada, Denmark and Austria can be accounted for by changes in real GDP, the cost of capital and stock market capitalisation. To a lesser, albeit significant, extent increases in investment in Australia, Greece, the Netherlands and Sweden cannot be fully explained either. Considering that the approach focuses on the contribution of the long-run coefficients, it may be that some of the unexplained rise might be captured by short-run dynamic factors. In fact, a rise in the long-run desired capital stock typically leads to an overshooting in investment without implying an overshooting in the capital stock, as is well known from the accelerator mechanism. However, assuming a reasonable speed of adjustment, short-run dynamic factors could only play a limited role over a five-year period. Hence, the results from the empirical analysis would still support the view that investment has exceeded its long-run equilibrium level in a number of countries.[18]

27. The difficulties in explaining the rise in investment in some cases may also reflect the absence of factors which can not be easily incorporated in the context of regression analysis based on information that is pooled across a relatively large set of countries and that focuses on the flow equilibrium. Starting from the simple capital accumulation identity (equation (A-1.3)) shown in Annex 1, and after expressing capital and investment as a ratio of output, one can find that in steady-state equilibrium, the investment *rate* is a function of the capital-output ratio, the depreciation rate and the trend growth rate of output:

$$i = \frac{k(g+\delta)}{(1+g)} \qquad (7)$$

where i is the ratio of real gross business investment to real GDP and k is the capital-output ratio.[19] The contributions of a change either in trend output growth (g) or the depreciation rate (δ) to the long-run stock equilibrium are not really captured in the regressions reported above, even though they could have played a significant role in some countries, in particular the United States. For instance, investment can be expected to rise faster than output for several years when an economy is adjusting to a higher trend output growth rate, which requires a higher investment rate to be maintained in the long run. Although it has become clearer recently that part of the sharp acceleration in US output in the 1990s was cyclical, a higher trend growth rate nevertheless looks likely to be sustained in the medium run.

28. Likewise, the possible change in the rate of depreciation has not been taken into account in the measurement of the cost of capital and therefore in the empirical estimates. And, while the shifting

18. Using a short-run dynamic model of investment growth for the United States and a one-step ahead forecast procedure, McCarthy (2001) finds that the strong growth in equipment expenditures in the late 1990s can be largely explained by output growth, changes in the rental cost of capital and equity values, and by lagged investment. In contrast, the model can not easily explain the steep decline in investment growth in 2000-01.

19. Under the simple version of the neo-classical growth model based on the Cobb-Douglas production function, the steady-state equilibrium capital-output ratio is a function of the cost of capital, as shown in Annex 1.

composition of capital towards computers and software, which tend to depreciate faster, may have increased the cost of capital and thereby reduced the desired capital-output ratio (k in equation 7), it would also have raised gross investment requirements. Estimates for the United States based on data for net capital stock and gross investment suggest an increase in the depreciation rate from around 4 per cent in the late 1980s to nearly 9 per cent the late 1990s.[20] Given that part of this implicit increase reflects market depreciation (*i.e.* capital losses due to the faster decline in capital goods' relative price) it probably overstates the extent of physical depreciation (*i.e.* the loss of value due to the ageing of the asset).[21] Nevertheless, even a more modest increase to around 6 per cent would, if sustained, have a huge impact on the longer-run equilibrium gross investment rate in the United States.

29. To illustrate the potential influence of these two factors, equation (7) can be used to compute rough estimates of steady-state investment rates for G-7 countries on the basis of assumptions regarding the trend growth rate of GDP, the capital-output ratio and the depreciation rate (Table 9). Looking at the results, it stands out that despite the capital spending boom of the late 1990s, the US business investment rate, at around 15 per cent, would still be at the low end of the range of estimated steady-state rates if it were assumed that the rise in trend output growth and the depreciation rate were permanent. Taken at face value, these simple calculations would suggest that if some excess investment took place during the 1990s, the recent retrenchment might have already brought the investment rate to a more sustainable level.[22] The results for other G-7 countries show current business investment rates within the "sustainable" range, albeit generally closer to the upper end.

6. Conclusions

30. In this paper, a set of business investment equations for OECD countries has been estimated using panel cointegration techniques over the period 1970-99. In addition to the level of output and the cost of capital, the set of determinants included alternative measures of financial market development. The estimation was performed based on OLS as well as on three alternative procedures correcting for parameter biases in finite samples. In most cases, the results were consistent with the predictions of the basic neo-classical model. First, the coefficient on output is close to one, consistent with a constant capital output ratio in the steady state. Previous papers often have either identified coefficients significantly different from one or had to impose a unit coefficient *a priori*. Second, the user cost of capital measure is negative and significant, as expected. The finding of a strong cost-of-capital effect has always been difficult to obtain in the case of aggregate data.

31. The alternative proxies for financial market development -- liquid liabilities, private credit, the ratio of stock market capitalisation to GDP and the value of domestic share traded -- are systematically significant, irrespective of the specific indicator and estimator chosen. While this can be seen as providing some support for the hypothesis that financial development contributes to growth through its effect on the level of investment, these variables could also capture elements of the user cost of capital which are missing from the measure of relative price used in the estimates. Among the proxies for financial

20. This is obtained from re-arranging the capital accumulation identity to solve for the depreciation rate. Tevlin and Whelan (2000) show that as a result of the shift in the compositional mix, the aggregate depreciation rate for *equipment* in the United States has risen from 0.13 in 1990 to 0.16 in 1997.

21. Referring to equation (A1-5) in Annex 1, market depreciation is captured by the term π_t and the physical depreciation by the parameter δ. Market depreciation is assumed to be zero in the steady state.

22. A similar conclusion is reached by Tevlin and Whelan (2000) who argue that the US investment boom of the late 1990s can be attributed to the rise in capital depreciation and the higher sensitivity of investment to the cost of capital.

development, the estimated coefficients suggest a stronger role for private credit, than for stock market indicators. However, the relative significance of the latter has grown during the second half of the 1990s.

32. Based on these estimation results, the rise in the volume of business investment observed in a number of countries during the second half of the 1990s can only be partly explained by output growth, the steady decline in the relative price of capital goods and, until mid-2000, the relatively low cost of equity financing. This is particularly the case for most countries where real business investment has been buoyant, but also for Japan where investment has grown very modestly. On that basis, the empirical analysis would tend to support the view that investment has exceeded its steady-state level, not least in the United States. In the latter case, however, increases in depreciation rates associated with the changes in the composition of capital, may have boosted gross investment sufficiently to make the current investment rate look sustainable.

