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KINGDOM OF THE NETHERLANDS—NETHERLANDS

Selected Issues

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Approved by the European Department

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Contents Page

Figures

Tables

I. Potential Growth and Total Factor Productivity in the Netherlands[1]

A. Overview and Introduction

1. **After exceeding average euro area growth during the 1990s, Dutch growth was lower during the first half of this decade.** This comparatively weak performance in the recent past surprised many observers, also because growth was only one-quarter of its average rate of the 1990s. During the earlier decade, an important factor raising growth was that policy measures raised trend employment and labor participation (Zhou, 2003). In addition, by redirecting resources to the private sector and enhancing confidence, fiscal consolidation also appeared to contribute to raising trend growth. One key policy question is whether the recent slowdown is a temporary phenomenon or whether trend growth (used synonymously with potential growth in this paper) has declined to a new lower rate as the positive effects of past reforms have run their course. This paper uses a rigorous statistical approach to try to address this question.

2. **While trend growth matters generally for the well-being of economic agents, it also has relevance for the design of fiscal policy.** In particular, the real expenditure ceilings under the Dutch fiscal framework (and the growth in real spending they imply) are set with an eye on the trend growth rate of the economy and the new government will be setting the ceilings for the upcoming four years. If, for example, the estimate of trend growth turns out to be too high, the government will have, unwittingly, committed itself to a more expansionary policy stance for multiple years than would seem to have been intended—an especially relevant consideration when wanting to ensure structural fiscal consolidation during an upturn.

3. **Earlier research at the Fund analyzed the slowing of Dutch labor productivity and total factor productivity growth that had occurred so far this decade through 2003.** According to Bell (2004), the slowdown in labor productivity (measured in hours)—albeit from a level above the level of productivity in the United States—coincided with an increase in labor participation and employment growth. It also coincided with a deceleration of total factor productivity (TFP) growth across all industries, but relatively more forcefully in the important Dutch industries of construction, nonmarket service sectors, and financial intermediation.[2] This led Bell to conclude that policies aimed at increasing labor participation and research and development, while necessary, were likely insufficient to increase both

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[1] Prepared by Francisco Nadal De Simone. I thank Robert A. Feldman for his insights, the CPB, De Nederlandsche Bank, and the Ministry of Social Affairs and Employment for their helpful comments, Mostafa Tabbae for kind assistance with the data, and Susan Becker for her able data management support.

[2] TFP growth in Zhou (2003) and Bell (2004) was calculated by applying growth accounting to a Cobb-Douglas technology with constant returns to scale, but without adjusting the stock of capital for the intensity in its use as is done, and later described, in this paper.

trend growth and productivity growth.[3] Related to this point, recent research suggests that structural reforms aimed at increasing productivity should try to enhance the flexibility of both labor and product markets (e.g., Conway and others, 2005; and Estevão, 2005). Additional research, using the IMF's Global Economic Model (GEM), suggests that undertaking labor and product market reforms simultaneously has advantages because of the sizable gains in employment and output from reducing markups in both of these markets (Everaert and Schule, 2006). In addition, the research suggests that raising competition in goods markets can mitigate the transition costs (e.g., from lower consumption) of labor and service market reforms.

4. **This chapter explores the factors that explain the recent slowing in Dutch output and TFP growth, providing in particular new estimates of the trends in those economic aggregates in a simultaneous econometric framework.** The chapter estimates a Cobb-Douglas production function of the Dutch economy, treating TFP growth as a latent variable, an approach seldom used in the literature, but one that has several advantages (see below). Another important point is that the capital stock is adjusted for its utilization rate, and confidence in the corresponding estimation results is therefore enhanced for a number of reasons. The study is not subject to the apparent inconsistency of theoretically-predicted diminishing returns to labor, when empirically, procyclical movements in labor productivity, real wages, and TFP are observed in the data.[4] In addition, the results in this paper are consistent with factor income shares computed from national accounts providing further comfort from the estimation technique. They are also consistent with a constant returns to scale technology, supporting the use of the Cobb-Douglas production function. Finally, since TFP growth is meant to be driven by underlying structural forces—including the institutions that frame agents' choices—when factors of production are measured correctly, a final favorable aspect of the estimate of TFP growth is that it is not correlated with variables that display a strong cyclical component (e.g., employment). The results indicate that average trend growth was 2.2 percent during 2000–04, with TFP growth averaging 1.3 percent. This is down from 3.4 percent for trend growth and average TFP growth of 1.5 percent during 1990–99 (Figure 1).[5]

5. **The results show that the decline in trend growth started around 1999.** This decline was accompanied by a deceleration in the trend growth rate of the utilization-adjusted capital stock, reinforced soon afterward by a slowdown in the trend growth rate of the labor force. The trend growth of the adjusted capital stock reached a peak in 1998, after the

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[3] DNB (2005) concluded that, to bring the fall in productivity growth to a standstill, several measures should be taken, including enhancing the knowledge and training level of the labor force and further market liberalization.

[4] This inconsistency prompted Lucas (1970) to argue that one possible reconciliation could lie in allowing for cyclical variation in the utilization of the capital stock.

[5] This study uses the most recent national accounts available. In the period 1977–2004, average annual growth is about 0.2 of a percentage point higher in the most recent set of national accounts.

continuous acceleration that followed the 1991 trough of the European recession. Thus, a process of capital deepening supported the period of high growth rates.[6] In contrast to the rising trend in participation and employment that characterized the period of "job-rich" growth that began in the 1980s, the contribution of labor services to growth declined after 1999 because of the deceleration of the labor force trend growth (Figure 2). These demographic forces halved the labor force growth rate between 1999 and 2004, a process that reinforced the growth-dampening effects of the decline in hours worked that followed the proliferation of temporary and part-time arrangements.

6. **The decline in TFP growth also started around 1999 and, statistically, the paper finds that its reduction was associated with certain institutional features of the labor market.** In particular, Dutch TFP growth decelerated as the secular fall in the ratio of the minimum wage to the median wage and in union density tapered off after 1998. While it is somewhat surprising to get results from time series analysis that are consistent with cross-country studies, the results from the analysis in this paper are, in fact, in line with statistical evidence from cross-country studies that suggests a strong negative effect of changes in the ratio of the minimum wage to the median wage and in union density on TFP growth (WEO, 2003 and 2004).[7] By comparison, increases in the replacement rate of unemployment benefits seem to have had a positive, albeit small, impact on TFP growth, but at the cost of increasing the Nairu. While modeling explicitly the channels by which increases in replacement rates interact with TFP growth is clearly beyond the scope of this paper, the results seem consistent with relevant analysis in the literature suggesting that inflexible labor market institutions induce a deepening in the utilization-adjusted capital stock and, at the same time, induce an increase in structural unemployment. Accordingly, the paper finds that there is a statistically significant effect of the increase in the replacement rate on the adjusted capital stock and on the Nairu.

7. **This paper is organized as follows.** Section B discusses the production function estimated in this study, how factor inputs are measured, and the data used. Section C first presents the econometric estimates of the production function and TFP growth, and then discusses the robustness of the results. Section D calculates trend growth. Section E explores the determinants of the deceleration of trend growth and TFP growth. Section F concludes and draws policy implications.

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[6] That movements in the (utilization-adjusted) capital stock can be characterized by a relatively long "cycle" has been observed in several other advanced economies, e.g., France (Nadal De Simone, 2003), and is most likely associated with specific technical factors such as the average obsolescence of the capital stock and time-to-build arguments (Prescott, 1982).

[7] The reason why it can be surprising is that time series for individual countries often show less variation than cross-country data. Here, because estimated TFP is a "statistically clean" series, this may be less of a problem.

B. Production Function Specification and Data Properties

8. **Production functions can be specified in a variety of ways for the purpose of growth accounting and the computation of TFP growth.** The latter is most often obtained as a residual: that part of GDP growth that cannot be attributed to changes in the volume of factor inputs weighted by their share of value added. Consequently, how factor inputs are measured matters a great deal for what TFP growth contains, as well as for the econometric properties of the estimated production function and therefore any estimates of TFP growth. In this regard, it has been shown that the omission of a measure of intensity in the use of capital in empirical work introduces a bias in estimated labor shares, and also results in TFP growth appearing, incorrectly, to have a procyclical character (Lucas, 1970; Basu and Kimball, 1997; and Basu, Fernald, and Kimball, 2004). Fortunately, the use of different proxies for the intensity of capital utilization (e.g., capacity utilization, energy use and material inputs) in simulations and growth-accounting exercises has been shown to eliminate most of the observed cyclicality of TFP growth (e.g., Bils and Cho, 1994, for the United States; and Imbs, 1999, for 10 industrialized countries). In addition, several authors (including Finn (1995); Shapiro (1993 and 1996); Dupaigne (1998); Imbs (1999); Baxter and Farr (2001); Rumbos and Auernheimer (2001); Hornstein (2002)) have convincingly argued that profit-maximizing firms also choose the intensity with which they utilize their capital stock, thus it would be inappropriate to use a measure of the capital stock that did not adjust for the intensity of it use. With all this in mind, this study sees considerable merit in trying to adjust the net stock of capital to take into account the intensity of its use. To do so, it uses the information contained in the capacity utilization rate in the business sector, the measure most widely employed to this end.

(i) Production function specification

9. **This study estimates a production function specification that builds on the version of Bils and Cho's (1994) model of real business cycles with changes in effective factor utilization and constant work effort.**[8] Effective labor input, for instance, can vary by changing the number of workers and the duration of the workweek, via recourse to shift work, or simply by changing work effort. As in Bils and Cho (1994), this paper assumes constant work effort, but uses hours worked to capture changes in the number of workers and shifts as well as the duration of the workweek.[9] With respect to capital, direct measures of the utilization of the capital stock are not available for the Netherlands, so the rate of capacity

[8] There are alternatives to this specification. For example, some specifications assume that labor and capital utilization do not move in tandem, as when capital is subject to a variable depreciation rate (e.g., Greenwood, Hercowitz, and Huffman, 1988).

[9] There is an average difference of about 0.4 of a percentage point between measuring labor services by using hours worked and measuring labor services by using labor participation, structural employment and labor force growth. Thus, the estimated trend growth could be viewed as an upper bound, with the lower bound about 0.4 of a percentage point relatively lower.

utilization (including new hires) in the business sector is used as a proxy.[10] This is because capacity utilization is highly correlated with the cycle and should therefore reflect both changes to the utilization of the capital stock when the same capital stock is utilized more intensively—for example when a shift is added—and it will also reflect changes to capital stock utilization when more or less machines are brought on stream. In this regard, it is generally accepted that if the net physical capital stock measure used in empirical production function estimates understates excess capacity, input shares will be unrealistically high, and consequently, TFP growth will be unrealistically low. In addition, unobserved input movements such as changes in the intensity in the use of capital will be interpreted as changes in TFP growth.

10. **The Cobb-Douglas production function is defined in terms of the flow of services provided by the factors labor (*L*) and capital (*Z*).[11]** Formally:

$$Y = AL^{\alpha}Z^{\beta}, \tag{1}$$

where Y is output, and A is TFP. When the factors of production are properly measured, A represents technical progress, including the level of efficiency in the utilization of the factors of production. In a competitive equilibrium, the exponents α and β represent the output elasticities of labor services and capital services, respectively. In the special case where $\alpha + \beta = 1$, the production function exhibits constant returns to scale, with α and β representing the income shares of labor and capital services, respectively.

11. **Factor services are defined as follows.** Labor services are represented by the total numbers of hours worked at a given effort level during a period of time ($L=N\,H$), where N refers to the number of employees, and H refers to the number of hours worked per employee in that time period.[12] The services of the physical capital stock are represented by ($Z = K\,U$), where K refers to the physical stock of capital and U to its utilization, as proxied by the rate of capacity utilization with hiring. Annual data for the period 1979–2004 on real output, total labor hours, and the rate of capacity utilization are from the Netherlandsche Bank (DNB). The capital stock series was provided by the Bureau of Economic Policy Analysis. The

[10] Changes in the rate of capacity utilization with new hiring proxies changes in the use of the capital stock when the number of machines brought on stream changes—even though there may be no changes in the duration of the workweek or the organization of labor. The rate of capacity utilization without new hiring proxies changes in the duration of the workweek over the cycle, through overtime and temporary layoffs. Even though the latter measure would be preferred to adjust the capital stock—as it does not include changes in the workforce—it is unfortunately unavailable in the Netherlands.

[11] A CES production function specification was not attempted. While more general than the Cobb-Douglas production function, the econometric tests and the quality of the results obtained with the later simpler specification is reassuring.

[12] This specification assumes, like in the majority of empirical studies, a constant work effort.

capital services indicator that results from adjusting the net stock of capital for its utilization behaves quite differently from the unadjusted physical capital stock. Unfortunately, the measure of capacity utilization is available only for the business sector, while the capital stock covers the entire economy.[13] Although it is unlikely that there is full synchronization between changes in the capacity utilization of the business sector and the rest of the economy, the approach can be justified by the fact that fluctuations in the business sector are largely responsible for the overall business cycle (Corrado and Mattey, 1997).

(ii) Data properties

12. **A battery of tests for stationarity and cointegration was used to decide on the form of the production function to be estimated.** While the levels of output and labor hours are found to be stationary at the 95 percent confidence level when a constant and a time trend are included in the alternative hypothesis, they are nonstationary at the 97.5 percent level. Their rates of change are stationary when the alternative hypothesis includes a constant (Table 1a).[14] The unadjusted capital stock is clearly stationary, but the adjusted capital stock is borderline nonstationary, even at the 97.5 percent confidence level (its rate of change is clearly stationary, when the alternative hypothesis contains a constant). Given these conflicting results, and the importance of the tests for the correct specification of the econometric model, an alternative unit root test with the null hypothesis of stationarity was applied (Table 1b). This test confirmed that the level of output, labor hours and the unadjusted capital stock are nonstationary while the adjusted capital stock is stationary. As a further test on the order of integration of the series, a novel fractional integration test (Shimotsu and Phillips, 2005) was applied to the data which confirmed the stationarity of the adjusted capital stock series in levels (Table 1c).

13. **The production function was estimated in first differences.** Estimation of the production function in the levels of the variables would require two cointegrating vectors: one representing the equilibrium relation derived from production theory, and the other one representing the stationarity of the adjusted capital stock. However, the cointegration tests, corrected for small sample bias (Cheung and Lai, 1993), yield conflicting results: while the trace statistic accepts the absence of cointegration at the 95 percent level, the λmax statistic suggests that there is one cointegrating vector (Tables 2a and 2b). If there is only one cointegrating vector, full identification of the model cannot be achieved in the level of the variables. As a result, the estimation of the production function was done in first differences.

[13] As indicated above, caution is necessary when using official capital stock series, which normally assume a constant depreciation rate (Burnside and others, 1995). Ultimately, however, the estimation results have a natural benchmark, i.e., that the estimated factor shares match national accounts' factor shares.

[14] The unit root test is the augmented Dickey-Fuller test proposed by Elliott, Rothenberg, and Stock (1996). Including a deterministic trend in the test is important when working with trending data.

C. Econometric Estimation

14. **A standard practice in the calculation of TFP has been to first compute *α* and *β* from national accounts as the shares of output accruing to the factors of production, or to estimate a Cobb-Douglas production function constrained to exhibit constant returns to scale.** Then, in either case, the residual has been viewed as a proxy for TFP and dubbed the "Solow residual" (Solow, 1967). Given the importance of obtaining a precise estimate of TFP growth, that approach seems suboptimal as the residual embodies a host of other factors beyond TFP growth.[15] Similarly, the production function has usually been estimated in the first differences of the logarithms (with constant returns to scale imposed) without always paying due regard to the statistical properties of the data. As noted above, the use of first differences in this study is instead justified on statistical grounds: although output and measures of labor and capital services contain a unit root, they are not cointegrated, and estimation of Equation (1) in the levels of the time series using an error correction model therefore cannot be justified.[16]

15. **With the benefit of the various statistical tests, the production function was estimated jointly with TFP growth in first differences, with the latter specified as a latent variable:**

$$\Delta Y_t = \Delta A_t + \alpha \Delta L_t + \beta \Delta Z_t + \varepsilon_t \,. \qquad (2)$$

In line with the data properties, the unobserved variable ΔA_t was modeled as an autoregressive process. Thus, technically, shocks to TFP growth would have transitory effects—which can nevertheless be quite persistent as it indeed turned out to be the case. Formally:

$$\Delta A_t = \sum_{i=1}^{p} \rho_i \Delta A_{t-i} + \varepsilon_t \,, \qquad (3)$$

with the roots of the autoregressive polynomial outside the unit circle. Equations (2) and (3) are estimated in state-space form using the maximum likelihood estimator based on the prediction error decomposition generated by the Kalman filter (Table 3). Estimates of the model with the adjusted capital stock and imposing constant returns to scale result in output elasticities of labor and capital that are broadly in line with factor income shares from national accounts. These elasticities are 0.63 and 0.37, respectively.[17] The level and the

[15] The residual includes measurement errors, as discussed above in the text, but also production function specification errors and estimation inefficiencies due to multiple causes such as possible simultaneity.

[16] See Färe and others (1994) for a detailed survey on production frontiers work; and Temple (1999) for a related survey on the empirical research on growth.