ANNEX 1. CONCEPTUAL FRAMEWORK

33. In the neo-classical theory of investment (Jorgensen, 1971), the long-run desired capital stock can be derived from the solution of a multi-period profit maximisation problem by a representative firm. In a simple version of the framework that ignores tax considerations and uncertainty, the profit or cash-flow relationship of the firm can be simply expressed as:

$$R_t = P_t Y_t - (W_t L_t \lambda_t) - q_t I_t \tag{A1-1}$$

where P_t is the output price, Y_t is real output, W_t is the efficiency wage, L_t is the number of hours worked, λ_t is an index of labour-augmenting technical progress, q_t is the price of investment good and I_t is gross investment.[23] The production technology can be characterised by a two-factor Cobb-Douglas production function with Harrod-neutral technical progress and constant returns to scale:

$$Y_t = A \cdot K_t^{\alpha} \cdot (L_t \ \lambda_t)^{1-\alpha} \tag{A1-2}$$

where K is the aggregate capital stock and α represents the share of capital in total income. Assuming that capital depreciates at the rate δ, capital accumulates according to the following identity:

$$K_{t+1} = (1-\delta)K_t + I_t \tag{A1-3}$$

34. The standard objective of the firm is to maximise the present value of the future path of revenues (A1-1) under the constraints of technology (A1-2) and the capital accumulation process (A1-3).

$$V_t = \sum_{i=1}^{T} \frac{R_{t+i}}{\prod_{j=1}^{i}(1+r_{t+j})} \tag{A1-4}$$

where r_t is the nominal discount rate. The firm's problem consists of choosing K_t and L_t to maximise the present value V_t. Under the simplifying assumption of no adjustment costs, the multi-period dimension is reduced to a two-period optimisation problem. Substituting (A1-1) to (A1-3) into (A1-4) and taking the derivatives with respect to K_t gives the familiar first-order condition linking capital to real output and the relative price of capital.

$$K_t = \frac{\alpha Y_t}{\frac{q_t}{p_t}\left(\frac{(1+r_t)}{(1+\pi_t)} - 1 + \delta\right)} \tag{A1-5}$$

23. q_t truly is the shadow price of capital and is equal to the price of investment good only under the assumption of no adjustment costs.

where $(1+\pi_t) = q_t / q_{t-1}$, the rate of change of the price of the capital good, also referred to as the rate of market depreciation, which is distinct from the rate of physical depreciation δ that measures the loss of value due to the ageing of the asset. Following Jorgensen's approach and ignoring time indices, the cost of capital can be defined as:

$$c = q\left(\frac{(1+r)}{(1+\pi)} - 1 + \delta\right) \qquad \text{(A1-6)}$$

and re-write the equilibrium condition as:

$$K = \frac{\alpha Y}{c / P} \qquad \text{(A1-7)}$$

35. Equation (A1-7), which represents a long-run equilibrium condition, can be estimated as a cointegration relationship between capital, the level of real output and the real user cost of capital. Note that although the endogenous variable in (A1-7) should be the capital stock, there are certain conditions under which it can be replaced by gross investment while keeping the rest of the specification unchanged. The equivalence stems from the fact that according to the capital accumulation identity (A1-3), and assuming a constant growth rate of the capital stock in the steady state, gross investment can be expressed as a constant fraction of the capital stock:

$$I_t = (g + \delta) K_{t-1} \qquad \text{(A1-8)}$$

where g is the (constant) growth rate of real output and the capital stock. In the steady state, K_{t-1} can be replaced by its long-run equilibrium value as given by (A1-7). Under these conditions, a long-run relationship between gross investment, output and the cost of capital can be written in log-linear form:

$$i = \alpha' + y - (c - p) \qquad \text{(A1-9)}$$

where $\alpha' = \log(g + \delta) + \log(\alpha)$ and $c - p$ stands for the real user cost of capital. Except for the difference in the constant terms, this long-run equilibrium expression for gross investment is equivalent to that for the capital stock. The main advantage of this specification is that compared to gross investment, the reliability of aggregate capital stock data has in many countries been increasingly called into question, reflecting serious measurement difficulties.

ANNEX 2. DESCRIPTION OF ALTERNATIVE ESTIMATORS

36. To describe the four different estimators used, equation (1) can be re-written as follows:

$$\begin{aligned} \boldsymbol{Y} &= \alpha + \boldsymbol{X}^{\boldsymbol{t}}\beta + \boldsymbol{u}_1 \\ \Delta\boldsymbol{X} &= \boldsymbol{u}_2 \end{aligned} \qquad \text{(A2-1)}$$

where Y is an NT x 1 vector, β is a 3 x 1 vector of the slope parameters and X is a 3 x NT matrix composed of each regressor (output, real adjusted interest rate and one of the measures of financial development), with N the number of countries and T the number of years. u_1 and u_2 are NT x 1 vectors of residuals. The second equality in (A2-1) states that the independent variables are an integrated process of order one for all i so that their first differences are stationary. Under these specifications, equation (A2-1) specifies a system of cointegrated regressions. In addition, we assume that $\{y_{i,t}, x_{i,t}\}$ are independent across countries and $w_{i,t} = \{u_{i,t}, \varepsilon_{i,t}^{'}\}^{'}$ satisfies the assumptions of Kao and Chiang (2000).

37. The standard OLS estimator, $\hat{\beta}_{\boldsymbol{OLS}}$, is obtained by subtracting individual means for each cross-section and regressing $\boldsymbol{y}_{\boldsymbol{i},\boldsymbol{t}} - \boldsymbol{y}_{\boldsymbol{i},.}$ on $\boldsymbol{x}_{\boldsymbol{it},\boldsymbol{k}} - \boldsymbol{x}_{\boldsymbol{i}.,\boldsymbol{k}}$, where $y_{i,.}$ and $y_{i.,k}$ are the mean of the dependent variable of each cross-section element and the mean of the *k*-th explanatory variable for each cross-section and *k* denotes the *k*-th regressor with *k*=1, 2 and 3, i.e. the OLS estimator of β is $\hat{\beta}_{OLS} = \left[\sum_{i=1}^{N}\sum_{t=1}^{T}(x_{i,t}-\bar{x}_i)(x_{i,t}-\bar{x}_i)^{'}\right]^{-1}\left[\sum_{i=1}^{N}\sum_{t=1}^{T}(x_{i,t}-\bar{x}_i)(y_{i,t}-\bar{y}_i)\right]$ where $\bar{x}_i = (1/T)\sum_{t=1}^{T}x_{i,t}$ and $\bar{y}_i = (1/T)\sum_{t=1}^{T}y_{i,t}$.

The BCOLS is obtained by subtracting an error correction term from the standard OLS estimator, *i.e.* $\hat{\beta}_{BCOLS} = \hat{\beta}_{OLS} - \frac{\hat{\delta}}{T}$. The FMOLS estimator is obtained by modifying the variable $\boldsymbol{y}_{\boldsymbol{i},\boldsymbol{t}}$ to correct for possible endogeneity, $\boldsymbol{y}_{\boldsymbol{i},\boldsymbol{t}}^{+} = \boldsymbol{y}_{\boldsymbol{i},\boldsymbol{t}} - \hat{\Omega}\Delta\boldsymbol{x}_{\boldsymbol{i},\boldsymbol{t}}$, where $\hat{\Omega}$ is derived from consistent estimates of partitioned elements of the long-run covariance matrix of $\{w_{i,t}\}$. As well, a term, $\hat{\Delta}_{\varepsilon u}^{+}$, is included to correct for serial correlation, with $\hat{\Delta}_{\varepsilon u}^{+} = \hat{\Delta}_{\varepsilon u} - \hat{\Delta}_{\varepsilon}\hat{\Omega}^{'}$ where $\hat{\Delta}_{\varepsilon u}$ and $\hat{\Delta}_{\varepsilon}$ are kernel estimates of their respective elements in the one-sided long-run covariance matrix of $\{w_{i,t}\}$. Thus, the FMOLS estimator is $\hat{\beta}_{FMOLS} = \left[\sum_{i=1}^{N}\sum_{t=1}^{T}(x_{it}-\bar{x}_i)(x_{it}-\bar{x}_i)'\right]^{-1}\left[\sum_{i=1}^{N}\left(\sum_{t=1}^{T}(x_{it}-\bar{x}_i)\hat{y}_{it}^{+} - T\hat{\Delta}_{\varepsilon u}^{+}\right)\right]$

Finally, the DOLS estimator is calculated by estimating the following equation:

$$\begin{aligned} \mathrm{i}_{\mathrm{i,t}} &= \alpha + \beta_1 \mathrm{y}_{\mathrm{i,t}} + \beta_2(\mathrm{c}_{\mathrm{i,t}} - \mathrm{p}_{\mathrm{i,t}}) + \beta_3 \mathrm{fd}_{\mathrm{i,t}} \\ &+ \sum_{\mathrm{j=-p}}^{\mathrm{q}} \gamma_{\mathrm{j}}^{1}\Delta \mathrm{y}_{\mathrm{i,t+j}} + \sum_{\mathrm{j=-p}}^{\mathrm{q}} \gamma_{\mathrm{j}}^{2}\Delta(\mathrm{c}_{\mathrm{i,t+j}} - \mathrm{p}_{\mathrm{i,t+j}}) + \sum_{\mathrm{j=-p}}^{\mathrm{q}} \gamma_{\mathrm{j}}^{3}\Delta \mathrm{fd}_{\mathrm{i,t+j}} + \mathrm{u}_{\mathrm{i,t}} \end{aligned}$$

where *q* and *p* are the lead and lag orders.

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Table 1. **Gross investment as a per cent of GDP**

(Average over sub-periods)

	1980s	1990s	1990-1994	1995-1999	Change between: 1980s and 1990s	Change between: First and second half of 1990s
United States						
Total fixed	20.1	18.4	17.5	19.3	-1.7	1.8
Public	3.6	3.4	3.5	3.2	-0.3	-0.3
Private	16.5	15.1	14.0	16.1	-1.4	2.1
Household	4.3	3.9	3.7	4.1	-0.5	0.4
Business	12.1	11.2	10.4	12.0	-0.9	1.7
Of which: M & E[1]	7.8	8.2	7.4	9.0	0.5	1.6
Japan						
Total fixed	29.3	28.9	30.4	27.5	-0.4	-2.9
Public	7.6	7.7	7.4	7.9	0.1	0.5
Private	21.7	21.2	22.9	19.5	-0.4	-3.4
Household	5.3	4.8	5.1	4.5	-0.5	-0.6
Business	16.4	16.4	17.8	15.0	0.0	-2.8
Of which: M & E[1]		10.6	10.8	10.3		-0.5
Germany						
Total fixed	21.0	22.4	23.1	21.7	1.4	-1.5
Public	2.6	2.3	2.7	2.0	-0.3	-0.7
Private	18.4	20.1	20.4	19.7	1.7	-0.8
Household	5.8	7.1	6.7	7.5	1.3	0.8
Business	12.6	12.9	13.7	12.2	0.4	-1.6
Of which: M & E[1]	8.6	9.0	9.6	8.5	0.4	-1.2
France						
Total fixed	21.7	19.7	20.8	18.5	-2.0	-2.2
Public	3.3	3.3	3.5	3.0	0.0	-0.5
Private	18.4	16.4	17.2	15.5	-2.1	-1.8
Household	6.1	4.8	5.0	4.6	-1.3	-0.3
Business	12.3	11.6	12.3	10.9	-0.8	-1.4
Of which: M & E[1]	10.2	10.2	10.6	9.9	0.1	-0.6
Italy						
Total fixed	22.6	19.2	19.9	18.5	-3.4	-1.4
Public	3.6	2.6	2.9	2.3	-1.0	-0.6
Private	19.1	16.6	17.0	16.2	-2.5	-0.8
Household	6.2	5.0	5.4	4.5	-1.2	-0.9
Business	12.8	11.6	11.6	11.7	-1.2	0.1
Of which: M & E[1]	11.4	10.2	10.1	10.4	-1.2	0.4
United Kingdom						
Total fixed	18.5	17.1	17.3	16.9	-1.4	-0.4
Public	2.3	2.1	2.5	1.6	-0.2	-0.9
Private	16.2	15.1	14.8	15.3	-1.2	0.5
Household	4.3	3.7	3.7	3.7	-0.7	0.0
Business	11.9	11.4	11.2	11.6	-0.5	0.5
Of which: M & E[1]	9.0	8.5	8.1	8.8	-0.5	0.7
Canada						
Total fixed	21.4	18.6	18.7	18.4	-2.8	-0.3
Public	2.8	2.5	2.7	2.2	-0.4	-0.5
Private	18.5	16.1	16.0	16.2	-2.4	0.2
Household	5.9	5.3	5.7	4.9	-0.6	-0.8
Business	12.7	10.8	10.4	11.3	-1.8	1.0
Of which: M & E[1]	9.3	8.6	8.4	8.8	-0.7	0.5

1. Machinery and equipment.
Source: OECD.

Table 1. **Gross investment as a per cent of GDP** (cont.)

(Average over sub-periods)

	1980s	1990s	1990-1994	1995-1999	Change between: 1980s and 1990s	Change between: First and second half of 1990s
Australia						
Total fixed	25.5	22.7	22.2	23.2	-2.8	0.9
Public	2.9	2.4	2.6	2.3	-0.5	-0.3
Private	22.6	20.3	19.7	20.8	-2.3	1.2
Household	4.8	4.9	4.9	5.0	0.2	0.2
Business	17.8	15.3	14.8	15.8	-2.5	1.0
Of which: M & E[1]	8.6	8.2	7.5	8.9	-0.4	1.3
Austria						
Total fixed	21.8	23.2	23.0	23.5	1.4	0.5
Public	3.5	2.7	3.1	2.3	-0.8	-0.8
Private	18.3	20.5	19.8	21.1	2.2	1.3
Household	5.5	6.1	5.6	6.6	0.6	1.0
Business	12.8	14.4	14.2	14.5	1.6	0.3
Of which: M & E[1]	9.5	9.5	9.6	9.4	0.0	-0.2
Belgium						
Total fixed	19.4	21.0	21.3	20.6	1.5	-0.6
Public	3.4	1.7	1.8	1.7	-1.7	-0.2
Private	16.0	19.2	19.5	19.0	3.2	-0.5
Household	4.0	5.1	5.0	5.2	1.1	0.1
Business	12.0	14.1	14.4	13.8	2.1	-0.6
Of which: M & E[1]	..	..	..	..	..	..
Denmark						
Total fixed	20.3	18.9	18.3	19.4	-1.4	1.2
Public	2.2	1.8	1.7	1.8	-0.5	0.1
Private	18.1	17.1	16.5	17.6	-1.0	1.1
Household	4.6	3.8	3.5	4.1	-0.9	0.6
Business	13.4	13.3	13.0	13.6	-0.1	0.5
Of which: M & E[1]						
Finland						
Total fixed	26.5	19.4	20.9	17.8	-7.1	-3.2
Public	3.4	3.1	3.3	2.9	-0.3	-0.4
Private	23.0	16.3	17.7	14.9	-6.8	-2.8
Household	6.7	4.5	5.1	3.9	-2.2	-1.2
Business	16.3	11.8	12.5	11.0	-4.6	-1.5
Of which: M & E[1]	13.9	7.0	7.5	6.6	-6.9	-0.8
Greece						
Total fixed	24.2	20.8	21.2	20.4	-3.4	-0.8
Public	3.1	3.2	3.0	3.5	0.1	0.5
Private	21.0	17.6	18.2	16.9	-3.5	-1.3
Household	9.5	6.0	6.7	5.2	-3.6	-1.6
Business	11.5	11.6	11.5	11.8	0.1	0.3
Of which: M & E[1]	..	..	..	..	..	..
Netherlands						
Total fixed	21.4	21.2	21.1	21.3	-0.2	0.2
Public	3.2	3.0	3.0	3.0	-0.2	0.0
Private	18.2	18.2	18.1	18.3	0.1	0.2
Household	6.0	5.7	5.5	5.8	-0.4	0.3
Business	12.1	12.6	12.6	12.5	0.5	-0.1
Of which: M & E[1]	6.8	7.1	7.1	7.1	0.2	0.0
New Zealand						
Total fixed	23.4	19.6	18.3	20.8	-3.9	2.5
Public	6.7	3.2	3.4	3.0	-3.5	-0.4
Private	16.7	16.4	14.9	17.8	-0.3	2.9
Household	4.2	5.1	4.6	5.6	0.9	1.0
Business	12.5	11.2	10.3	12.2	-1.3	1.9
Of which: M & E[1]	13.3	13.2	14.1	12.3	-0.1	-1.8

1. Machinery and equipment.

Source: OECD.