[17] These results are consistent with Zhou (2003).

square of the residuals are white noise, as indicated by the Kolmogorov-Smirnov statistic. The data support the view that TFP growth can be estimated as an autoregressive process of order one.[18] The results indicate that TFP growth declined almost steadily from 2.5 percent in 1984 to 1.4 percent in 1993; it remained at about 1.6 percent during the following three years, and declined steadily to 1.3 percent in 2004.[19] The autoregressive coefficient is 0.98, and it is highly significant. TFP growth is indeed very persistent.[20]

16. **Aside from the microeconomic foundations provided by the Cobb-Douglas production function, the simultaneous estimation of the production function and TFP growth generates satisfactory results.** Estimation results are encouraging not only in terms of the model identification and the well-behaved nature of the estimation residuals. They are also consistent with other findings in the literature, raising confidence in them. Importantly, the estimated TFP growth has several favorable features that are consistent with findings in the literature (e.g., Finn, 1995; Shapiro, 1996; Chen, 1997; Baxter and Farr, 2001; and Basu and others, 2004). Three key aspects of the results are discussed below.

17. **The first is that estimated TFP growth in this paper (and the Solow residual based on the intensity-adjusted capital stock) tends to be higher on average than the traditional Solow residual based on unadjusted capital** (henceforth referred to as the unadjusted Solow residual). Imbs (1999), for example, found in 9 out of 10 countries in the period 1971–93 that TFP growth, when he used proxies for labor and capital services, was higher than the unadjusted Solow residual using only the physical capital stock as a proxy for capital services. Similarly, our results for the whole period (1984–2004) show that Dutch estimated TFP growth using the adjusted capital stock was indeed 20 basis points higher *on average* per annum than the unadjusted Solow residual. This held for two of the three periods identified below. The three distinct periods were identified depending on whether the unadjusted capital stock overstated or understated excess capacity (Table 4). The first period is the 1980s during which, following structural reforms, employment performance improved significantly and offset the unused capital stock triggered by the first oil shock observed in other European countries. As a result, the unadjusted Solow residual underestimated TFP growth. In the 1990s, especially after the European recession of 1993, the opposite held. The capital stock overestimated excess capacity, factor shares were unrealistically low and the

[18] TFP growth was also estimated as an AR(2) process, and as an ARMA(1,1) process. The coefficients of the AR(2) process or the MA(1) were statistically insignificant. Importantly, using the adjusted capital stock, the sum of the autoregressive coefficients of the AR(2) process was not statistically different from 0.98, the estimated value of the coefficient of the preferred AR(1) process. Finally, neither the estimated values of factor shares nor their standard errors were affected by the choice of the order of the AR process.

[19] As a reference, for the period 1990–98, Nicoletti and Scarpetta (2003) estimate TFP growth at an annual average of 1.6 percent. In this study, for the same period, TFP growth based on adjusted capital is 1.8 percent.

[20] A constant added to the AR(1) process was statistically insignificant, and thus dropped. The autoregressive coefficient estimate is very similar to estimates obtained in empirical work that allows for variable labor effort or changes in physical capital utilization (e.g., Bils and Cho, 1994).

unadjusted Solow residual overestimated TFP growth. Finally, so far this decade, with substantial excess capacity, the unadjusted Solow residual is well below TFP growth.

18. **A second finding is that estimated TFP growth is less volatile than the unadjusted Solow residual.** This is to be expected as TFP has been purged from the volatility in input utilization. Thus it is reassuring that the full-sample volatility of the unadjusted Solow residual is found to be about 1.8 in this study, compared with a much lower volatility, a bit over 0.3, for estimated TFP growth. This is broadly consistent with the literature: Imbs (1999) finds that in half of the 10 countries of his sample, TFP growth is less volatile than the Solow residual (reductions in volatility vary between 5 and 46 percent) while Basu and others (2004) find that the variance of their adjusted TFP is about 55 percent of the variance of the Solow residual.

19. **Finally, estimated TFP growth is not significantly correlated with output growth, employment, or hours worked.** General equilibrium models with monopolistic competition have positive persistent technological shocks that drive output growth and reduce employment or hours worked (e.g., Basu and others, 2004). Indeed, unadjusted or adjusted changes in the Solow residual (widely believed to be mostly driven by technology shocks) have a strong correlation with output growth in the entire sample used in this study. The estimated TFP growth, in contrast, is uncorrelated with output growth. Similarly, employment or hours worked are uncorrelated contemporaneously with TFP growth.[21] These results are relevant on two counts. First, they confirm Lucas' (1970) insight and subsequent findings in the literature on the importance of taking into account variations in the intensity of capital utilization and contrast sharply with estimates in which capital services are proxied by the unadjusted physical capital stock. Second, the estimated TFP growth can account for the observed cyclicality of the Solow residuals without making reference to increasing returns to scale.

D. Trend Growth

20. **Having robustly estimated TFP growth, the trend growth rate for the Netherlands is calculated as follows**:

$$\overline{Y}_t = N_t \overline{P}_t \left(1 - Nairu_t\right)^{\alpha} \overline{K}_t^{1-\alpha} \overline{A}_t \,, \qquad (6)$$

[21] To increase confidence in the estimated TFP growth series, a test of TFP growth exogeneity proposed by Hall (1989) was performed. The results of the test based on either changes in real government military spending in isolation, or together with changes in oil prices, concluded that TFP growth is uncorrelated with variables known to be neither the causes of productivity shifts nor to be caused by productivity shifts. In contrast, there is some weak evidence of correlation between the unadjusted Solow residual and military spending. These results provide further support to the constant returns-to-scale outcome of the estimation using the adjusted capital stock.

where bars over variables represent trends, and all variables are in annual growth rates. $\overline{Y}_t$ is natural trend growth, N_t is the population of working age, $\overline{P}_t$ is trend in the participation rate, $\overline{K}_t$ is trend growth in capital stock services, and $\overline{A}_t$ is trend in total factor productivity growth. The calculation of trend output growth assumes that the economy is at its production possibility frontier. However, it is to be expected that there is a significant statistical difference between actual and potential labor effort because, for instance, the hours worked used in the estimation, as a result of preference changes as well as policy changes, have been affected by variations in the rate of labor force participation, changes in the age structure of the population, and shifts in patterns of part-time work. It is thus necessary to assess the natural or structural level of this factor of production, and this implies determining the trends of the participation rate, and the unemployment rate. This study uses the ideal band-pass filter developed by Ouliaris (2001).[22] The filtering procedure is applied to the time series on capital stock services, estimated total factor productivity, and the labor force participation rate.[23] The definition of the potential or natural contribution of employment to output is consistent with the nonaccelerating inflation rate of unemployment (Nairu), provided by the DNB.

21. **The Dutch trend growth rate averaged 3.4 percent per annum in the period 1984–2004, showing two distinct periods.**

- The first period is 1984–99, when the Netherlands experienced an average trend growth rate of 3¾ percent. After increasing during the second half of the 1980s, trend growth remained consistently high except during the years around the U.S. and European recessions of 1991 and 1993, respectively. The production function approach shows that Dutch high trend growth rates coincided with an increase in labor force participation and employment growth. Trends in hours worked show the same picture. TFP growth, while adding to trend growth in the second half of the 1980s—presumably as a result of policy measures that enhanced labor market flexibility and fiscal consolidation—was quite stable during most of the 1990s.

- By comparison, in the period 2000–04, Dutch trend growth decelerated to about 2¼ percent. TFP growth contributed somewhat to the slowdown of trend growth, as it decelerated after reaching a peak in 1999. The deceleration of trend growth and TFP growth also coincided with the deceleration in trend growth of the capital stock, and was soon accentuated by a slowdown in the labor force growth. Trend growth in the utilization-

[22] This filter is not affected by leakage from the zero frequency component of nonstationary series. In contrast to Baxter and King's band-pass filter, the filter does not involve the loss of observations at either end of the series, and it is consistent. The standard Hodrick-Prescott filter was not used because it is bound to introduce spurious cycles, and it suffers from end-of-sample bias (Cogley and Nelson, 1995).

[23] The application of the filter to estimated total factor productivity growth left the series practically unchanged, as it already contained no significant cyclical component.

adjusted capital stock reached a peak in 1998, after the persistent acceleration that followed the 1991 European recession, a process of capital deepening that supported high growth rates. In contrast to the rising trend in participation and employment that characterized the period of "job-rich" growth that began in the 1980s, labor services growth declined after 1999 because of the deceleration of trend labor force growth. Therefore, demographics reinforced the growth-dampening effects of the fall in hours worked that followed the proliferation of temporary and part-time arrangements. Overall, developments in labor and capital services explain about 80 percent of the deceleration of trend growth with TFP growth explaining the remainder.

E. What Happened to TFP Growth?

22. **The recent deceleration of TFP growth can mostly be attributed to a deceleration of labor efficiency.** Even though the contribution of TFP growth to the deceleration of trend growth has been relatively less important than developments in the trend labor force and capital stock utilization, the question of what happened to TFP growth has significant policy relevance. To explore it, let us first decompose estimated TFP growth into three parts associated, respectively, with: (i) technological change, which normally represents the largest share; (ii) changes in the efficiency with which factors are used, as economies are most of the time growing somewhat below their production possibility frontier; and (iii) changes in the utilization of trend inputs. Efficiency changes are measured as deviations of labor and capital from their trend growth rates, and thus, technological change is the residual once changes in the trend growth rates of factors utilization have been taken into account. The net contribution of the trend in intensity-adjusted capital was small: the negative changes in the use of this factor (with intensity-adjusted capital trend growth decelerating after 1999) was nearly completely offset by the increased efficiency of its use (Table 5). In contrast, the deceleration in labor services trend growth contributed nearly 20 basis points to the deceleration of TFP growth, mostly as a result of a decline in the efficiency in its use. Technological change, as expected, made the largest contribution to TFP growth, but since this component was unchanged between the two periods, 1990–99 and 2000–04, it did not contribute to TFP's deceleration.

23. **The deceleration of labor efficiency may have reflected recent developments in labor market institutions.** Evidence in the (mostly cross-section) literature (e.g., WEO, April 2004, and Nickel and others, 2005) indicates that labor market institutions do affect TFP growth.[24] To probe what the eventual effect of institutional changes, and by implication, of changes in labor efficiency on TFP growth might be, an exploratory econometric exercise was conducted using data on Dutch labor market institutions. This is necessarily a first pass, as further analysis in a model with explicit mechanisms showing how labor market institutions affect labor efficiency and TFP growth would be better. Nevertheless, the

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[24] While some factors such as education and ICT can be important, their effects are embodied in the factor input variables.

approach taken here can at least take some comfort from the evidence that TFP growth is exogenous à la Hall (see footnote 21), and that the production function satisfactorily represents the Dutch economy. The labor market institutional indicators were taken from Nickel and Nunziatta (2001) and extended by Giuseppe Nicoletti.[25] The indicators can be interpreted as proxies for institutional factors that contribute to shaping agents' economic choices—for example with regard to work effort and labor participation. A first result is that the ratio of the minimum wage to the median wage, as well as social benefits, seem to have affected TFP growth negatively, at least insofar as these variables showed up in a statistically significant way (Table 6). While exploring the mechanisms of the underlying process is clearly beyond the scope of this paper, reasons often advanced in the abundant literature on the subject include reducing labor demand, promoting poverty traps, and hampering capital deepening. These forces are expected to pull the economy below its production possibility frontier. A second result is the statistically significant negative effect of union density, which can also proxy the coverage of collective agreements, on TFP growth. This channel may work through its effect on reducing wage differentiation and labor mobility, which could also put a brake on human capital investment and increase the costs of firms' entry and exit strategies. Although union density actually declined in the Netherlands in the period 1984-2001, albeit at a decelerating rate, collective bargaining coverage increased in the 1990s compared to the 1980s. Union density has been found in the literature to significantly increase unemployment (e.g., Nickel and others, 2005).[26] Finally, notwithstanding the result that the unemployment replacement rate was found to have a statistically significant positive impact on TFP growth, this seems to have resulted from substituting capital for labor (capital deepening with labor-saving technology).[27] Relatively high and persistent replacement rates induce benefits-dependency and weaken incentives to search for a job, increasing structural unemployment (e.g., OECD, 2004).

24. **These results are to be interpreted in the context of evidence suggesting that TFP growth depends also on "creative destruction," and thus on the benefits of further liberalized goods and services markets.** Mostly labor market developments seem to have been responsible for the recent deceleration of Dutch TFP growth. However, as pointed out in Bell (2004), in the Netherlands—as in most euro area countries—it can be difficult to relocate labor and scale back relatively inefficient firms, with adverse consequences for TFP growth. In this light, labor market reforms aimed at raising productivity must facilitate labor

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[25] TFP growth was regressed on a constant, the ratio of the minimum wage to the median wage, union density, gross replacement rates, and different measures of the tax wedge. The R^2 of the regression is 84 percent and the residuals show no evidence of serial correlation.

[26] That indicator was not available in the time series form of the others used in the econometric exercise performed in this paper.

[27] A regression of the same labor market institutional indicators on the adjusted capital stock and on labor services shows a positive significant impact of the replacement rate on the former and a negative significant impact of the replacement rate on the latter. Regression results are available upon request.

reallocation, reduce the cost of doing business, and increase competition. For instance, it has been estimated that Dutch TFP growth has been lowest recently in areas such as nonmarket services and construction—quite sheltered sectors—and in network industries such as gas and electricity—where state control is high. Estevão (2005) found robust evidence that product market deregulation, by increasing competition and reducing barriers to entry and exit, maximizes the positive output and employment effects of labor market reforms that result in "wage moderation."

25. **The bottom line is that without further reforms, TFP growth and thus Dutch trend growth are likely to be significantly below their long-run averages.** As in other advanced economies, aging of the population is expected to weigh negatively on TFP growth and trend growth. In addition, if no new reforms are put in place, this study suggests that annual trend growth, while expected to recover from its recent low level as the investment cycle rekindles, will likely be around 2 percent. Thus, in the absence of further reforms that boost TFP growth, trend growth of around 2 percent would seem a prudent estimate for the remaining years of this decade. This is broadly in line with the projected 0.15 percent per annum fall in the labor force, with an expected moderate increase in the participation rate and a rekindling of the investment cycle as offsetting factors, and TFP growth rates remaining at 1.3–1.4 percent per annum.

F. Concluding Remarks

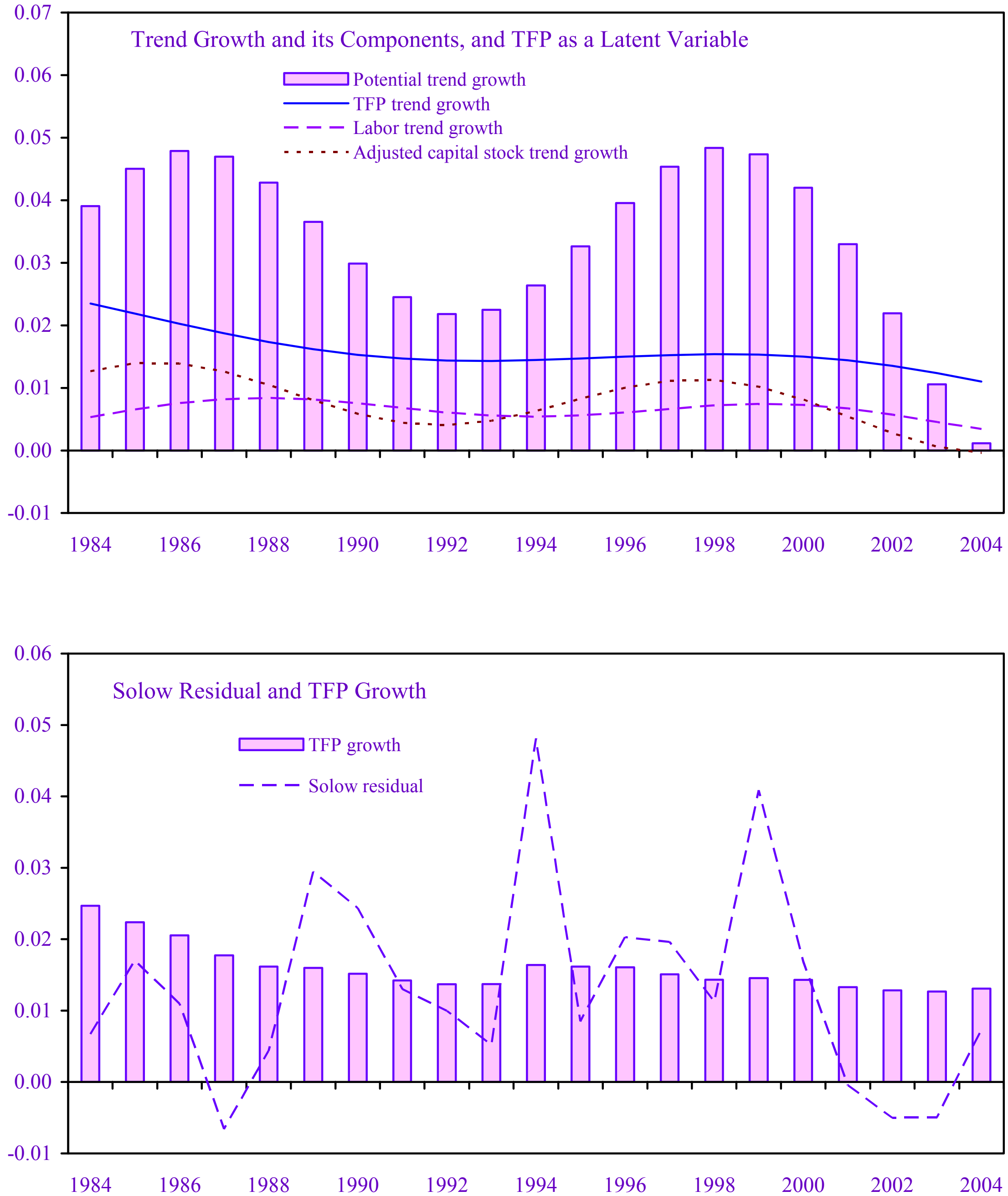
26. **This chapter investigated the determinants of trend growth and TFP growth in the Netherlands.** The estimation was based on a rigorous statistical methodology, which resulted in production function factor elasticity estimates closely aligned with actual factor shares in the national accounts. Estimated TFP growth was free of its cyclical components and can therefore be seen as driven by underlying structural factors.

27. **The deceleration of labor force trend growth, a moderation of capital deepening, and a deceleration of TFP growth contributed to the recent slowdown in trend GDP growth.** In addition, trend growth was negatively affected by the net decline in hours worked that followed the proliferation of temporary and part-time work arrangements. Although TFP growth was not the major factor, its deceleration contributed to the slowdown in trend growth and was associated in a statistically significant way with developments in labor market institutions that may have impaired, in one way or another, labor flexibility.

28. **The results of this chapter underscore the importance of boosting structural reforms in the Netherlands if TFP and trend growth rates are to be raised.** Faced with negative demographic trends, the Netherlands needs to make a more efficient use of all of its resources. Dutch growth performance strongly improved following the bold structural reforms of the 1980s and early 1990s. With a number of key reforms already taken to increase labor participation—including most recently disability reform—raising it further will be increasingly difficult, though more could be done. Boosting TFP growth would seem to be the main avenue for raising trend growth. Besides enhancing labor market flexibility, to do so would require continued efforts to reduce barriers to entrepreneurship and innovation,

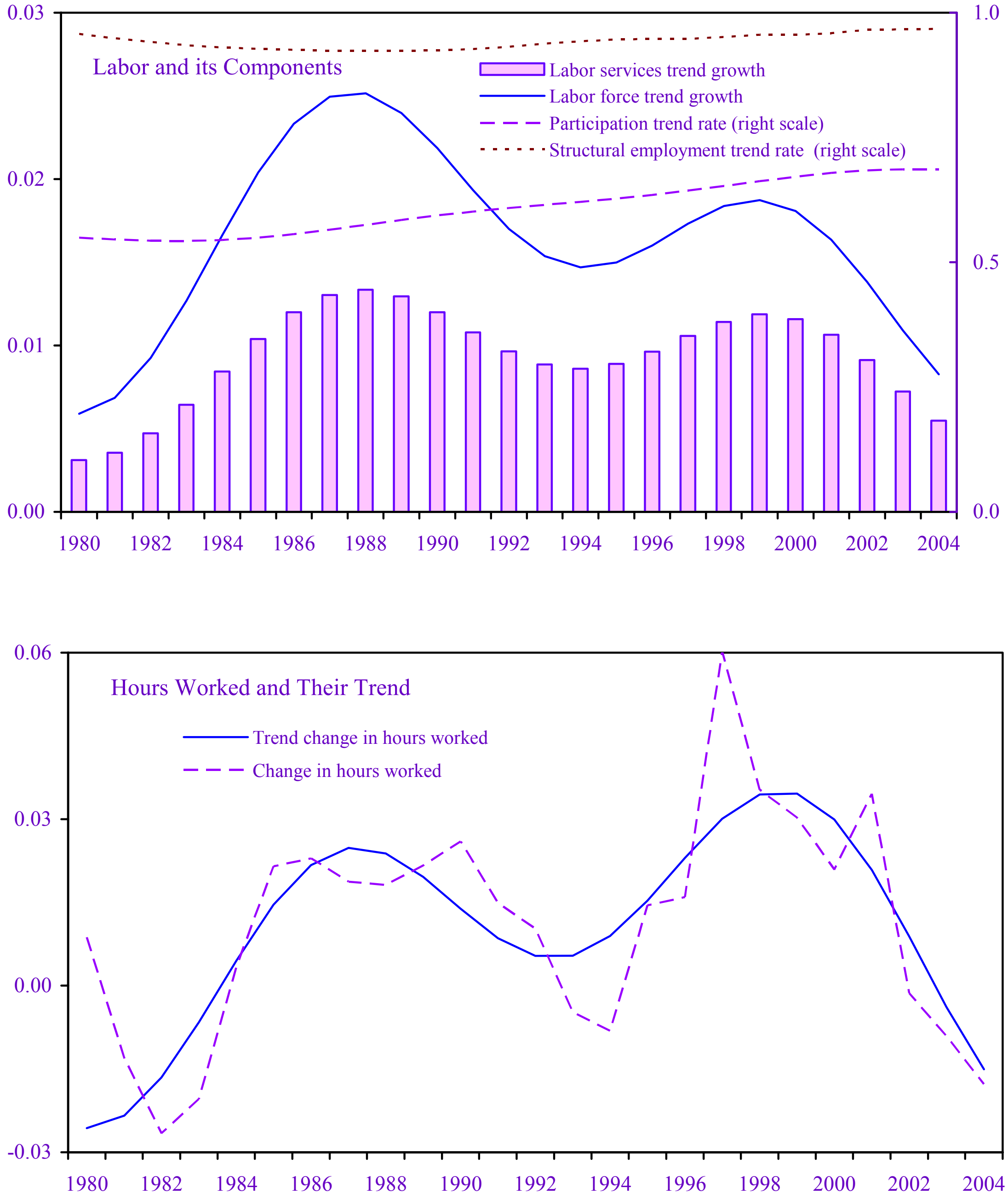
and continuing to open up good and service markets. Without those measures, the Dutch trend growth rate may become stuck at historically low levels in circumstances in which it will also be pulled down by population aging.

Figure 1. Netherlands: Trend GDP and TFP Growth



Sources: DNB; CPB; and IMF staff calculations.

Figure 2. Netherlands: Labor Indicators



Sources: DNB; CPB; and IMF staff calculations.

Table 1a. The Netherlands: Elliot, Rothenberg, and Stock Test for Unit Roots (1980-2004) 1/

Statistics for $\rho = 0$

Levels [2]			First Differences [3]		
Variables	Lags	ΔFGLS$^{\tau}$	Variables	Lags	ΔFGLS$^{\tau}$
GDP	1	-2.94	GDP	1	-3.37
Labor hours	2	-3.05	Labor hours	2	-3.22
Unadjusted capital stock	2	-3.83	Unadjusted capital stock	4	-3.18
Adjusted capital stock	3	-3.15	Adjusted capital stock	1	-3.61

Table 1b. The Netherlands: Kwiatkowsky, Phillips, Schmidt, and Shin Stationarity Test (1980-2004) 1/

Statistics for $\sigma^2 = 0$

Levels [4]			First Differences [5]		
Variables	Lags	η^{τ}	Variables	Lags	η^{μ}
GDP	1	0.166	GDP	1	0.202
Labor hours	2	0.151	Labor hours	2	0.173
Unadjusted capital stock	2	0.093	Unadjusted capital stock	4	0.109
Adjusted capital stock	3	0.114	Adjusted capital stock	1	0.115

Table 1c. The Netherlands: Shimotsu and Phillips Exact Local Whittle Estimation of Fractional Integration, 1980-2004 1/

2-step feasible exact local Whittle estimator with detrending

Levels	Fractionally Integrated I(d) Process d
GDP	1.46
Labor hours	2.24
Unadjusted capital stock	2.57
Adjusted capital stock	0.94

[1] All variables are measured in natural logarithms. Lags are determined according to Schwarz information criterion and checking that the residuals are white noise.
[2] The DFGLS$^{\tau}$ has a null of unit root with a constant and a linear trend. The 5 percent critical value is -2.89, and the 2.5 percent critical value is -3.15.
[3] The DFGLS$^{\tau}$ has a null of unit root with a constant. The 5 percent critical value is -1.95.
[4] The η^{τ} has a null of stationarity with a linear trend. The 5 percent critical value is 0.146.
[5] The η^{μ} has a null of stationarity with a constant. The 5 percent critical value is 0.463.

Table 2a. The Netherlands: The Johansen-Juselius Maximum Likelihood Test for Cointegration (1979–2004)

Eigen values	Lags	λ max	Trace	H_0 : r 1/	λ max 90% 2/	Trace 90% 2/
0.5288	2	18.06 *	24.15	0	17.81	35.51
0.2173		5.88	6.09	1	14.10	17.70
0.0087		0.21	0.21	2	3.60	3.60
			Serial Correlation	LM(1) 3/	χ^2_9 = 13.19 (0.15)	
				LM(4) 3/	χ^2_9 = 13.28 (0.15)	

The estimated models include a drift term in the variables but not in the cointegration space.

1/ The letter "r" refers to the number of cointegrated vectors.
2/ The λmax and the trace statistics critical values are corrected for small samples using Cheung and Lai (1993).
3/ The LMs are Lagrange multiplier tests. The p values are between parentheses.

Table 2b. The Netherlands: The Johansen-Juselius Maximum Likelihood Test for Cointegration (1979–2004)

Eigen values	Lags	λ max	Trace	H_0 : r 1/	λ max 95% 2/	Trace 95% 2/
0.6222	3	22.39 *	29.12	0	21.96	43.78
0.2322		6.08	6.73	1	17.38	21.82
0.0281		0.65	0.65	2	4.44	4.44
			Serial Correlation	LM(1) 3/	χ^2_9 = 14.11 (0.12)	
				LM(4) 3/	χ^2_9 = 7.88 (0.55)	

The estimated models include a drift term in the variables but not in the cointegration space.

1/ The letter "r" refers to the number of cointegrated vectors.
2/ The λmax and the trace statistics critical values are corrected for small samples using Cheung and Lai (1993).
3/ The LMs are Lagrange multiplier tests. The p values are between parentheses.

Table 3. The Netherlands: Parameter Estimates of the Cobb-Douglas Production Function with TFP as a Latent Variable, 1979-2004

Log Likelihood	Variables	Estimates	Standard errors	K-S Levels 1/	K-S Squared 1/
Constrained parameters and TFP growth as an AR(1) process; adjusted net capital stock					
54.17	Labor	0.63	0.25	0.25	0.14
	Capital 2/	0.37	-.-		
	Autoregressive	0.97	0.03		

[1] The Kolmogorov-Smirnov statistic is 0.31 at the 10 percent level.
[2] The sum of the coefficients in the Cobb-Douglas production function is restricted to one.

Table 4. The Netherlands: Unadjusted Solow Residual, TFP and Potential Growth, 1984-2004

Average Annual Growth	Unadjusted Solow Residual	TFP Growth	Potential Growth
1984-2004	1.38	1.59	3.36
1984-1999	1.77	1.67	3.73
2000-2004	0.15	1.32	2.17
Standard deviation (1984-2004)	1.84	0.32	1.31

Table 5. The Netherlands: TFP Growth Decomposition, 2000-2004

Average Annual Percent Change		
TFP growth		1.32
Technological change		1.52
Efficiency change		0.02
Of which : labor	-0.17	
capital	0.19	
Change in utilization of trend inputs		-0.22
Of which : labor	-0.01	
capital	-0.21	

Table 6. The Netherlands: TFP Growth and Institutional Variables, 1984-2001

Dependent variable: TFP growth

Regressors	Coefficients	T-statistics
Constant	1.44	31.55 *
Ratio of minimum to median wage	-0.25	-4.47 *
Union density (percentage)	-0.22	-3.50 *
Gross replacement rates average	0.08	2.72 *
Tax wedge, married, as percentage gross labor costs	0.03	1.05
Payments, married, as percentage of gross wage earnings	-0.01	-0.32
Average effective tax wedge (percentage)	0.03	1.58
R^2	0.84	
K-S 1/	0.18	

1/ The Kolmogorov-Smirnov statistic is 0.31 at the 10 percent level.

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II. House Prices in the Netherlands: Determinants, Concerns, and Considerations Related to Phasing out the Tax Deductibility of Mortgage Interest Payments[28]

A. Introduction

1. **Developments in house prices are of considerable interest in the Netherlands.** During the boom of the late 1990s, the rapid increase in house prices added to household wealth and helped boost consumer spending.[29] As the momentum of house price increases moderated considerably in the new millennium, some of the fire under consumer spending was extinguished. While the recovery has now gathered steam, falling house prices, in light of prospects for interest rate hikes, are an ever-present concern that could impact negatively on the economy as well as banks. In this context, it is important to take stock of recent developments in house prices, with a view to continuing to assess the risks that prices may be out of line with fundamentals or fall in the future.[30]

2. **Associated developments in household debt are also of economic importance.** In this connection, residential mortgage indebtedness and household leverage in the Netherlands have been rising, reaching levels that are high compared with other industrialized countries. High debt can raise vulnerabilities, for banks and the economy more generally.

3. **With various fiscal incentives making mortgage debt attractive, this paper pays special attention to the tax deductibility of mortgage interest payments.** The Financial System Stability Assessment of 2004 recommended, over the medium term, to phase out the tax deductibility of mortgage interest, preferably in a gradual fashion to avoid disruptive effects.[31] Among the reasons for eliminating this incentive, (i) tax deductibility of mortgage interest introduces a distortion in the housing markets—making holding mortgage debt attractive and reducing the incentive to pay back the principal; (ii) this policy favors wealthy households, as the tax advantage increases with higher tax brackets and is larger the larger the real estate assets of a household; (iii) removing tax deductibility would help the budget in

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[28] Prepared by Sibel Yelten.

[29] The DNB estimated that housing price and asset increases added an average of 1–1½ percent to real GDP growth between 1998 and 2000, a key factor in explaining the comparative resilience of Dutch private consumption through 2001.

[30] This follows on a selected issues paper from the 2005 Article IV Consultation, *House Prices in the Netherlands* by David Hofman. That paper did not find evidence of a deviation from fundamentals as of the second quarter of 2004 but also noted the limited comfort in the finding because the analysis also showed that the equilibrium price of housing was quite sensitive to interest rates.

[31] The Kingdom of the Netherlands—Netherlands: Financial System Stability Assessment, including Reports on the Observance of Standards and Codes on the following topics: Banking Supervision, Securities Regulation, Insurance Regulation, Corporate Governance, and Payments Systems, and Anti-Money Laundering/Combating the financing of Terrorism, IMF Country Report N. 04/312, September 2004.

the context of rising costs related to population aging; and (iv) the revenue received from removing tax deductibility could be used for policies that more directly aim to make housing affordable for low-income households that currently cannot afford a house due to high house prices. Against this background, and based on the experience of other countries that removed tax deductibility of mortgage interest payments, this paper attempts to quantify and shed some light on the expected price impact of phasing out this incentive.

4. **The paper is organized as follows:** Section B summarizes recent developments in the housing market in the Netherlands, with Section C providing a cross-country comparison. Section D reflects on the unusual developments in housing markets in industrialized countries. Section E discusses policy issues, in particular the tax deductibility of mortgage interest payments. Section F draws lessons from the experience of other countries that phased out mortgage interest deductibility. Section G discusses how tax deductibility of mortgage interest payments could be phased out, drawing on the U.K. and Swedish experiences. This is followed by concluding remarks in Section H.

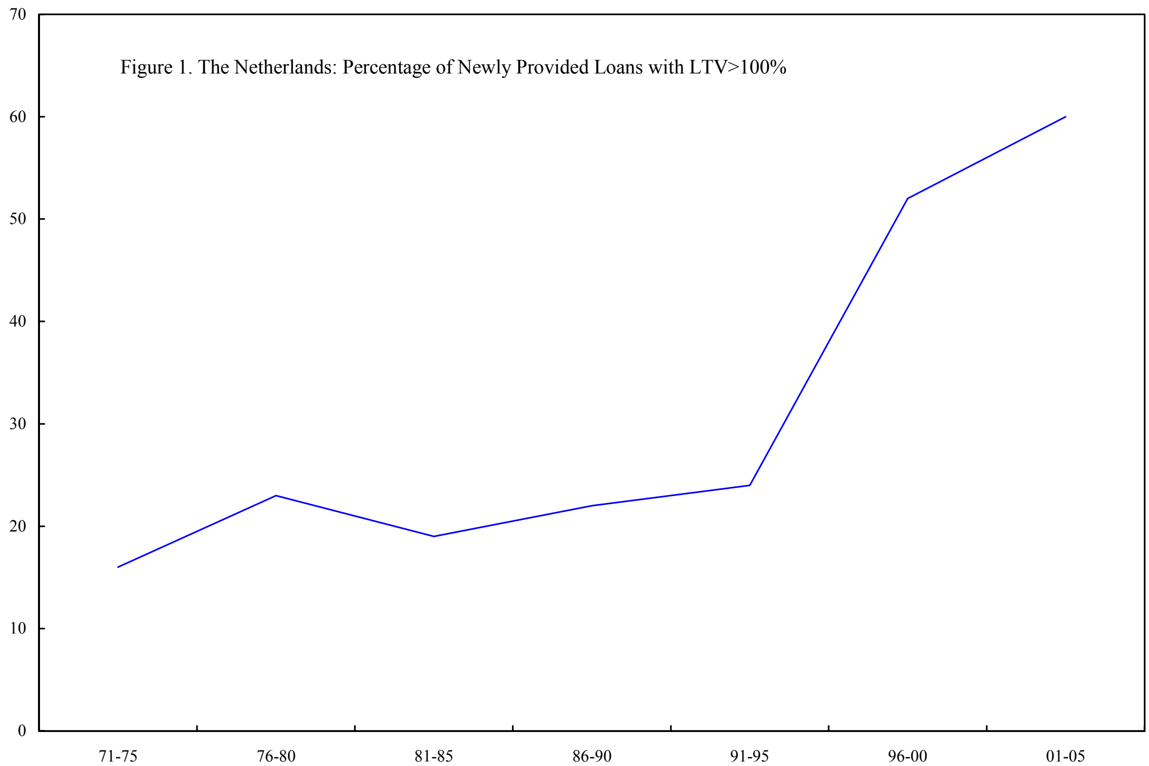
B. What is the Current Situation in the Housing Market in the Netherlands?