Table 1. **Gross investment as a per cent of GDP** (cont.)

(Average over sub-periods)

	1980s	1990s	1990-1994	1995-1999	Change between: 1980s and 1990s	Change between: First and second half of 1990s
Norway						
Total fixed	27.0	21.5	20.6	22.4	-5.5	1.8
Public	3.5	3.5	3.5	3.4	-0.0	-0.1
Private	23.5	18.1	17.1	19.0	-5.5	1.9
Household	5.5	2.7	2.6	2.8	-2.8	0.1
Business	18.1	15.4	14.5	16.3	-2.7	1.8
Of which: M & E[1]	6.3	5.1	4.8	5.5	-1.2	0.7
Spain						
Total fixed	22.4	22.9	23.3	22.5	0.5	-0.8
Public	3.2	3.9	4.5	3.3	0.7	-1.2
Private	19.2	19.0	18.8	19.3	-0.2	0.5
Household	6.3	5.5	5.5	5.6	-0.7	0.1
Business	12.9	13.5	13.3	13.7	0.5	0.4
Of which: M & E[1]	10.7	10.2	10.2	10.2	-0.5	0.1
Sweden						
Total fixed	20.6	17.1	18.4	15.8	-3.5	-2.6
Public	2.9	2.7	2.9	2.6	-0.2	-0.3
Private	17.7	14.4	15.5	13.2	-3.3	-2.3
Household	4.5	3.1	4.6	1.6	-1.4	-2.9
Business	13.2	11.3	11.0	11.6	-1.9	0.6
Of which: M & E[1]						

1. Machinery and equipment.

Source: OECD.

Table 2. **Panel unit root tests**

	Variables	t-value	p-value
Im, Pesaran and Shin (1995)			
Without time trend	Investment	7.55	0.00
	Gross domestic product	7.52	0.00
	Real adjusted interest rate	7.18	0.00
	Liquid liabilities	7.39	0.00
	Private credit	7.66	0.00
	Stock market capitalisation	6.49	0.00
	Total value traded	6.46	0.00
With time trend	Investment	10.80	0.00
	Gross domestic product	10.72	0.00
	Real adjusted interest rate	10.95	0.00
	Liquid liabilities	10.40	0.00
	Private credit	10.87	0.00
	Stock market capitalisation	9.37	0.00
	Total value traded	9.27	0.00

Table 3. **Panel co-integration tests**

	Benchmark model	Inclusion of financial development variables			
	Without financial development	Liquid liabilities	Private credit	Stock market capitalisation	Total value traded
Pedroni (1995)[1]					
PC1	-13.93	-15.41	-15.32	-17.76	-18.09
PC2	-13.69	-15.14	-15.05	-17.37	-17.71
Kao (1999)[2]					
ADF	-3.52	-4.00	-3.91	-5.97	-5.03
Kao (1999)[3]					
DF-rho	-3.55	-4.18	-4.13	-5.33	-5.48
DF-t	19.33	18.81	18.87	13.99	13.90
DF-rho*	-6.91	-7.87	-7.85	-8.67	-9.19
DF-t*	-2.30	-2.65	-2.60	-3.39	-3.45

Note: All tests are left-hand side, i.e. large negative values are used to reject the null of no co-integration. Given that the null hypothesis is strongly rejected in all cases except for the Df-t panel test (bottom row), P-values are not reported in the table.

1. PC1 and PC2 are based on the non-parametric Phillips-Perron test in time series. Regressors are assumed to be strictly exogenous and the limiting distributions are free of nuisance parameters.
2. ADF test is analogous to the parametric Augmented Dickey-Fuller test for non-stationary time series. The statistic does not depend on consistent estimates of long-run parameters.
3. DF test is analogous to the parametric Dickey-Fuller test for non-stationary time series. The DF-rho and DF-t statistics assume strict exogeneity of the regressors with respect to errors and no auto-correlation. DF-rho* and DF-t* statistics are based upon endogenous regressors. These tests depend on consistent estimates of the long-run variance-covariance matrix to correct for nuisance parameters once the limiting distribution has been found.

Table 4. **Panel estimates of investment equations**
(Data from 1970 to 1999 for 18 countries)

	Benchmark model	Inclusion of financial development variables			
	Without financial development	Liquid liabilities	Private credit	Stock market capitalisation[2]	Total value traded[2]
OLS estimates					
Financial development[1]		0.162	0.115	0.045	0.019
		(0.037)**	(0.022)**	(0.013)**	(0.008)**
Gross domestic product	1.230	1.158	1.158	1.423	1.396
	(0.031)**	(0.034)**	(0.036)**	(0.049)**	(0.045)**
Adjusted real interest rate	-0.290	-0.291	-0.445	-0.376	-0.409
	(0.191)	(0.187)	(0.187)**	(0.169)**	(0.137)**
Memorandum item: R^2	0.78	0.78	0.79	0.88	0.88
Bias-corrected OLS estimates					
Financial development[1]		0.219	0.145	0.045	0.016
		(0.071)**	(0.045)**	(0.015)**	(0.008)**
Gross domestic product	1.181	1.083	1.048	1.352	1.393
	(0.076)**	(0.078)**	(0.082)**	(0.078)**	(0.080)**
Adjusted real interest rate	-0.300	-0.299	-0.508	-0.305	-0.313
	(0.256)	(0.247)	(0.246)**	(0.202)	(0.204)**
Memorandum item: R^2	0.78	0.78	0.79	0.88	0.88
FMOLS estimates					
Financial development[1]		0.387	0.257	0.045	0.036
		(0.074)**	(0.046)**	(0.016)**	(0.008)**
Gross domestic product	0.926	0.931	0.933	0.931	0.933
	(0.079)**	(0.081)**	(0.085)**	(0.081)**	(0.084)**
Adjusted real interest rate	-0.259	-0.183	-1.071	-1.704	-1.810
	(0.266)	(0.256)	(0.254)**	(0.211)**	(0.213)**
Memorandum item: R^2	0.73	0.77	0.77	0.74	0.79
DOLS estimates[3]					
Financial development[1]		0.180	0.166	0.064	0.041
		(0.076)**	(0.050)**	(0.018)**	(0.009)**
Gross domestic product	1.004	0.995	0.998	1.006	1.005
	(0.082)**	(0.084)**	(0.092)**	(0.090)**	(0.093)**
Adjusted real interest rate	0.105	0.090	-0.505	-1.227	-0.969
	(0.275)	(0.266)	(0.274)*	(0.232)**	(0.235)**
Memorandum item: R^2	0.54	0.62	0.68	0.72	0.76

Note: Standard deviation shown in brackets. ** significant at 5 per cent level. * significant at 10 per cent level.

1. Financial development is alternatively proxied by liquid liabilities, private credit, stock market capitalisation and total value traded.
2. When measuring financial development by stock market and total value traded, data availability required reducing the sample size to 16 countries. Excluding stock market capitalisation from the sample leads to a coefficient estimate for gross domestic product of a similar magnitude.
3. The results shown here are those for our preferred lead-lag combination. They are one lead and no lag (1,0) for the model without financial development, (1,0) for liquid liabilities, (2,0) for private credit and (0,2) for stock market capitalisation and total value traded.

Table 5. **Robustness of DOLS estimates to different lead and lag profiles**

	Benchmark model	Financial development variables			
	Without financial development	Liquid liabilities	Private credit deposits	Stock market capitalisation[2]	Total value traded[2]
Financial development[1]		(0.176;0.213)	(0.165;0.178)	(0.044;0.066)	(0.035;0.047)
Gross domestic product	(0.998;1.004)	(0.987;0.995)	(0.989;1.001)	(1.001;1.009)	(1.002;1.008)
Real adjusted interest rate	(0.074;0.817)	(0.080;0.957)	(-0.505;0.295)	(-1.958;-0.736)	(-1.324;-0.507)

1. Financial development is alternatively proxied by liquid liabilities, private credit, stock market capitalisation and total value traded.
2. The maximum number of leads and lags was set to 3.

Table 6. **Estimates of investment equations over the period 1970-1995**

	Benchmark model	Inclusion of financial development variables			
	Without financial development	Liquid liabilities	Private credit	Stock market capitalisation[2]	Total value traded[2]
OLS estimates					
Financial development[1]		0.117 (0.042)**	0.087 (0.024)**	0.039 (0.015)**	0.020 (0.006)**
Gross domestic product	1.174 (0.037)**	1.122 (0.041)**	1.094 (0.043)**	1.476 (0.060)*	1.416 (0.055)**
Adjusted real interest rate	-0.174 (0.189)	-0.164 (0.189)	-0.267 (0.190)	-0.408 (0.189)**	-0.468 (0.184)**
Memorandum item: R^2	0.74	0.74	0.75	0.84	0.84
Bias-corrected OLS estimates					
Financial development[1]		0.168 (0.072)**	0.120 (0.046)**	0.037 (0.017)**	0.012 (0.008)
Gross domestic product	1.125 (0.078)**	1.048 (0.082)**	1.013 (0.087)**	1.416 (0.086)**	1.391 (0.092)*
Adjusted real interest rate	-0.187 (0.251)**	-0.169 (0.247)	-0.315 (0.246)	-0.410 (0.220)*	-0.515 (0.232)**
Memorandum item: R^2	0.74	0.74	0.75	0.84	0.84
FMOLS estimates					
Financial development[1]		0.398 (0.075)**	0.273 (0.048)**	0.036 (0.018)**	0.030 (0.009)**
Gross domestic product	0.925 (0.081)**	0.931 (0.085)**	0.932 (0.090)**	0.932 (0.090)**	0.931 (0.097)**
Adjusted real interest rate	-0.180 (0.262)	-0.107 (0.257)	-0.980 (0.256)**	-1.441 (0.233)**	-1.513 (0.245)**
Memorandum item: R^2	0.71	0.72	0.71	0.67	0.71
DOLS estimates[3]					
Financial development[1]		0.169 (0.078)**	0.178 (0.051)**	0.058 (0.020)**	0.037 (0.010)**
Gross domestic product	1.005 (0.085)**	0.995 (0.090)**	0.996 (0.099)**	1.004 (0.103)**	1.004 (0.106)**
Adjusted real interest rate	0.126 (0.273)	0.107 (0.268)	-0.446 (0.271)*	-0.975 (0.262)**	-0.709 (0.271)**
Memorandum item: R^2	0.51	0.59	0.68	0.71	0.73

Note: Standard deviation in shown brackets. ** significant at 5 per cent level. * significant at 10 per cent level.

1. Financial development is alternatively proxied by liquid liabilities, private credit, stock market capitalisation and total value traded.
2. When measuring financial development by stock market and total value traded, data availability required reducing the sample size to 16 countries. Excluding stock market capitalisation from the sample leads to a coefficient estimate for gross domestic product of a similar magnitude.
3. The results shown here are those for our preferred lead-lag combination. They are one lead and no lag (1,0) for the model without financial development, (1,0) for liquid liabilities, (2,0) for private credit and (0,2) for stock market capitalisation and total value traded.

Table 7. **Relative importance of indicators of financial market development**

	1976-95	1976-99	1976-95	1976-99
OLS estimates				
Financial development				
Private credit	0.243	0.204	0.280	0.251
	(0.056)**	(0.048)**	(0.057)**	(0.049)**
Stock market capitalisation	0.063	0.063		
	(0.014)**	(0.012)**		
Total value traded			0.025	0.029
			(0.006)**	(0.005)**
Gross domestic product	1.233	1.259	1.251	1.250
	(0.063)**	(0.051)**	(0.063)**	(0.052)**
Adjusted real interest rate	-0.399	-0.470	-0.410	-0.483
	(0.177)**	(0.159)**	(0.178)**	(0.159)**
Memorandum item: R^2	0.86	0.89	0.85	0.90
Bias-corrected OLS estimates				
Financial development				
Private credit	0.284	0.225	0.319	0.275
	(0.081)**	(0.077)**	(0.085)**	(0.079)**
Stock market capitalisation	0.062	0.063		
	(0.016)**	(0.014)**		
Total value traded			0.018	0.026
			(0.008)**	(0.007)**
Gross domestic product	1.148	1.180	1.201	1.189
	(0.092)**	(0.080)**	(0.097)**	(0.007)**
Adjusted real interest rate	-0.463	-0.480	-0.466	-0.490
	(0.205)**	(0.080)**	(0.097)**	(0.084)**
Memorandum item: R^2	0.86	0.90	0.85	0.90
FMOLS estimates				
Financial development				
Private credit	0.427	0.356	0.397	0.293
	(0.085)**	(0.081)**	(0.089)**	(0.083)**
Stock market capitalisation	-0.006	0.013		
	(0.017)	(0.015)		
Total value traded			0.004	0.018
			(0.008)	(0.008)**
Gross domestic product	0.930	0.932	0.931	0.933
	(0.096)**	(0.084)**	(0.103)**	(0.088)**
Adjusted real interest rate	-1.121	-1.612	-1.115	-1.557
	(0.215)**	(0.129)**	(0.103)**	(0.195)**
Memorandum item: R^2	0.74	0.78	0.75	0.81
DOLS estimates				
Financial development				
Private credit	0.266	0.240	0.249	0.218
	(0.095)**	(0.088)**	(0.100)**	(0.091)**
Stock market capitalisation	0.029	0.036		
	(0.018)*	(0.016)**		
Total value traded			0.015	0.020
			(0.009)*	(0.008)**
Gross domestic product	1.005	1.006	1.004	1.005
	(0.108)**	(0.092)**	(0.115)**	(0.096)**
Adjusted real interest rate	-0.594	-0.923	-0.511	-0.866
	(0.241)**	(0.211)**	(0.251)**	(0.214)**
Memorandum item: R^2	0.71	0.74	0.71	0.74

Note: Standard deviation shown in brackets. ** significant at 5 per cent level. * significant at 10 per cent level.