5. **House prices accelerated again after a brief slowdown.** Following two decades of strong house price inflation, house price growth decelerated sharply in the fourth quarter of 2000 and then remained subdued until recently. In 2005, prices accelerated again, with the quarter-over-quarter increase in the third quarter registering 3.1 percent. Whether this increase is just a temporary revival in prices or reflects a return in house price growth to its exceptional upward trend remains to be seen.

6. **Reports suggest that credit quality is deteriorating because of the continued expansion of mortgages.** This is not all that surprising, since most European banks have been struggling to find growth and profit opportunities in an increasingly competitive banking environment. In many European countries, banks have been faced with a drop in corporate demand for loans, and residential real estate loans have been one of the few growth opportunities. The Netherlands has been no exception in this trend: the debt-to-equity ratio of the corporate sector fell from 69 percent in 1998 to 32 percent in 2004, causing a shift in the loan portfolio of banks; corporate sector loans of the banking sector fell from 38 percent of total loans to 30 percent over the same period; and, in contrast, household sector loans as a percent of total loans remained constant at 50 percent over that period. At the same time, mortgages guaranteed by the National Mortgage Guarantee have been expanding rapidly and reached €60 billion in 2004. For these mortgages, banks have little incentive to scrutinize the loans, as they are essentially risk free.

7. **Meanwhile, households have become more sensitive to interest rate changes.** Reports by De Nederlandsche Bank (DNB) indicate that the proportion of mortgages subject to an interest rate adjustment within two years increased from 21 percent in 2003 to 31 percent in 2005. Moreover, the percentage of newly provided loans with loan-to-value ratios (LTV) exceeding 100 percent has been increasing significantly (Figure 1). Households

are also more indebted, insofar as the ratio of mortgage debt-to-GDP is high at more than 100 percent and has been increasing.



C. How does the Situation in the Netherlands Compare to Other Industrialized Countries?

8. **Price developments in the Netherlands have, in a number of respects, been unique.** A feature that differentiates the Netherlands from most other European countries is that house prices have been increasing for two decades. One of the few countries that had a similarly long expansion is Belgium. However, while prices in Belgium have been growing at a moderate pace for this entire period, price increases in the Netherlands accelerated in the 1990s. Hence, if one were to look at the cumulative real house price increase from trough to peak, the increase of 103 percent in the Netherlands surpasses all its neighbors. In addition, countries such as the United Kingdom and Spain have been experiencing much more volatile housing markets, with real estate bust and booms over shorter cycles. Table 1 and Figure 2 provide an overview of the differences among various countries in their real estate price cycles.

Table 1. Accumulated Inflation-Adjusted House Price Increases

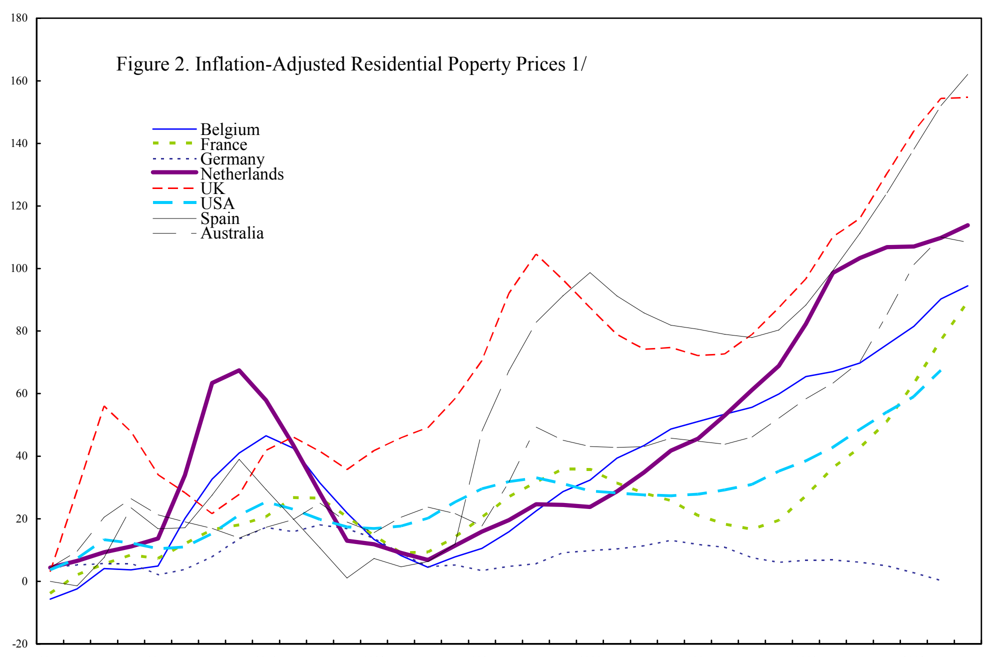
(Percent cumulative change as of end-2004)

	Peak-to-peak Increase	Trough-to-peak Increase	Duration of Price Boom	Last Peak	Last Trough
Belgium	44	86	19	1979	1985
United Kingdom	50	82	9	1989	1995
Netherlands	52	103	19	1978	1985
France	41	60	7	1991	1997
Spain	53	74	7	1991	1997
Australia	61	67	12	1989	1992
United States	34	40	10	1989	1994

Sources: Inflation-adjusted real estate prices are from BIS calculations using national data; and author's calculations.

Note: Nominal price increases are deflated by CPI.

9. **On a cross-country basis, mortgage debt in the Netherlands is among the highest in industrialized countries (Table 2).** In 2004, the ratio of overall mortgage debt to GDP was 46 percent in EU-15 countries. At 111 percent in the Netherlands, this ratio was the highest in Europe, followed by Denmark at 90 percent and the United Kingdom at 73 percent. Even in the United States, mortgage debt-to-GDP at 65 percent is significantly lower than in the Netherlands. Per capita mortgage debt in the Netherlands was around €32,000, surpassed only by Denmark. Furthermore, despite the already high debt level, mortgage debt in the Netherlands increased again in 2004 by 14 percent, compared with increases of 11 and 6 percent, respectively, in the United Kingdom and Denmark.



Sources: Provided by the national authorities; and BIS.

1/ BIS calculations based on national data, cumulative real growth rates (1970=0).

Table 2. Mortgage Debt in 2004

	Mortgage Debt (In millions of euros)	Mortgage Debt (Growth over 2003)	Residential Debt/GDP (Percent)	Per Capita Mortgage Debt (In euros)
Belgium	88,434	8.2	31.2	8,506
Czech Republic	6,576	34.9	7.6	644
Denmark	174,300	6.0	89.7	32,292
Germany	1,157,026	0.1	52.4	14,019
Estonia	1,500	57.3	16.6	1,110
Greece	34,052	28.3	20.6	3,084
Spain	384,631	22.9	45.9	9,083
France	432,300	12.2	26.2	7,217
Ireland	77,029	29.8	52.7	19,125
Italy	196,504	13.4	14.5	3,395
Cyprus	2,182	4.6	17.6	2,988
Latvia	1,273	67.5	11.5	549
Lithuania	1,258	88.3	7.0	365
Luxembourg	8,797	12.3	34.3	19,480
Hungary	7,767	35.1	9.6	768
Malta	1,236	20.6	28.6	3,090
Netherlands	518,115	14.3	111.1	31,868
Austria	48,064	20.9	20.3	5,905
Poland	10,686	22.9	5.5	280
Portugal	70,834	6.9	52.5	6,762
Slovenia	387	30.3	1.5	194
Slovakia	2,032	82.3	6.1	380
Finland	56,522	10.8	37.8	10,829
Sweden	147,163	10.0	52.7	16,396
United Kingdom	1,243,261	11.1	72.5	20,835
EU-15	4,566,198	9.6	46.4	11,931

Source: European Mortgage Federation.

10. **The Netherlands is one of the most densely populated countries in Europe, and supply restrictions tend to contribute to the excess demand for housing that has been met by price increases.** With 478 people per square kilometer, undeveloped land is in short supply. In addition, zoning laws are very strict. Consequently, the supply elasticity of housing is usually regarded as very low.

D. Is There a Reason to be Concerned?

11. **Viewed from a cross-country perspective, the current real estate boom cycle in industrial countries is unusual by historical standards.** The unprecedented low interest rate environment and the development of new mortgage products contributed to housing markets reaching unprecedented highs in many countries. Moreover, housing price cycles have generally tended to last only 3–4 years, with cumulative price increases averaging around 30 percent during the boom phase and, in those cases of a complete cycle, the entire increase was often reversed during the bust phase.[32] By comparison, the duration and the

[32] World Economic Outlook (April 2003) and Bank for International Settlements, BIS Papers, No. 21.

magnitude of the current expansion in prices in several industrial countries has surpassed this record by far.

12. **No country is immune to real estate boom and bust cycles—the Netherlands is no exception.** Expert and media accounts of residential property markets—historically and across countries—describe price developments in these markets in terms of the recurrence of booms and busts;[33] the empirical literature confirms cyclicality and high autocorrelation in house prices.[34] Even though somewhat distant from the present, the Netherlands did experience a real estate boom in the 1970s followed by a painful and complete reversal of the price gains in the early 1980s. What is striking about the Netherlands it that the current price increases have been exceptional both on a cross-country basis and compared to its own historical experience.

13. **Estimating whether the housing market can be characterized by overpricing can be tricky and varies from study to study.** One reason for large discrepancies among studies is differences in the sample period chosen and the period over which the overvaluation is calculated. Further, estimation methodology differs from study to study, and estimates using annual vs. quarterly data can differ substantially. Finally, in all studies, coefficients are somewhat unstable and jump around depending on inclusion and exclusion of various variables.[35] Having listed these reservations, the estimation by Hofman (2005), using a quarterly sample during 1970–2004, suggested that house prices (as of the second quarter of 2004) had not moved beyond what could be explained by changes in fundamentals. Other studies, by comparison, found evidence of overpricing: a recent study by Verbruggen and others (2005), using an annual sample from 1980–2003, found Dutch house prices "somewhat" overvalued; and Van den End and Kakes (2002) found a positive long-run correlation between stock market and house prices, at a two to three year lag, suggesting that there may have been substantial scope for downward movement in current house price levels at the time of the study, in light of the severe losses in the Dutch stock market at the beginning of the new millennium.

14. **Nonetheless, all studies suggest that housing prices are highly sensitive to interest movements, so housing prices could fall and negatively affect consumption if interest rates were to rise further.** In this regard, Hofman (2005) finds that a 1 percent increase in the real interest rate reduces the long-run equilibrium house price by about 10 percent. Verbruggen and others (2005) confirm the significant impact of interest rates on housing prices. Further, various studies suggest that aggregate consumption is sensitive to house price

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[33] The special Report on "The global housing boom: In come the waves" published in *The Economist* on June 16, 2005 provides a good illustration of these views.

[34] Ceron and Suarez (2006); Muellbauer and Murphy (1997); Herring and Wachter (1999); OECD Economic Outlook 75; World Economic Outlook, April (2003).

[35] A good example that demonstrates this point is the study by Verbruggen and others (2005).

developments. According to calculations using CPB's quarterly model SAFE, for the period 1995–2002, 40 percent of consumption growth could be attributed to the increase of households' stock of dwellings. Estimates by the IMF (Nadal de Simone, 2005) suggest that consumption is sensitive to changes in house prices insofar as the long-run elasticity of consumption with respect to per capita real net wealth is 0.21.

15. **An interesting and important result from a study by the CPB is that price developments are asymmetric.** In this connection, Verbruggen and others (2005) show that downward adjustment in prices are slower. Nevertheless, a prolonged adjustment process could still potentially keep consumption at a lower level for a longer time period.

16. **Our estimates suggest that real house prices in the Netherlands are highly responsive to changes in disposable income and the real interest rates (Table 3)**. The model in this paper explains historic price developments quite well (Figure 3). Further, the coefficients are highly significant, stable, and do not change significantly if we change lag length or change the sample period. It is likely that this is due to the inclusion of the nominal interest rate in the cointegration relationship, after correctly identifying it as a stationary variable with a trend. [36] Our findings suggest that the 1990s episode, with its very large price increases, was similar to the 1970s episode when housing markets were overheated (in the sense that actual prices exceeded fitted values). However, when prices slowed down in the new millennium, this allowed fundamentals and house prices to come more in line. The current pickup in prices may lead to a renewed upward deviation from fundamentals—and it remains to be seen whether the upward trend in prices will continue in the future. Nonetheless, our model predicts that, should fundamentals change sufficiently—for example because of rising interest rates—house prices would experience a downward adjustment.

[36] We estimate a cointegration relationship using the nominal interest rate and the disposable income per household. Since the nominal interest rate is stationary (with trend and constant), this variable is detrended in the short run relationship. See Appendix I for details.

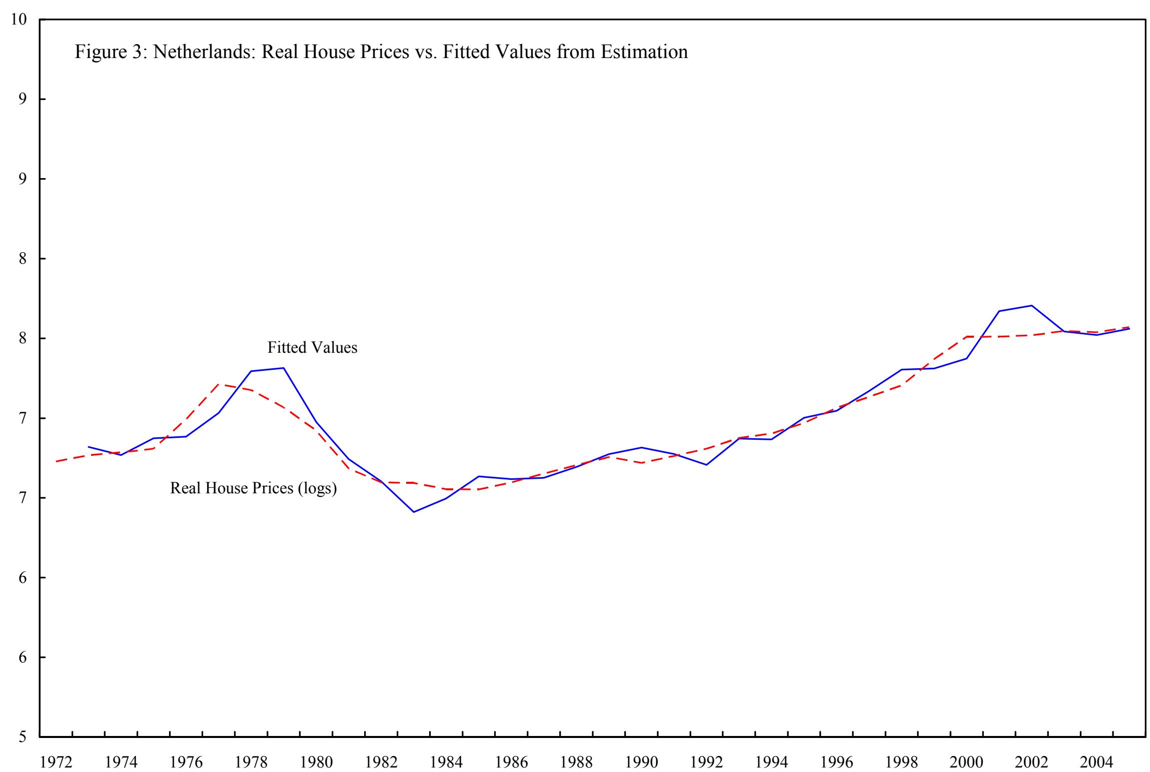
Table 3: The Netherlands: Regression Results, 1970-2005

Variable	Coefficient	t-statistic	Significance	R^2	Cumulated Periodogram Test on Residuals 1/
				0.97	Max Gap 0.13
Long Run					
Disposable income per household	1.0222*	4.19	0.00		
Nominal interest rate	-0.0451*	-4.06	0.00		
Short Run					
Δ Per household disposable income (lag 1)	1.0784*	2.79	0.00		
Nominal interest rate (detrended), (lLag1)	-0.0336*	-3.35	0.00		
Δ Real house price (Lag 1)	0.4646*	3.16	0.00		
Δ Real house price (Lag 2)	-0.3406*	-2.20	0.02		

Source: IMF staff estimates.

1/ Critical value 0.17.

* Denotes signifcance at the 5 percent critical value.



17. **The risks in the system also seem to have moved into unchartered waters.** Current indebtedness levels in industrial countries and particularly in the Netherlands are unprecedented. Further, various new mortgage products have allowed households to leverage themselves to the limit, not pay back principal, and take on interest rate risk and other risks associated with the increased utilization of these products. With price developments in various countries, including the Netherlands, also exceptional compared to other cycles, it

would seem that countries' abilities to deal with the associated risks have not been tested historically. In a related vein, at this juncture, it makes sense to review policies that encourage households to leverage themselves excessively or policies that affect banks' lending practices.

E. Policy Issues

18. **Various steps could help reduce the incentives for the risks that households and banks are taking.** This paper concentrates on the tax deductibility of mortgage interest payments but briefly discusses other issues.

19. **The NHG guarantee encourages banks to extend mortgage loans and shifts the risk of default to the government.** For banks, mortgages guaranteed by the NHG carry no credit risk, and are inexpensive, since mortgage loans guaranteed by the NHG have a risk weighting of zero. In contrast, the current solvency requirements for Dutch banks regarding the treatment of mortgages provide for a distinction according to the (perceived) riskiness of the loan. Mortgage loans that do not exceed 75 percent of the liquidation value of the property have a risk weighting of 50 percent. When the mortgage loan exceeds 75 percent of the liquidation value of the property—so called *top mortgages*—the "loan surplus" on top of the liquidation value will have a risk weighting of 100 percent. While the reasons for NHG guarantees may be commendable to some on social grounds, the implicit cost of this guarantee is covered by the government. That this guarantee comes at no cost to banks and households introduces a price distortion.

20. **Tax deductibility of mortgage interest payments is another fiscal advantage that strongly encourages households to leverage themselves.** Various empirical studies found strong evidence that household leverage is highly sensitive to the tax advantage created by interest rate deductibility (Dunsky and Follain, 2000; Follain and Dunsky, 1997; Follain and Ling, 1991; Ling and McGill, 1998; and Hendershott, Pryce, and White 2003). These studies show that removing interest deductibility provides a strong incentive to homeowners with existing loans to pay off their loans and causes new homeowners to choose loans with less leverage. This is particularly true for households that are not income-constrained and are in higher tax brackets, since they tend to chose the higher leverage because of tax advantages.

21. **In addition, the extent to which interest deductibility meets social goals is not entirely clear.** Even though this policy is intended to make housing more affordable, it is not clear whether it does so, since housing prices adjust to tax incentives. Further, interest deductibility favors households in higher tax brackets—thus using foregone government resources in ways that are less advantageous to those of lower income. It also encourages households to leverage themselves while reducing the incentive to pay off the principal part of the loan.

22. **The next section takes a selective look at the country experience in removing the tax deductibility of mortgage interest payments.** In particular, the experience of the United Kingdom and Sweden suggests that the timing of the phase-out of the tax deductibility of mortgage interest payments in terms of prevailing economic conditions, as well as the speed with which the phase-out occurs, are important variables to keep in mind for policy design.

F. The Experience of Other Countries that Phased Out the Tax Deductibility of Mortgage Interest Payments

The United Kingdom

23. **One country that has gradually but fully eliminated the tax deductibility of mortgage interest payments is the United Kingdom.** The United Kingdom phased out the tax deductibility over the course of 25 years (1974–99). Before 1974, mortgage interest payments in the United Kingdom were fully deductible at the marginal tax rate. In 1974, a ceiling was introduced on the size of mortgages that were eligible for tax deductibility of interest payments. This ceiling was set at £25,000, and households with a mortgage loan that exceeded this limit could only deduct interest payments for the portion that was at or below this limit. In 1983, this limit was raised to £30,000. Subsequently, the limit was never raised again. Later, the maximum tax rate at which interest could be deducted was cut from a 40 percent maximum income tax rate to 25 percent in 1992, to 20 percent in 1994, to 10 percent in 1995, and finally down to zero in 1999 (Table 4).

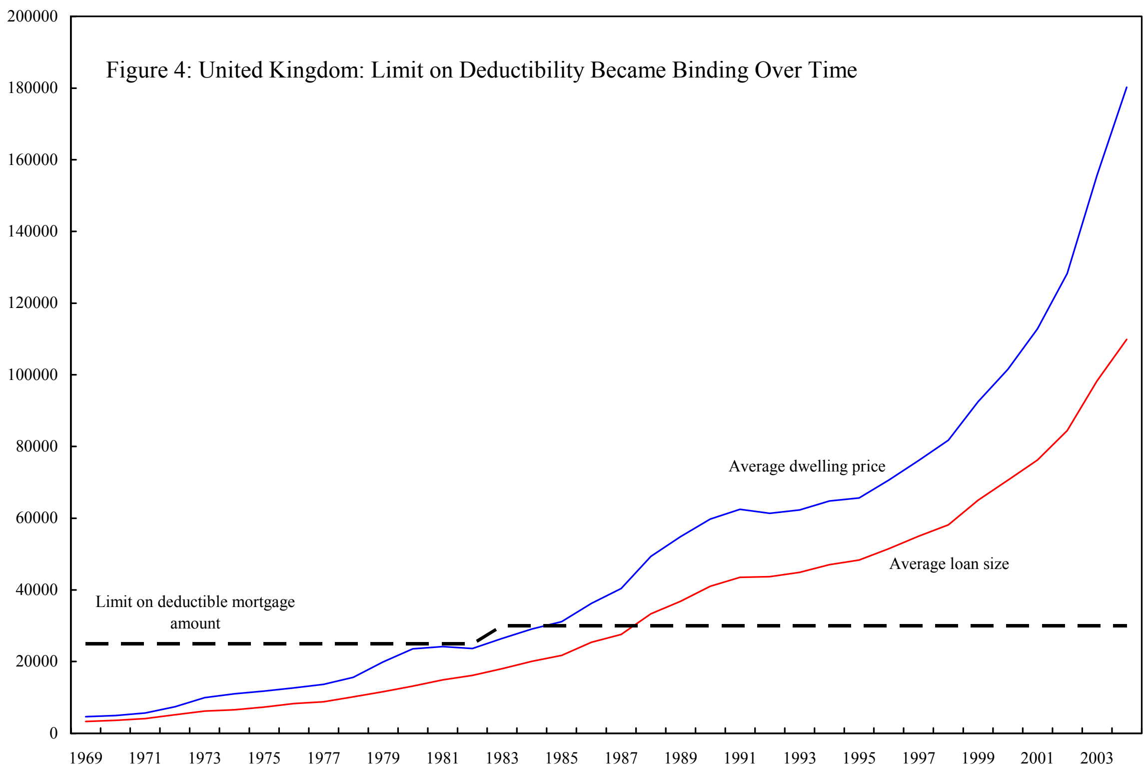
24. **The success of the U.K. experience reflected the introduction of a nominal ceiling—on the size of mortgage loans that qualified for tax deductibility of mortgage interest payments—that became binding over time (Figure 4).** In 1974, when the ceiling was set at £25,000, the median price of a house in the United Kingdom was only £10,800, and just a few very rich households were affected by this restriction. However, since the cap was nominal and the limit was only raised once (to £30,000), the rapidly increasing house prices and the rapidly increasing loan sizes made this limit binding for the majority of households in a gradual manner. By 1988, about half the new mortgage originations were above this limit, and by 1995, two thirds were above the limit (Table 4). It was fortuitous that the ceiling was introduced towards the end of a recession and just before an upturn, as there was immediate upward pressure on house prices after the introduction of this policy. Thus, the success of the U.K. experience also demonstrates how timing is important.

Table 4: United Kingdom: The Gradual Phase-out of
Tax Deductibility of Mortgage Interest Payments

Limits on Amounts Deductible				
Year	Limit (In pounds sterling)	Median House Price (In pounds sterling)	Mean House Price (In pounds sterling)	Mortgages Above Limit (In percent)
1974	25,000	10,800	10,990	0
1983	30,000	29,400	26,471	5.4
1988 to 1991	30,000	63,000	56,610	48.4
1995 to 1998	30,000	73,800	73,537	67.4

Limits on Rate Deductibility			
Year	Tax rate (In percent)	Maximum Deductible (In percent)	Mortgages above Maximum (In percent)
1988 to 1991	25, 40	25, 40	0
1992 to 1993	25, 40	25	26.0
1994	25, 40	20	100.0
1995 to 1998	23, 24, 25, 40	10	100.0
1999	23, 40	0	100.0

Source: Hendershott, P.H., Pryce, G., White, M. "Household Leverage and the Deductibility of Home Mortgage Interest: Evidence from U.K. House Purchasers," Journal of Housing Research, Vol. 14, Issue 1.



25. **With the reform taking place over 25 years, the phasing-out of the tax deductibility of mortgage interest payments appeared to have a limited impact on house prices in the United Kingdom.** Figure 5 shows changes to the tax deductible amount for a representative household in real terms and the cumulative real house price increases in the United Kingdom. For the calculation of the tax deduction of a representative household, a representative household is defined as a household that buys a house at the average house price in that year, using the average housing loan that has been recorded for that year.[37] Further, it is assumed that, as a new mortgage holder, the representative household pays interest on the mortgage loan according to the interest rate in that year. Hence, the mortgage interest a representative household pays and the tax deduction not only change due to changes in the tax law but are also sensitive to interest rate fluctuations in the market and the average price of a new house. Notice, for example, that from 1989 to 1993, the interest rate fell from 13.3 to 5.2 percent, and this fall reduced the interest burden of households; at the same time, it implied that the tax they could deduct declined. It is noteworthy that lowering the deductible rate after 1992 led to a sharp drop in the deductible amount. Further, while from 1989 to 1994, the drop in tax deductibility coincided with a drop in house prices, after 1996, house prices increased strongly despite a complete removal of tax deductibility by 1999—though, of course, the removal of tax deductibility was not the only factor at play. Thus, an econometric exploration was also tried.

[37] The average tax advantage for this representative household is calculated in the following way. Before 1987, the average loan size is smaller than the deductible mortgage limit; therefore the average loan size, the maximum deductible rate, and the long-term interest rate in each year are used to calculate the tax advantage for an average household. After 1987, the cap on the mortgage loan size becomes binding for an average household, therefore the £30,000 limit is used to calculate the tax advantage, again using the maximum deductible percent and the interest rate in each year.

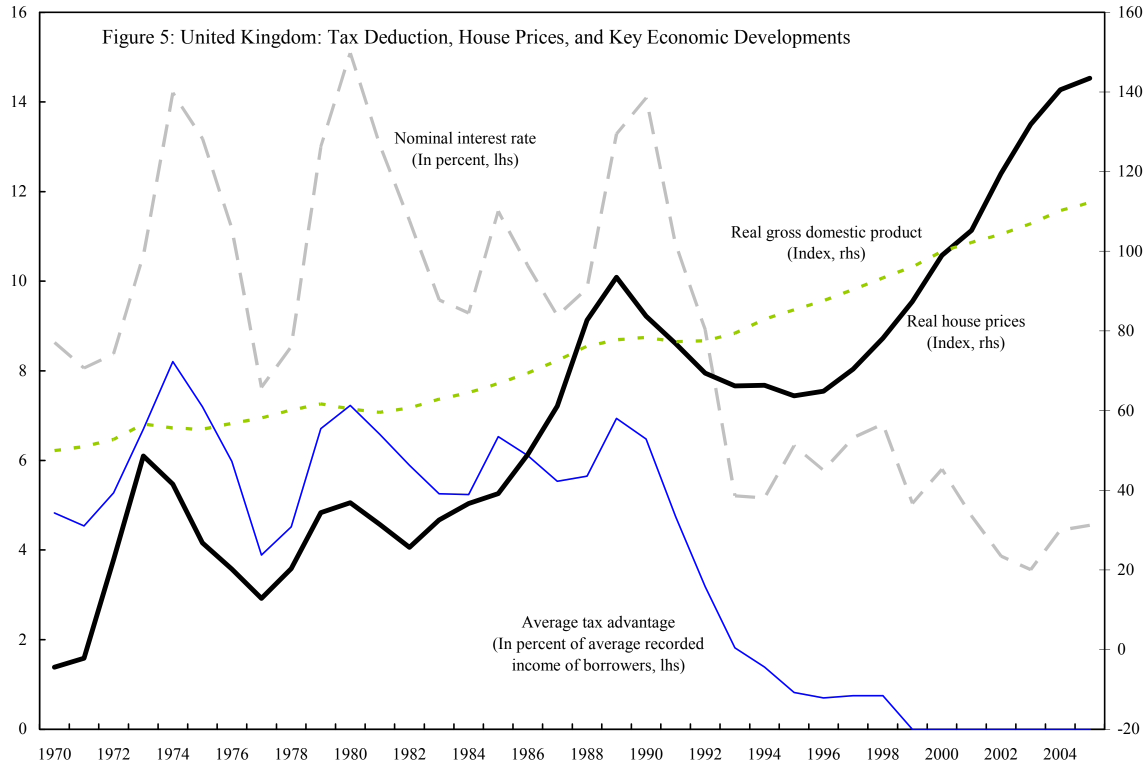


Figure 5: United Kingdom: Tax Deduction, House Prices, and Key Economic Developments

26. **Econometrically, the impact of tax deductibility on U.K. house prices seems to have been limited (Table 5).** Using disposable income, long-term interest rates, and tax deductibility as explanatory variables for real house price changes, we estimate the impact of having removed tax deductibility on real house prices. The coefficient on tax deductibility is small but significant at the 10 percent level. While these estimates may underestimate the impact of tax deductibility on housing prices because of the correlation of this variable with disposable income and interest rates, the impact nevertheless seems moderate. Though difficult to prove, this may well have reflected the long time period over which tax deductibility was phased out.

Table 5. United Kingdom: Regression Results

Variable	Coefficient	t-statistic	Significance	R^2	Cumulated Periodogram Test on Residuals /1
Full Sample (1970-2005)				0.8	Max Gap 0.13
Δ Real disposable income	1.8162*	3.85	0.00		
Nominal interest rate (detrended)	-0.01567*	-4.00	0.00		
Δ Representative HH tax deductibility	0.000102**	1.66	0.10		
Δ Real house price (lag 1 period)	0.30942*	2.30	0.02		

Source: IMF staff estimates.

* Denotes significance at the 5 % critical level ** Denotes signifiance at the 10% critical level.
1/ The 10 percent critival level is 0.15.

Sweden

27. **Sweden reduced the tax deductibility of mortgage interest payments over a short span of time (1985–91).** Sweden reduced the maximum deductible rate that could be applied to mortgage interest payments to 50 percent in 1985 and 30 percent in 1991. Prior to this reform, the maximum deductible rate was 80 percent. After the reform, households that were in a higher marginal tax category than these maximum limits had to apply these limits when calculating their deduction, rather than their actual marginal income tax rate.

28. **In the case of Sweden, it is difficult to isolate the impact of the partial phasing out of tax deductibility on housing prices, due to a number of important changes that happened at the same time.** In addition to changes to the maximum deductible rate, Sweden went trough a number of significant tax reforms in the late 1980s and early 1990s. In 1991, taxes on labor income were reduced to a basic marginal tax rate of 30 percent and a top marginal tax rate of 50 percent (previously, the top marginal tax rate could be as high as 75 percent). In addition, in order to reduce inter-asset tax distortions and reduce overinvestment in housing and durable goods, various changes were made to the taxation of owner-occupied housing and other financial assets.[38] Further, the country went through a recession in the early 1990s. Thus, for Sweden, due to various data limitations, and the changes to several taxes over the same time period, it was decided that it would be impractical, if not implausible, to try to empirically isolate the impact of changes to tax deductibility of mortgage interest payments on house prices.[39]

29. Nonetheless, a graphical analysis of house price developments suggests that the timing of the phasing-out of the tax deductibility of mortgage interest payments could have been better from the standpoint of the economic conjuncture. Many of the changes in taxes and the final reduction in the rate applied to the mortgage interest payment deduction (to 30 percent) were introduced in 1991. This was in the middle of a recession and during a time when house prices had already stagnated and started to fall. Thus it would seem reasonable to conclude that the sizable reduction in the tax deduction only compounded the impact of the recession in contribution to the drop in house prices during that period. By comparison, when Sweden first reduced the maximum rate that applied to the mortgage interest payment deduction (from 80 to 50 percent in 1985), this occurred in the midst of strong economic growth, the change only affected high-income households with very high marginal tax rates, and real house prices experienced spectacular growth, despite the partially offsetting effects of the reduction in deductibility.

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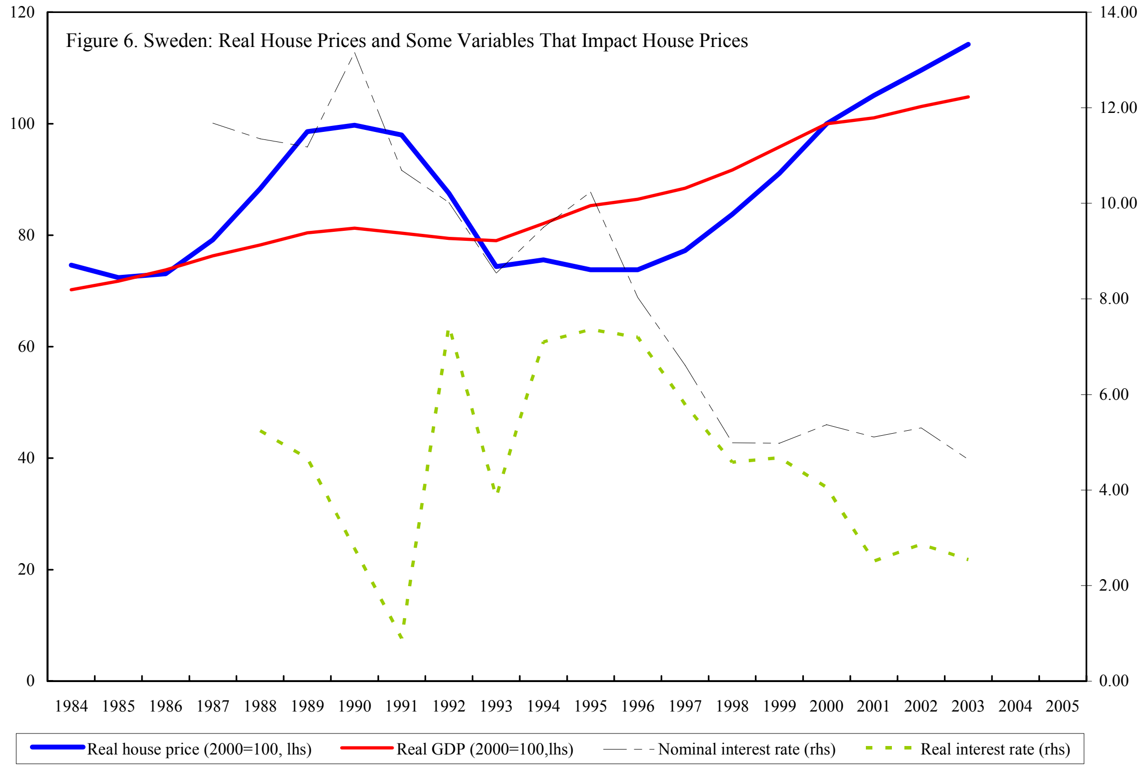
[38] See Agell, Berg, and Edin (1995).