Table 8. **Contributions to the changes in real business investment between 1995 and 1999**

	United States	Japan	Germany	France	Italy	United Kingdom	Canada	
Percentage changes in investment	50.3	10.5	12.1	18.2	21.3	48.9	44.3	
Contribution from:								
Real GDP	17.5	5.0	6.1	9.8	6.7	11.5	15.7	
Real-adjusted interest rate	0.5	1.3	0.8	1.8	5.5	3.9	1.9	
Stock market capitalisation	3.6	0.1	5.2	4.2	5.7	1.8	2.7	
Total explained[1]	21.5	6.4	12.0	15.9	17.9	17.2	20.3	
	Australia	**Austria**	**Belgium**	**Denmark**	**Greece**	**Netherlands**	**Spain**	**Sweden**
Percentage changes in investment	34.8	23.1	24.5	42.3	52.1	36.2	32.9	29.9
Contribution from:								
Real GDP	18.8	9.8	10.2	10.9	12.9	15.9	15.9	11.4
Real-adjusted interest rate	3.7	0.8	2.0	4.7	3.3	2.5	5.3	4.1
Stock market capitalisation	1.6	1.8	10.3	2.2	21.4	6.5	8.4	6.0
Total explained[1]	24.2	12.3	22.5	17.8	37.6	24.9	29.6	21.5

1. May not exactly add up due to rounding.
Source: OECD estimates.

Table 9. **Estimates of underlying "steady-state" business investment rates**

as a per cent of total GDP

	Capital output ratio[a]	Potential growth[a]	Depreciation rate[a]	Steady-state investment rate[b]	Current investment rate[c]
United States	2-3	3-3½	5-7	13-25	15
Japan	2-3	1¼-1¾	3-5	7-17	16
Germany	2-3	2-2½	2½-4½	7-17	13
France	2-3	2¼-2¾	2½-4½	7-15	12
Italy	2-3	2-2½	2-4	6-15	14
United Kingdom	2-3	2¼-2¾	3-5	10-18	14
Canada	2-3	2¾-3¼	3-5	8-17	13

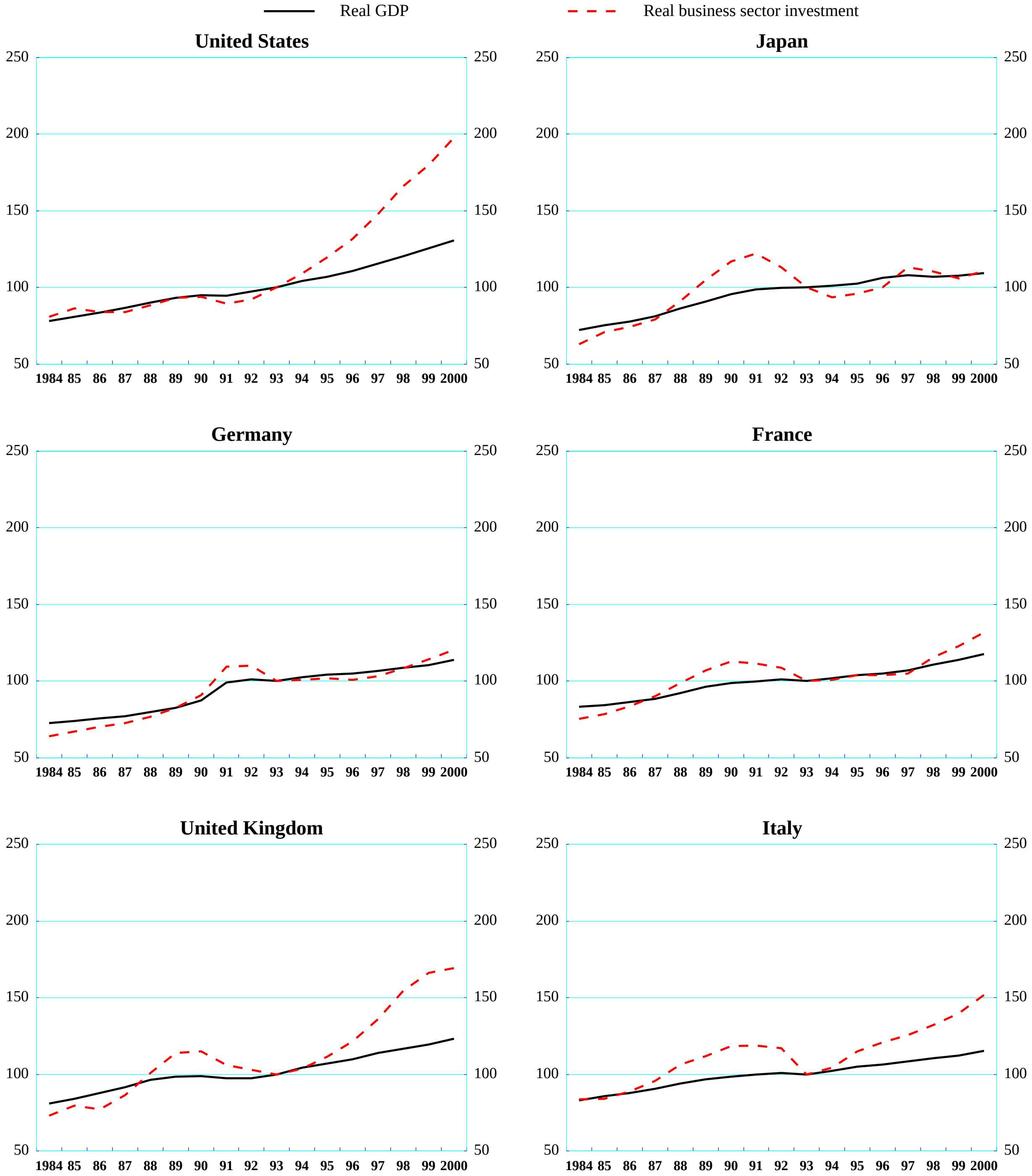
a) Given the pitfalls in properly measuring capital output ratios and depreciation rates at the aggregate levels, and the fact that these could be changing, a range of plausible assumptions is used. A range is also used for trend growth rates, based on the OECD's latest estimates.

b) Under the steady-state assumption of a constant capital-output ratio (K/Y), this is calculated by $[K(g+\delta)/Y(1+g)]$, where g is the potential GDP growth rate and δ is the rate of depreciation. The result from this calculation is then multiplied by the ratio of real business sector GDP to real total GDP (average 1996-2000) so as to make it comparable to the current business investment rate (last column), which is expressed as a per cent of total GDP.

c) Real business investment as a share of real GDP in the year 2000. This ratio of real terms is reported for comparison with the steady-state rate; in countries using chain-weighting aggregation methods, it represents only an approximation of the true underlying real investment rate.