[39] For example, the Swedish national income series for disposable income is very short and starts only in 1993; thus, it does not cover the time period when tax deductibility was reduced. To estimate the determinants of real house price developments in Sweden, it would be important to have a sufficiently long time series on disposable income, interest rates, and other data that would allow the quantification of the impact of each tax change in isolation.



G. When and How to Phase out Mortgage Interest Deductibility in the Netherlands?

30. **If policy makers were to decide to phase out the tax deductibility of mortgage interest payments, they would need to make decisions on certain aspects of this policy—with various implications for households and house prices.** In particular, illustrated below for the Netherlands is the relevance of the timing of the phase-out (in terms of the economic conjuncture) and the speed of the phase-out (that is, the time period over which policies are binding), with some quantitative analysis. In the analysis, it is assumed that a loss in household income when tax deductibility is reduced can be treated in the same way as a drop in disposable income. The estimates of the determinants of real house prices in the Netherlands (Table 3) are then used to quantify the price impact of future changes in tax deductibility. Given the limitations of any modeling exercise of this kind, the numbers presented are not meant to be actual forecasts of what housing prices might be. Rather, they should be taken as being illustrative of the fact that policy options matter as do the economic circumstances under which policy is implemented.

31. **Three policy options are analyzed**. Policy 1: An immediate and complete removal of tax deductibility. Policy 2: Introduction of a nominal limit on the size of the mortgage loan that qualifies for tax a deduction. The nominal limit is set at the average size of a mortgage loan in 2005. Hence, because mortgage loans only qualify for a tax deduction up to that limit, this option becomes gradually more binding as house prices increase. Policy 3: A reduction of the deductible rate—meaning that the tax rate that would apply to the mortgage interest

payment deduction would be below the marginal rate that would otherwise apply to income. Figure 7 summarizes the impact of these policy options on real house prices, based on one of three economic scenarios, namely "normal economic growth." The assumptions behind this economic scenario are presented in Table 6, along with the assumptions behind the two other economic scenarios under which the different policy options are analyzed.

32. **Because of differences in the average loan size for and the actual marginal tax rate of different income levels, changes to tax deductibility affect low-, average-, and high-income households differently.** Table 6 summarizes the key characteristics of different households in different income categories. For example, the average tax saving for a high-income household with an average loan size of €209,000 and a marginal tax rate of 50 percent is €5,585; whereas, the average tax saving of a low-income household, with an average loan of €127,000 and a marginal tax rate of 30 percent is €2,034. Hence, a complete removal of tax deductibility would lead to an immediate drop in disposable income for high-income households (low-income households) of €5,585 (€2,034). In the following analysis, taking into consideration the different loan sizes and different tax brackets for different income categories allows us to differentiate the price impact of phasing out tax deductibility for these three household categories.

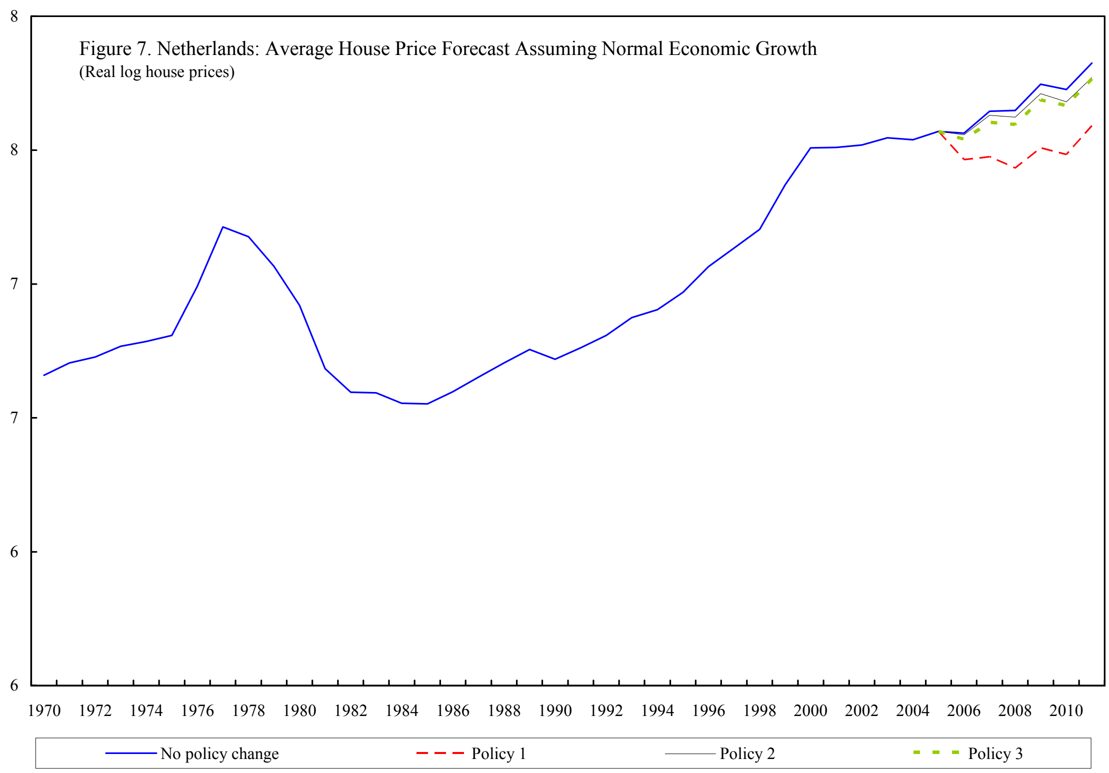


Table 6. Netherlands: Household Categories

(In euros; unless indicated otherwise)

	Low-Income Household	Average-Income Household	High-Income Household
Average house price for category	200,000	225,200	325,000
Average income of mortgage borrower	27,000	49,000	94,000
Average loan size of borrower	127,000	145,000	209,000
Mortgage interest rate (in percent)	5.3	5.3	5.3
Household tax category	30%	40%	50%
Calculated deduction from income	6,780	7,750	11,170
Tax saving (additional disposable income)	2,034	3,100	5,585
Ratios:	0	0	0
Leverage of average household (Loan/income)	4.70	2.96	2.22
Loan/house price	0.64	0.64	0.64

Source: Ministry of finance, March 20, 2006 ("Actualisatie varianten fiscale behandeling eigenwoningbezit").

Note: Age: all households <65; income categories: low <€30,000; average €30-60,000; high >€60,000.

33. **Under Policy 1—an immediate and complete removal of the tax deductibility of mortgage interest payments—there is a significant drop in house prices for all households.** For example, if the removal of tax deductibility were to coincide with the modest recession scenario, then real house prices for high-income households would decline by 20 percent in the first year after the policy change. If the modest recession were to continue, the real house price decline for high-income households would reach 36 percent at the end of the fifth year. A more severe recession, or higher interest rates, would lead to a more severe drop in real prices.

34. **Under Policies 2 and 3—which show the tax deductibility of mortgage interest rates payments reduced over time (Figure 7 and Table 7):**

- The drop in house prices during a recession is dampened compared with Policy 1. For example, one year after a policy change, the price drop for average income households during a modest recession would be -12.4, -3.0, and -5.2 under Policies 1, 2, and 3, respectively.

- Inflation pressures are mitigated during an economic expansion compared to no change in tax deductibility. Without any policy change, there is a 29.1 percent (assuming normal economic growth) and 48.8 percent (assuming exuberant economic growth) real house price increases after six years. Introducing a nominal limit on mortgage loans that qualify for interest rate deduction (Policy 2) would moderate these expected price increases during a period of economic expansion. For example, after six years (assuming normal economic growth), real house prices increase by 26.6, 22.2, and 14.4 percent, for low-, average-, and high-income households, respectively, figures lower than under the no-policy-change scenario. Broadly similar results hold under exuberant growth, and the implications on real house prices under Policy 3 are similar to Policy 2.

Table 7. Netherlands: Price Impact of Phasing Out Tax Deductibility

(Percent change in real house prices)

One Year After Policy Change	No Policy Change	Policy 1			Policy 2			Policy 3		
		HH1	HH2	HH3	HH1	HH2	HH3	HH1	HH2	HH3
Modest recession	-3.0	-9.2	-12.4	-20.0	-3.0	-3.0	-8.4	-3.0	-5.2	-7.5
Normal economic growth	-0.6	-6.8	-10.0	-17.5	-0.6	-1.2	-5.2	-0.6	-2.9	-0.6
Exuberant growth	0.6	-5.5	-8.7	-16.2	0.6	-0.3	-4.1	0.6	-1.7	-5.4

6 Years After Policy Change	No Policy Change	Policy 1			Policy 2			Policy 3		
		HH1	HH2	HH3	HH1	HH2	HH3	HH1	HH2	HH3
Modest recession	0.6	-14.0	-21.1	-36.3	0.6	-0.1	-13.0	0.6	-5.0	-10.4
Normal economic growth	29.1	11.0	2.1	-16.9	26.6	22.2	14.4	29.1	21.6	29.1
Exuberant growth	48.8	28.2	18.1	-3.6	43.1	37.0	31.1	48.8	39.8	31.9

Definitions:

Economic scenarios:	Disposable income growth per household per year	Change in interest rate, per year
Modest recession	0.00%	-0.10
Normal growth	3.50%	0.15
Exuberant growth	5.00%	0.20

Policy Scenarios:

Policy 1: Immediate abolition of tax deductibility of mortgage interest rates.

Policy 2: Mortgage loans that qualify for mortgage interest rate deduction are capped by a nominal limit. The nominal limit is set at €141,000, which is the average mortgage loan in the Netherlands in 2005.

Policy 3: The marginal tax rate at which mortgage interest payments can be deducted from income is reduced to 30%.

Households:

HH1: Low-income household; HH2: Average-income household; HH3: High-Income household.

35. **Different policy choices also have additional consequences.**

- Policy 3 would be progressive but would have a procyclical element to it. In terms of distributional consequences, Policy 3 affects all tax-paying households in sufficiently high tax brackets as soon as it is introduced. Low-income households are, however, not affected by this policy change, whereas there is a large and immediate impact on average- and high-income households—thus, the progressive element to this approach. Under Policy 3, the foregone tax benefits are greater as interest rates rise. Since an increase in interest rates also puts downward pressure on house prices, the change in the deductible rate would compound the effect of an interest rate increase in putting downward pressure on house prices—thus having a procyclical element.

- Policy 2 would be progressive, too, but in contrast to Policy 3, it would also have more of a countercyclical element to it. Households with high incomes and high loan values would be affected immediately. The larger a household's loan, the larger would be the foregone tax benefit. Low- and medium-income households would have time to adjust to the situation more gradually, since the nominal limit would only become binding for them over time, as house prices increase. If rising interest rates were to put downward pressure on house prices, the nominal limit would become less binding as prices fall—thus having a countercyclical element. In addition, if interest rates rise, households would benefit from higher deductions offsetting somewhat higher interest payments.

H. Concluding Remarks

36. **Low interest rates, a shift of bank lending toward the mortgage market, and new mortgage products have contributed to buoyant house price developments in the Netherlands in the last two decades.** On standard analysis, price increases have been considerable, raising the possibility of a slowdown or even a temporary reversal if interest rates were to rise. A slowing or a reversal in house price increases has the potential to weaken consumption and growth.

37. **House price increases and mortgage debt in the Netherlands have surpassed the experience of other industrial countries**. Even though fundamentals explain a large part of the price increases, price developments, compared to historical values and on a cross-country basis, have been exceptional. Further, mortgage debt in the Netherlands is higher than in any other industrialized country, reaching unprecedented heights.

38. **The development of new mortgage products in the Netherlands and the increased accessibility of loans are welcome from an efficiency perspective, but associated risks—well recognized by the Dutch officials—need to be well managed.** Banks overall seem on a strong financial footing. However, a rise in interest rates is likely to impact households, in particular those with variable rate loans and the marginal households that were just able to afford a house may experience a cash flow squeeze. Generous interest deductibility has encouraged households to leverage themselves. Further, government-financed insurance schemes for mortgage debt (NHG) have shifted some of the risk from banks to the government, and thus the taxpayer, and banks have little incentive to scrutinize mortgage contracts under NHG guarantee.

39. **The vulnerability of the economy and financial system to developments in real estate markets can be reduced.** In the first place, adequately educating the public about the risks associated with different kind of mortgage loans, which is part of the code of conduct for mortgage lenders, is essential. With the previous real estate bust a memory of the distant past, households may not be taking sufficiently into account the possibility of a downturn in house prices. Households may also concentrate excessively on their budget for the near term and the affordability of a loan in the first year, rather than taking a sufficiently long-term view on the mortgage product they purchase. Second, since the NHG guarantee comes at no cost to households and banks, it introduces a price distortion. Finally, a phase-out of the tax deductibility of mortgage interest payments would reduce the incentive of households to leverage themselves, and some of the additional tax revenues as a consequence of the reform could be directed to well-targeted programs for low-income families. Additional revenues would also leave room for tax cuts, which could lessen the downward impact on housing demand from the phase-out and stimulate labor participation.

40. **In thinking about ways to phase out the tax deductibility of mortgage interest payments, some key considerations would seem relevant.** These are to: (i) have a progressive impact, with a larger share of the burden on the rich, especially in light of Dutch concerns about equity; (ii) avoid procyclicality whenever possible; and (iii) minimize,

to the extent feasible, sudden disruptive effects. The latter concern points to considering a gradual phase-out of the deductibility of mortgage interest payments over time.

41. **Judged against these considerations, the analysis in this paper indicates that introducing a nominal limit on the tax-deductible component of mortgage loans is an attractive option.** As discussed earlier, particularly in paragraphs 34 and 35, it has progressive and counter-cyclical features. The quantitative analysis in Table 6 shows that it also has a gradual impact on households: the nominal limit tends to only become binding for low- and medium-income households over time, as house prices increase. And since this occurs more slowly than for high-income households, another progressive dimension is there. The option of reducing the deductible rate—meaning that the tax rate that would apply to the mortgage interest payment deduction would be below the marginal rate that would otherwise apply to income—also has positive features, but some elements of procyclicality make it less attractive. Of course, there is no guarantee with either option that forward-looking agents will not fully discount future changes, thus leading to sudden price drops. On the other hand, economic agents may put less weight on policy changes that will happen in the more distant future than those occurring more immediately, in which case a gradual phase-out will be less likely to have a sudden impact. In addition, with a gradual phase-out, households would continue to benefit from tax deductibility for a number of years, and it can be argued that they would therefore not adjust their portfolios suddenly. The quantitative analysis in this paper is in line with a more gradual decline in house prices when the tax deductibility is phased out over time and when implemented during a period of stronger economic growth. Further, while it is admittedly difficult to disentangle all the factors at play, the U.K. example is at least suggestive of the conclusion that the full impact of phasing out tax deductibility does not necessarily happen at once when the phase-out occurs over time. The U.K. example also underscores the importance of the timing of any policy initiative for avoiding disruptive effects.

APPENDIX I: Estimations for the United Kingdom

42. **Augmented Dickey Fuller tests and Elliot, Rothenberg, and Stock tests were performed to identify unit roots (Tables A1 and A2).** The nominal interest rate as expected is borderline stationary. In the Dickey Fuller test, if a constant and a trend is introduced in the unit root tests, this variable is stationary. We use a more powerful test, the Elliot, Rothenberg, and Stock to confirm that this variable is stationary. The Null hypothesis of unit root can be rejected at the 5 percent critical value.

Table A1. United Kingdom: Augmented Dickey Fuller Test, 1970-2005

Variable	Optimal Lag Length 1/	5 Percent Critical Value at Chosen Lag Length	ADF t-statistic
Variable in levels ADF test with constant			
Real house price	4	-2.96	0.35
Real disposable income per household	2	-2.95	0.75
Real 3-month treasury bills	0	-2.95	-2.36
Nominal 3-month treasury bills	1	-2.95	-2.81
Real tax deduction of average household	2	-2.95	-0.60
Variable in levels ADF test with constant and trend			
Real house price	4	-3.56	-1.85
Real disposable income per household	2	-3.55	-2.51
Real 3-month treasury bills	0	-3.53	-2.59
Nominal 3-month treasury bills	1	-3.54	-4.59*
Real tax deduction of average household	2	-3.55	-2.10
Variable in 1st Differences ADF test with constant			
Real house price	3	-3.00	-3.56*
Real disposable income per household	1	-2.96	-3.07*
Real 3-month treasury bills	0	-2.95	-7.3*
Nominal 3-month treasury bills	0	-2.95	-4.21*
Real tax deduction of average household	1	-3.00	-5.04*

Source: IMF staff estimates.