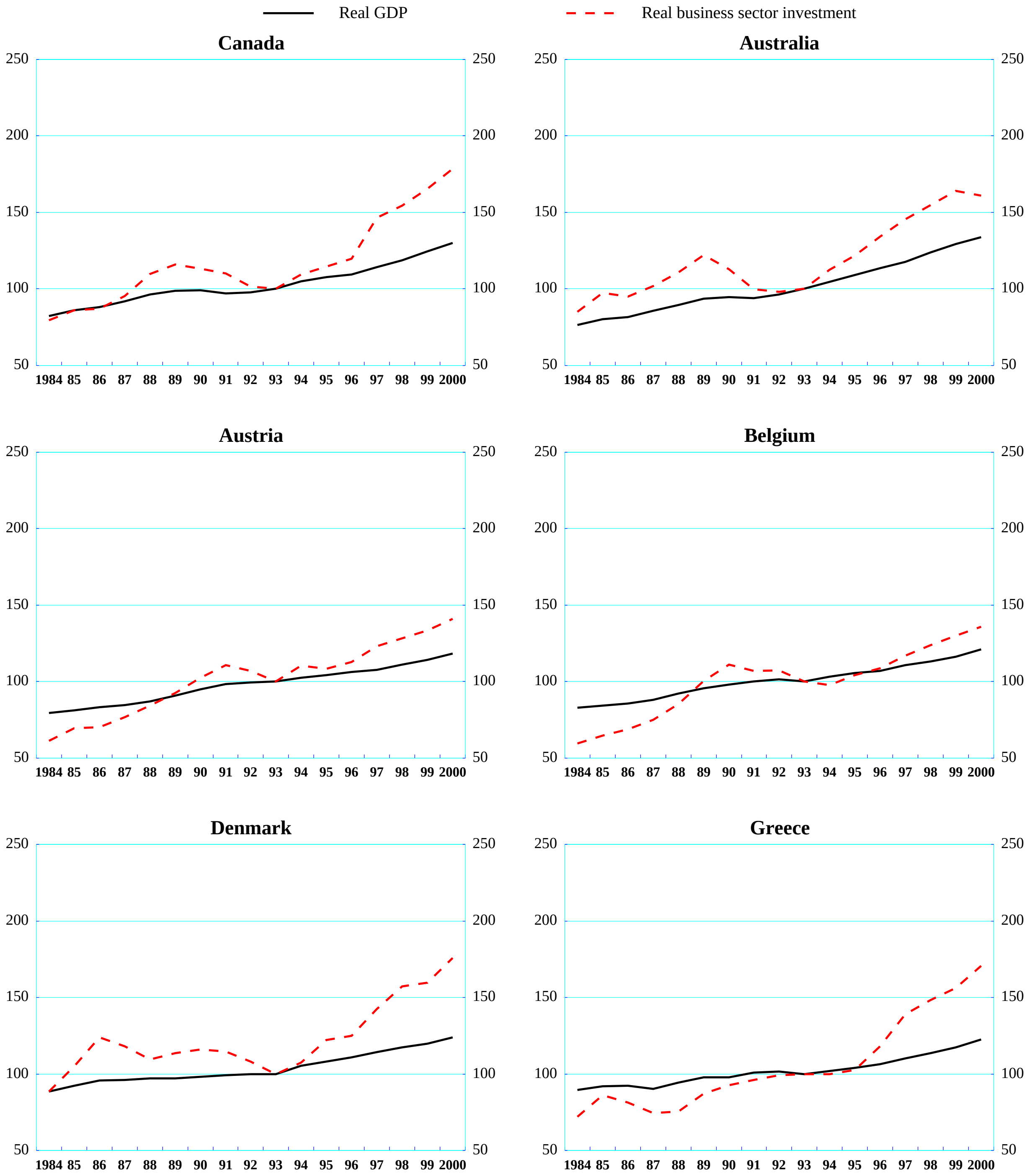
Source : OECD.

Figure 1. **Real output and business investment**
1993 = 100



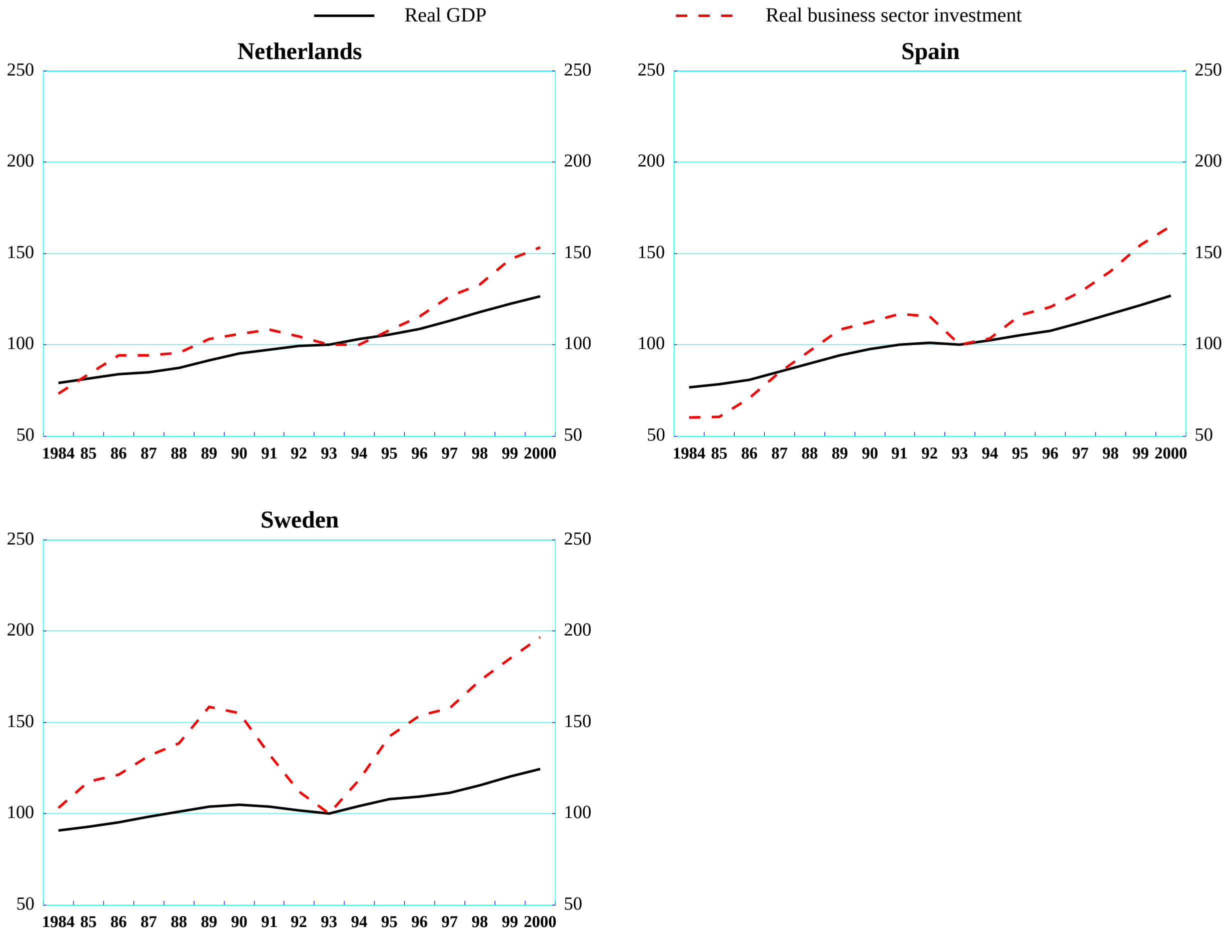
1. Including forecasts.
Source : OECD.