* Denotes rejection of null hypothesis at 5% critical value. Null Hypothesis: series has unit root.

1/ Optimal lag length is chosen using BIC and by looking at the autocorrelation in the residuals. Priority is given to removing autocorrelation.

Table A2. United Kingdom: Elliot, Rothenberg, and Stock Test for Unit Roots, 1970-2005

Variable	Optimal Lag Length 1/	ΔFGLS /2
Variable in levels (test with constant and trend)		
Real house price	4	-2.74
Real disposable income per household	2	-2.41
Real 3-month treasury bills	0	-2.56
Nominal 3-month treasury bills	1	-4.02*
Real tax deduction of average household	2	-1.69

Source: IMF staff estimates.

* Denotes rejection of null hypothesis at 5% critical value. Null hypothesis: series has unit root.

1/ Optimal lag length is chosen using BIC and by looking at the autocorrelation in the residuals. Priority is given to removing autocorrelation.

2/ The 5 percent critical value is -2.89.

43. **We find no cointegration for the United Kingdom data in our sample (Table A3).** It is often incorrectly assumed that for a cointegration relationship, all variables need to be I(1). However, near-integrated variables are often very important in establishing a sensible long-run relationship. If we include an I(0) variable in the cointegration relationship, the cointegration rank increases by one for each stationary variable included. Hence in the cointegration test, we are searching for two cointegration vectors. Using the Johansen-Juselius Maximum Likelihood Test for cointegration, we find no cointegration vector. Therefore, we use a model with first differenced variables and we include the interest rate in the regression as a detrended variable.

Table A3. United Kingdom: Johansen-Juselius Maximum Likelihood Test for Cointegration, 1970-2005

Eigen Values	Lags	λ max	Trace	H0: r 1/	λ max 90 % 2/	Trace 90 % 2/
Using real interest rate						
0.5229	3	23.68	43.76	0	27.42	70.14
0.307		11.74	20.07	1	21.42	42.72
0.228		8.07	8.33	2	16.96	21.30
0.0083		0.27	0.27	3	4.34	4.34
Using nominal interest rate						
0.5603	3	26.30	58.80	0	27.42	70.14
0.4776		20.78	32.50	1	21.42	42.72
0.2731		10.21	11.73	2	16.96	21.30
0.0464		1.52	1.52	3	4.34	4.34

Source: IMF staff estimates.

1/ Column r refers to the number of cointegration vectors.

2/ The λ max and the trace statistics critical values are corrected for small samples using Cheung and Lai (1993).

Estimations for the Netherlands

44. **Tables A4 and A5 summarize the results of the stationarity tests.** Again, the nominal interest rate is a borderline case. Using the Elliott, Rothenberg test results we conclude that the nominal interest rate is a stationary variable after detrending the series.

Table A4. Netherlands: Augmented Dickey Fuller Test, 1970-2005

Variable	Optimal Lag Length 1/	5 Percent Critical Value at Cchosen Lag Length	ADF t-statistic
Variable in levels ADF test with constant			
Real house price	4	-2.96	-0.08
Real income per household	1	-2.95	-2.71
Real 10-year interest rate	1	-2.95	-1.84
Nominal 10-year interest rate	1	-2.95	-1.14
Variable in levels ADF test with constant and trend			
Real house price	4	-3.56	-0.88
Real income per household	1	-3.54	-2.91
Real 10-year interest rate	1	-3.54	-1.51
Nominal 10-year interest rate	1	-3.54	-3.21
Variable in 1st Differences ADF test with constant			
Real house price	3	-2.96	-3.02*
Real income per household	0	-2.95	-3.15*
Real 10-year interest rate	0	-2.95	-5.86*
Nominal 10-year interest rate	0	-2.95	-4.58*

Source: IMF Staff estimates.

* Denotes rejection of null hypothesis at 5% critical value. Null hypothesis: series has unit root.
1/ Optimal lag length is chosen using BIC and by looking at the autocorrelation in the residuals. Priority is given to removing autocorrelation.

Table A5. Netherlands: Elliot, Rothenberg, and Stock Test for Unit Roots, 1970-2005

Variable	Optimal Lag Length 1/	ΔFGLS /2
Variable in levels (test with constant and trend)		
Real house price	4	-1.21
Real income per household	1	-1.56
Real 10 year interest rate	1	-1.41
Nominal 10 year iterest rate	1	-3.01*

Source: IMF staff estimates.

* Denotes rejection of null hypothesis at 5% critical value. Null hypothesis: series has unit root.
1/ Optimal lag length is chosen using BIC and by looking at the autocorrelation in the residuals. Priority is given to removing autocorrelation.
2/ The 5 percent critical value is -2.89.

45. **The Results of the Cointegration test are as expected and including a stationary variable in the cointegration test leads to 1 additional cointegration rank.** With two cointegration relationships and one stationary variable in the cointegration relationship, our system is correctly identified (Table A6).

Table A6. Netherlands: Johansen-Juselius Maximum Likelihood Test for Cointegration, 1970-2005

Eigen Values	Lags	λ max	Trace	H0: r 1/	λ max 90 % 2/	Trace 90 % 2/
Using real interest rate						
0.5307	3	24.21*	37.39*	0	17.85	35.60
0.3263		12.64	13.18	1	14.13	17.75
0.0168		0.54	0.54	2	3.61	3.61
Using nominal interest rate						
0.4731	3	20.51*	39.09*	0	17.85	35.60
0.4243		17.67*	18.58*	1	14.13	17.75
0.0282		0.91	0.91	2	3.61	3.61

Source: IMF staff estimates.

1/ Column r refers to the number of cointegration vectors.
2/ The λ max and the trace statistics critical values are corrected for small smaples using Cheung and Lai (1993).

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III. Volatility of Tax Revenues in the Netherlands[40]

A. Introduction

46. The recent fiscal ROSC for the Netherlands and related aide-mémoire had noted that volatility in tax revenues appeared to have increased over the last few years.[41] One manifestation of this had been in the difficulties encountered in forecasting these revenues, particularly from direct taxes, since the late 1990s. This paper provides a more extensive investigation of tax revenue volatility in Netherlands to assess the robustness of the earlier conclusions. In addition, it explores the extent to which other European countries have experienced similar changes in volatility.[42] The paper then examines some of the determinants of volatility in both personal income tax and corporate tax revenues in the Netherlands, and compares these to the determinants in other EU countries: in particular, it examines the role of changes in the amplitude of the business cycle and in the tax revenue base (specifically wages), as well as factors relating to corporate location decisions and profits.

47. A noticeable characteristic of the Dutch economy, which sets it apart from most of the other EU countries, is its extensive and well-established private pension system with defined pension benefits and contributions. The contributions are tax-deductible and can have implications for personal and corporate income tax contributions. This is because any marked changes in the value of pension fund assets, which are heavily invested in equity markets, are likely to entail changes in pension fund contributions, by employees or employers, with a direct impact on tax revenues. There are also likely to be indirect effects on tax revenues of changes in these contributions, arising from the impact on employment and corporate profitability. Given the potential magnitude of this channel in explaining revenue volatility, it is also examined in some detail below.

48. The empirical results suggest the following five main conclusions: (i) there is evidence of a substantial increase in tax revenue volatility in the Netherlands over the past decade compared to the preceding periods; (ii) the increase in volatility appears to have occurred during a period when *on average* there was a decline in tax revenue volatility in the EU-15 countries; (iii) this has led the ranking of the Netherlands in tax revenue volatility relative to other countries to increase over the past decade, particularly with regard to personal income tax and social security contributions; (iv) there is some evidence that business cycle volatility in the Netherlands has increased, while it seems, if anything, to have

[40] Prepared by Wendly Daal, Manmohan S. Kumar, and Michael Skaarup. We are grateful to Robert A. Feldman for comments and suggestions.

[41] Kingdom of the Netherlands—Netherlands: Report on the Observance of Standard and Codes—Fiscal Transparency Module, and the Aide-Mémoire Regarding the Fiscal Framework, IMF Country Report No. 06/124, 2006.

[42] Studies on tax revenue and tax base volatility have usually focused on developing countries, see for instance Purfield (2005); Talvi and Vegh (2000); and Zee (1998).

declined in many EU countries, which may account for some of the increased volatility in tax revenues; (v) the unique features of the Dutch pension system, commendable in many respects, may nonetheless have contributed to higher tax volatility through the tax deductibility of contributions.

49. The rest of the paper is organized as follows: Section B provides systematic empirical evidence on a key measure of volatility in different sources of tax revenues—income tax, corporate tax, indirect taxes—over the past three decades, and examines the extent to which it has changed in recent years. This analysis is undertaken for both the Netherlands, and other EU countries. Section C examines the role of business cycle fluctuations, the impact of the Dutch pension fund system, corporate location decisions, and other specific factors. Section D provides conclusions and notes some policy implications.

B. Tax Revenue Volatility in the Netherlands and in other EU-15 Countries

Experience of the Netherlands

50. There are a variety of indicators that have been used to assess tax revenue volatility in the OECD countries. The analysis below relies on the standard, and widely used, measure that takes into account fluctuations in tax revenues from period to period (for instance, quarterly or annual frequency), adjusted for the average values of revenues in a given period. Formally, the measure—the coefficient of variation (CV)—is defined as the standard deviation relative to the mean of the *ratio of tax revenues to GDP*. As a robustness check, this measure is supplemented by econometric evidence using regression analysis.

51. The basic results of using the CV measure for the Netherlands are provided in Table 1. This shows the magnitude of volatility in revenues from three types of taxes: personal income tax and social security contributions, corporate income tax, and indirect taxes, for the three decades since 1975. As the results using quarterly data indicate, for the most recent period, 1995–2004, the highest level of volatility (15.9 percent) is observed in corporate income tax, followed by indirect taxes, and lastly by personal income tax and social security contributions.[43] The changes in volatility over time are particularly striking: for direct taxes as a whole (personal income tax including social contributions and corporate taxes), the CV increased from 2.5 percent during 1975–84, to 3.0 percent in the following decade, and to 4.4 percent in the decade beginning 1995. The difference between the first period, which saw significant economic volatility associated with the two oil price shocks, and the most recent period which has also seen considerable economic as well as financial market volatility, is highly significant. There has also been a pronounced increase in volatility in revenues from indirect taxes in the most recent period compared to the preceding period, although in this case, relative to the first period there was a less sharp increase. The

[43] Note that since the mid-1990s, the *ratio* of total tax revenues to GDP has declined, reflecting a reduction in personal income tax and social contributions, even while indirect taxes increased relative to GDP.

above conclusions are robust to the frequency of data—analysis based on annual data (Table 2) yields very similar results.

Table 1. Coefficient of Variation of Tax Revenues (Share of GDP) in the Netherlands, Quarterly

	1975–84	1985–94	1995–2004
Direct taxes and social contributions	2.5	3.0	4.4
- Corporate income tax	8.2	5.5	15.9
- Personal income tax and social contributions	2.8	3.1	4.4
Indirect taxes	4.4	3.3	6.2
Memo: Wage bill	3.8	1.7	1.2

Source: Quarterly data from OECD Economic Outlook 78.

Table 2. Coefficient of Variation of Tax Revenues (Share of GDP) in the Netherlands, Annual

	1975–84	1985–94	1995–2004
Direct taxes and social contributions	2.2	2.9	4.5
- Corporate income tax	8.0	5.3	16.3
- Personal income tax and social contributions	2.5	3.0	4.4
Indirect taxes	4.2	3.2	6.4
Memo: Wage bill	3.6	1.5	1.2

Source: Annual data from OECD Economic Outlook 78.

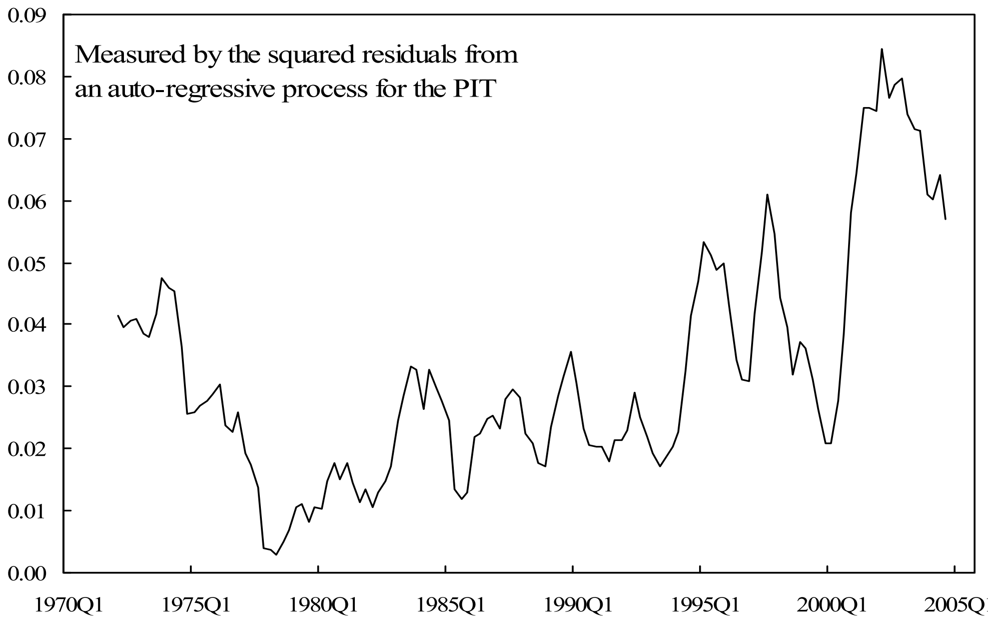
52. Looking at the components of direct tax revenues, the most marked increase has been in the volatility of corporate income taxes, which more than doubled from 1975-84 to 1995-2004 despite a noticeable drop in the interim ten-year period. Such an increase is significant, and makes the forecasting of such revenues particularly challenging. However, as corporate taxes account for around 8 percent of the total tax receipts, their impact on the overall revenue volatility of the government is likely to be limited. This is not the case for personal income tax and social security contributions, which account for almost 60 percent of total revenues. The volatility for the latter has increased substantially, rising from 3.1 percent during the 1985–94 period, to 4.4 percent during 1995–2004.

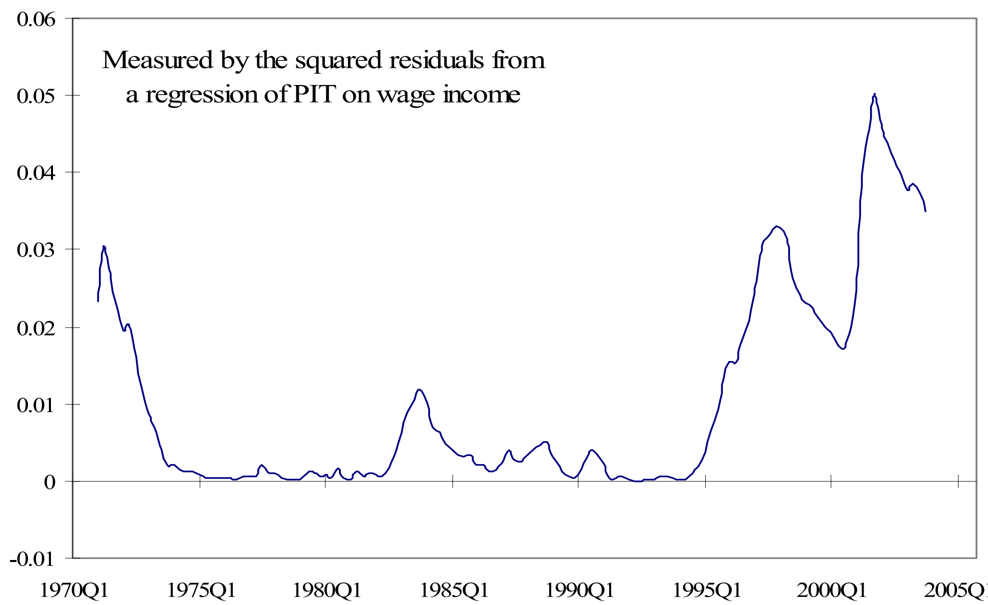
53. The above results using the CV measure are supported by formal econometric analysis, based on a variety of regression models. The first model considers the conditional volatility by estimating the autoregressive pattern in the personal income tax revenues series[44], and exploring the extent to which the residuals (taking into account the past history of personal income tax receipts) show any marked changes in recent years. As Figure 1 illustrates, there has indeed been a noticeable increase in the volatility over the past decade, compared to the earlier periods. A second model considers the conditional volatility by

[44] Including social contributions.

examining the extent to which changes in the main tax base, i.e. wages, account for the dynamics in personal income tax revenues. As the second panel of Figure 1 shows, the volatility in personal income tax revenues relative to the tax base—i.e., deviation from the conditional mean—also increased substantially in the period 1995–2004. This issue is examined in more detail below, in the context of the determinants of tax revenue volatility in the Netherlands.

Figure 1. Netherlands: Conditional Volatility of Personal Income Tax (PIT) Revenues, 1970-2005 1/ 2/





Source: Authors' calculations

1/ Including social contributions.

2/ A heteroskedastic consistent covariance method, i.e. the Bollerslev-Wooldridge robust standard error and covariance method, was used. The same pattern emerges when using annual data.