Figure 1. **Real output and business investment** (cont)
1993 = 100



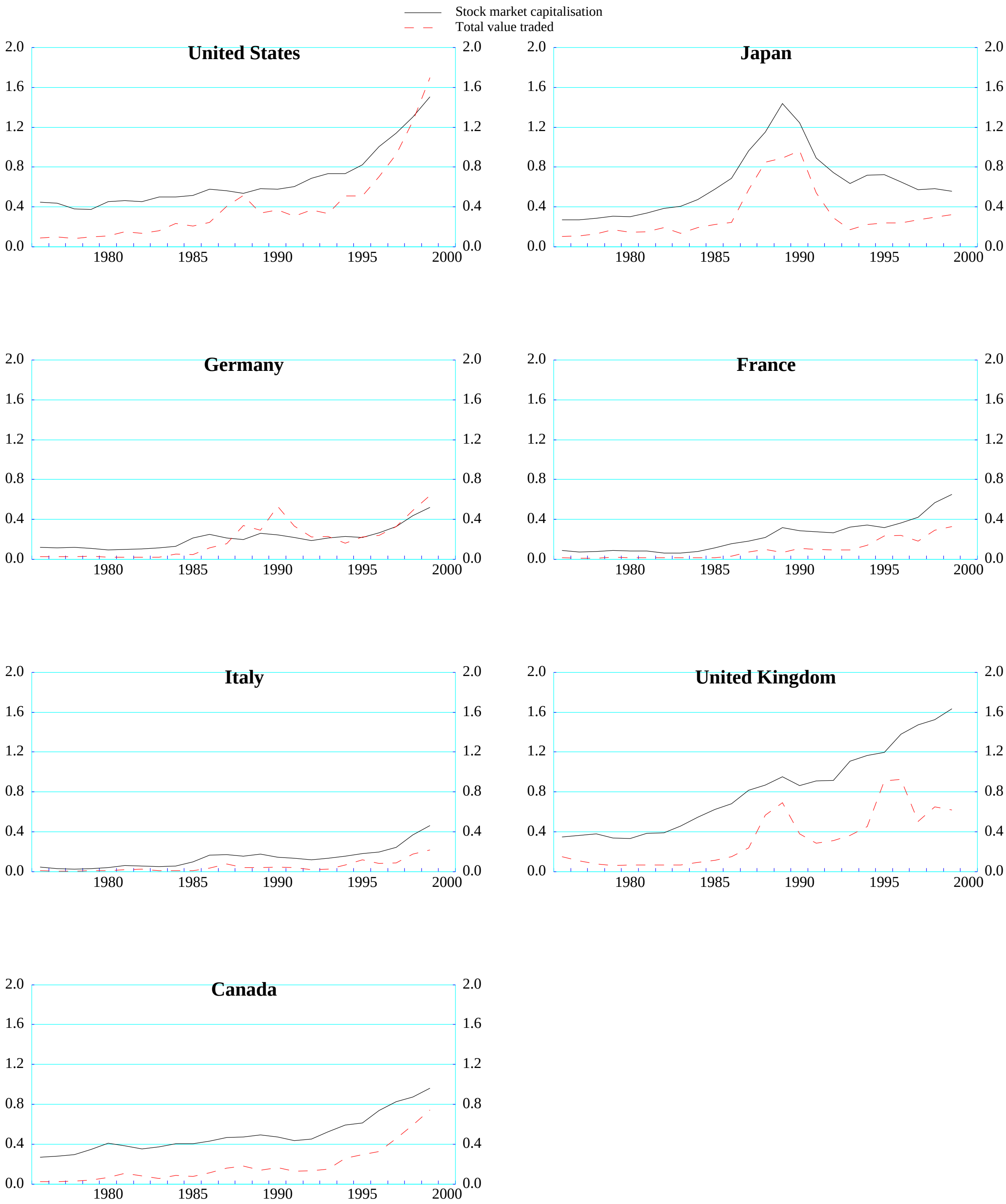
1. Including forecasts.
Source : OECD.

Figure 1. **Real output and business investment** (cont)
1993 = 100



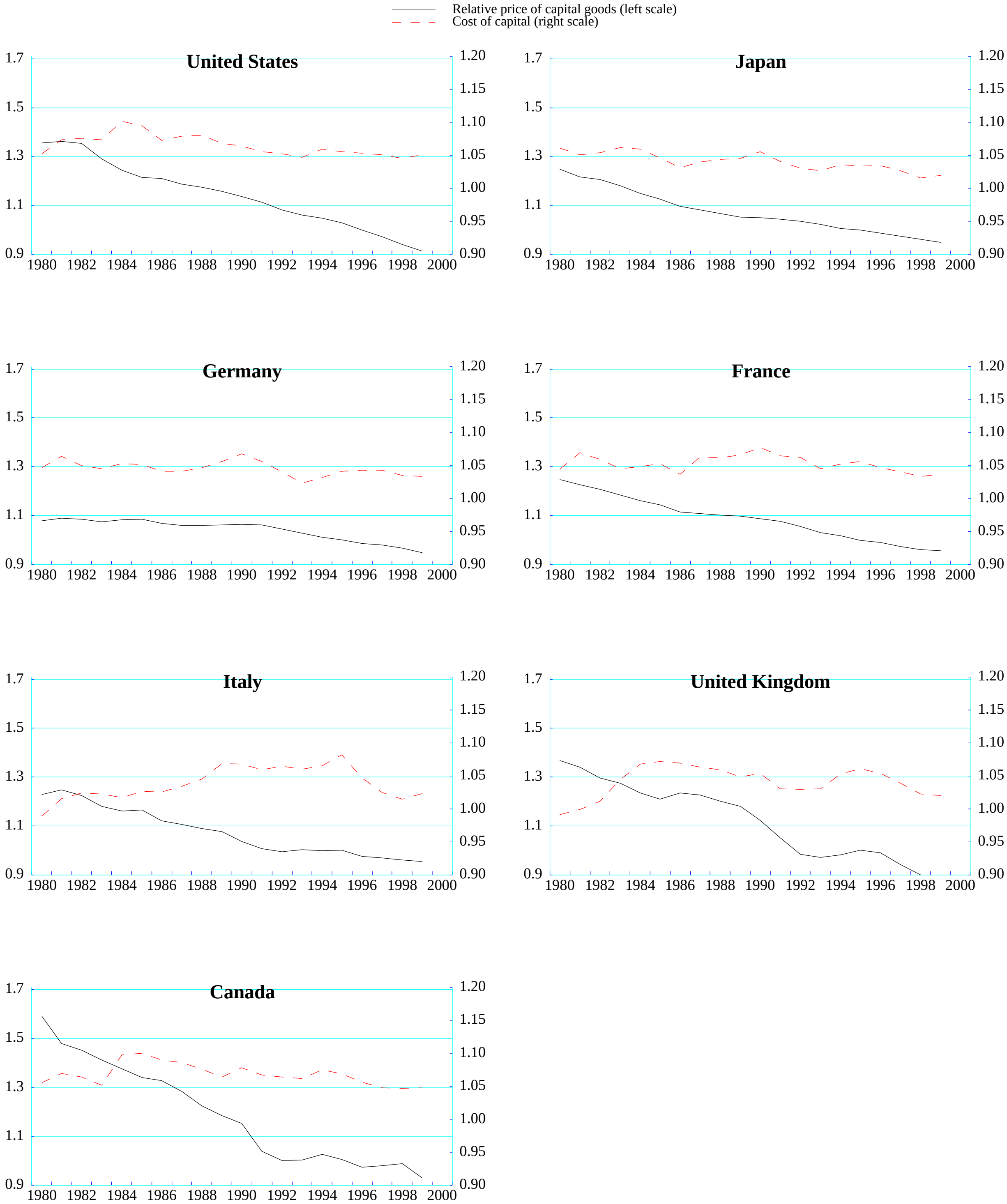
1. Including forecasts.
Source : OECD.

Figure 2. **Stock market capitalisation and total value traded**



Source: OECD.

Figure 3. **Relative pice of capital goods of capital**



Source: OECD.

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