Tax revenue volatility in a European context

54. An immediate question that arises is the extent to which the above developments reflect an EU-wide phenomenon, or whether they are peculiar to the Netherlands. If it is the former, there would be a prima facie case for examining EU-wide factors, as well as specific Dutch factors, that could have led to such a development. The empirical analysis using the CV measures suggests that the experience in the other European countries has not been the same. Indeed, for many countries the opposite appears to have been the case, with tax revenue volatility on average declining over the past decade.

55. For the composite category of direct taxes and social contributions, as Table 3 indicates, the CV for the average EU-15 declined from 6.8 percent in 1975–84 to 4.9 percent in 1985–94, and to 3.2 percent in 1995–2004. There was a corresponding decline in personal income tax and social security contributions from 7.2 percent in 1975-84 to 3.4 percent in 1995–2004. In the corporate taxes, after a small increase during the second decade, there was a marginal decline in the most recent period. Despite the small decline, it is the case, somewhat surprisingly, that *on average* revenues from the corporate income tax in the EU countries are more volatile than in the Netherlands. For both the Netherlands, and EU in general, this reflects a more volatile tax base than most other taxes and often more flexible rules for tax payments such as loss carry-over, payment lags, etc.

Table 3. Coefficient of Variation of Tax Revenues (share of GDP) in EU countries, Annual

	1975–84	1985–94	1995–2004
Direct taxes and social contributions	6.8	4.9	3.2
- Corporate income tax	16.9	19.9	18.3
- Personal income tax and social contributions	7.2	4.8	3.4
Indirect taxes	5.8	4.0	4.0
Memo: Wage bill	2.6	2.2	2.0

Source: Annual data from OECD Economic Outlook 78.

56. With regard to indirect taxes, the volatility for the average EU country also appears to have followed a different pattern than that in the Netherlands. During the 1975–84 period, the volatility for the average EU country was higher than that in the Netherlands. As in the Netherlands, the volatility declined in the subsequent period, but then unlike in the Netherlands, it remained unchanged over the subsequent period, and is now appreciably lower.

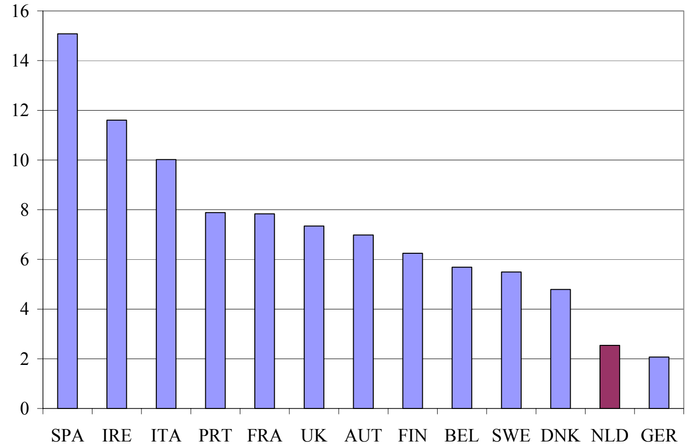
57. To explore the cross-country variation that underlies the above results, we examined the experience of individual countries in some detail. The results of that exercise are summarized in Figures 2–4. As the first of these Figures indicates, in Netherlands the volatility in personal income tax was almost the lowest in the EU-15 countries during the 1975–84 period. In the following decade, as average volatility declined, Netherlands' relative position was almost unchanged. It is during the last decade that, while average

volatility declined still further, volatility in the Netherlands continued to increase, pushing its ranking up to near the top, exceeded only by Ireland.

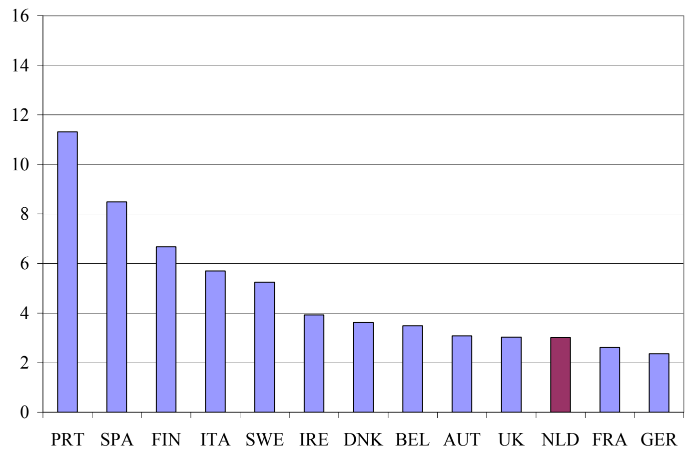
58. With regard to corporate income taxes, developments were quite different (Figure 3). The Netherlands—with the third lowest level of corporate income tax revenue volatility—had a relative position at the lower end of the distribution during the first period, and it improved even further during the second period when it had the lowest volatility in EU-15. Even though there has been a rebound in the most recent period, in relative terms, the Netherlands remains in the lower half of the distribution. The experience with regard to indirect taxes is different yet again (Figure 4), with the Netherlands moving from almost the middle of the range in the first two decades, to almost near the top in the most recent period.

Figure 2. Coefficient of Variation of Personal Income Tax and Social Contributions
(In percent of GDP)

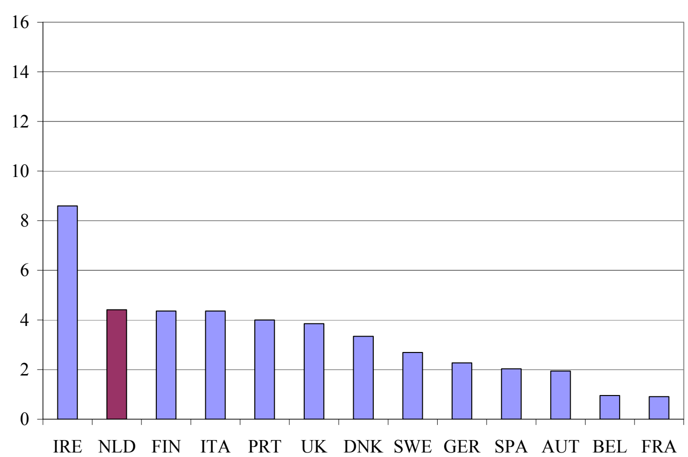
A. 1975–84



B. 1985–94



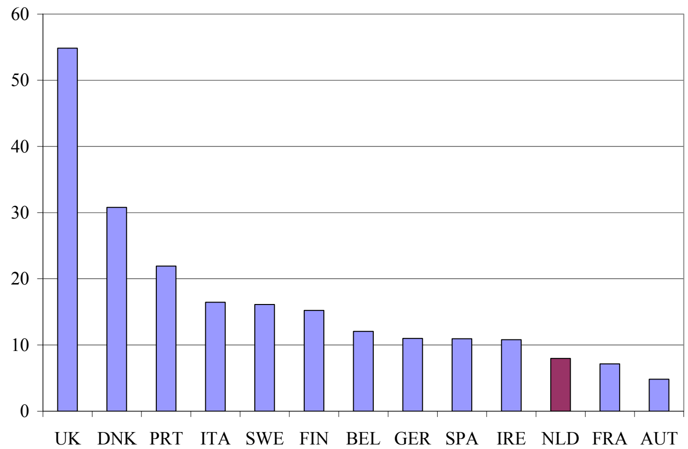
C. 1995–2004



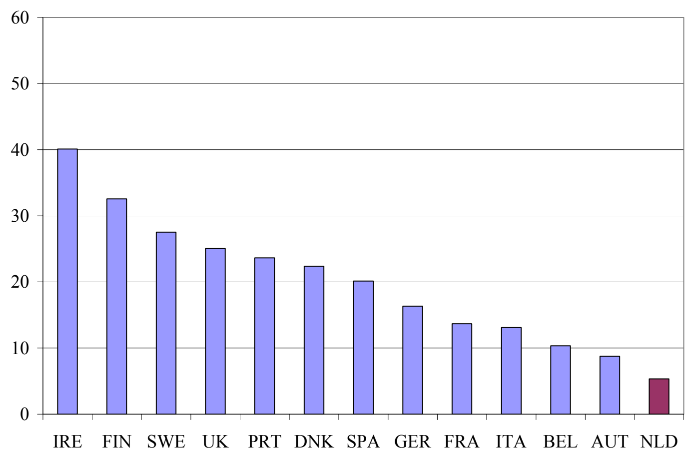
Source: Authors' calculations.

Figure 3. Coefficient of Variation of Corporate Income Tax (In percent of GDP)

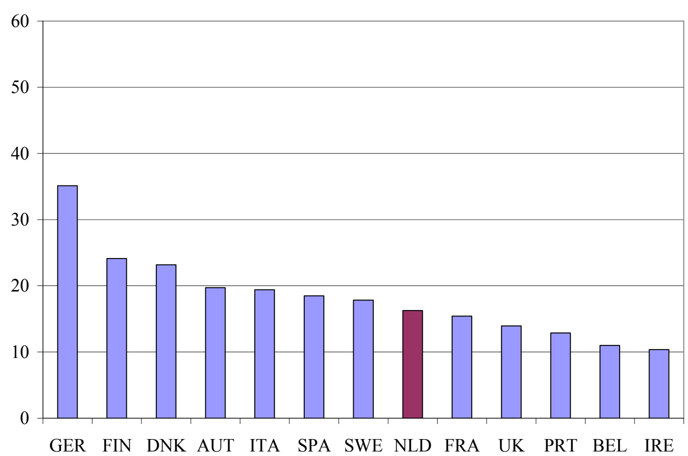
A. 1975–84



B. 1985–94



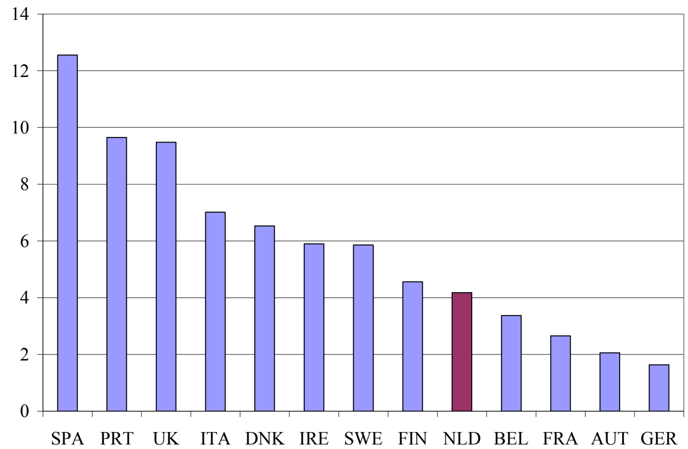
C. 1995–2004



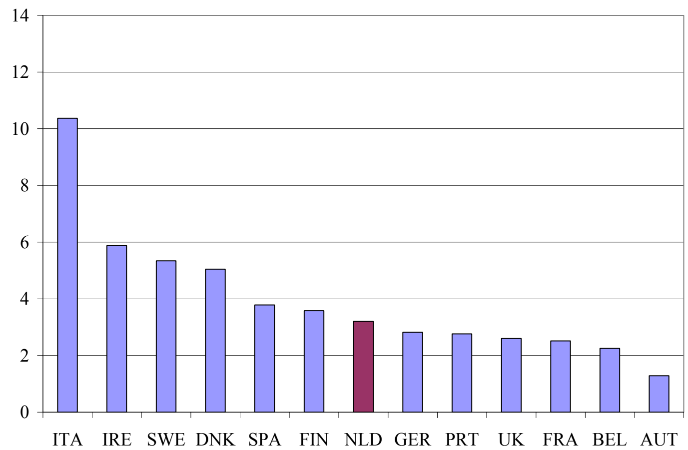
Source: Authors' calculations.

Figure 4. Coefficient of Variation of Indirect Taxes (In percent of GDP)

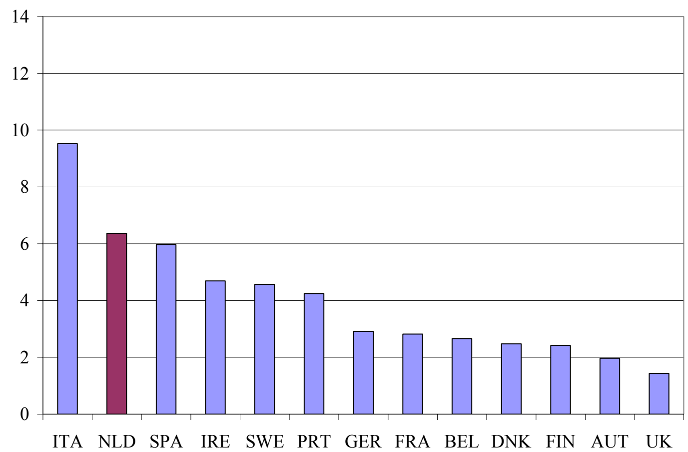
A. 1975–84



B. 1985-94



C. 1995-2004



Source: Authors' calculations

C. Determinants of Tax Revenue Volatility in the Netherlands

59. The above evidence suggests clearly that there has been a substantial increase in fluctuations in tax revenues in the Netherlands over the past decade and, particularly with regard to personal income tax, that the increase has been significantly greater than in most other EU countries. This section explores why this might have been so. The empirical analysis, focusing on direct taxes, starts by investigating whether there may have been an increase in the amplitude of the business cycles, and in the volatility in the wage bill. As mentioned in the introduction, the volatility in pension premiums could have had a substantial impact on tax revenues, and that is discussed in next. This is followed by a discussion of other factors that might have had a bearing, such as issues related to corporate location decisions, fluctuations in house prices, and the conduct of fiscal policy.

The role of the business cycle

60. An immediate question related to revenue volatility is how much of it reflects cyclical changes in the economy and how much is due to some basic underlying characteristics of the tax structure. If the cyclical changes are becoming more pronounced, this will directly amplify tax revenue fluctuations, particularly if the elasticity of tax revenues to activity is larger than unity.

61. For an assessment of this factor, we considered fluctuations in the output gap in the Netherlands, as well as in some EU countries.[45] As Table 4 indicates, measured by the average deviations from the mean, fluctuations in the Netherlands' output gap have widened noticeably over the past decade relative to the preceding one. Indeed, output gap volatility in the past ten years appears to have been even larger than during the 1975-84 period, when economic activity was significantly buffeted by the two oil crises, and ensuing economic and financial market turbulence.

Table 4. Output Gap Volatility

	1975–84	1985–94	1995–2005	2000–05
France	1.2	1.5	0.9	0.9
Ireland	2.8	2.2	2.6	1.8
Italy	1.9	1.4	0.9	0.9
Sweden	2.0	2.9	1.4	0.9
United Kingdom	1.9	2.5	0.5	0.4
Germany	2.3	2.0	1.1	1.5
Average	2.0	2.0	1.3	1.3
The Netherlands	1.8	1.4	1.9	2.4

Source: Quarterly data from OECD Economic Outlook 78.
Note: Volatility is measured as the average absolute deviation from mean

[45] The latter measure seemed to be of particular interest as a determinant of the volatility in tax revenues since it captures the fluctuations in output relative to the underlying potential, rather than simply changes in GDP per se.

62. An increase in economic fluctuations is likely to lead to an increase in tax revenue volatility. But its magnitude depends crucially on the associated short and long-term revenue elasticities with respect to the output gap. As they reflect different attributes of the tax system, these elasticities can differ substantially. In general, tax systems are structured such that, in the absence of discretionary changes, nominal tax revenues follow income growth in the long-term, implying that long-term elasticities of tax revenues to income are close to unity. This attribute of the tax system holds for the Netherlands where cumulative tax revenue growth was about the same as cumulative wage income growth.

63. The long-term elasticity, however, does not provide information about the path of tax revenues and the economy during specific periods. Such information can be provided by short-term elasticity estimates as these measure the responsiveness of tax revenues to, say, yearly changes in tax bases. In general, short-term tax revenue elasticities tend to be larger than unity, which in the case of personal income taxes reflects a certain amount of progressivity in the tax structure. The interpretation of a corporate income tax elasticity higher than unity is more ambiguous, but relates to the non-symmetrical tax treatment of profits and losses (a firm pays taxes if it makes a profit, but it does not receive a refund for tax losses) and the provisions for carrying losses forward into other tax years.

64. The estimates for the Netherlands by the OECD suggest the short-term elasticity of personal income taxes and social contributions to the output gap is 1.25 percent (see Andre and Girouard, 2005).[46] This means that tax revenues increase, on average, 25 percent faster than the economy in upturns and decrease by roughly 25 percent more than the economy during downturns. For corporate income taxes, the short-term elasticity is somewhat higher at 1.5 percent, indicating that corporate income taxes are even more responsive to fluctuations in the pace of economic activity.

65. Since the short-term elasticity of tax revenues to the output gap is higher than unity this suggests that not only has nominal tax revenue volatility increased, but also the volatility of tax ratios. The volatility of nominal tax revenues and tax ratios associated with higher output gap volatility is shown in Table 5, indicating that higher business cycle volatility clearly explains part of the observed increase in tax revenue volatility.

[46] OECD estimates the personal income tax elasticity and social contributions to 1.7 and 0.6, respectively. A weighted average of those equals 1.25.

Table 5. Average Absolute Deviation from the Unconditional Mean (In percentages)

	Output gap	Nominal Revenue		Tax Ratio	
		PIT and social contributions	CIT	PIT and social contributions	CIT
1975–84	1.8	2.3	2.8	0.5	0.9
1985–94	1.4	1.8	2.2	0.4	0.7
1995–2005	1.9	2.4	2.9	0.5	1.0
2000–2005	2.4	3.0	3.6	0.6	1.2

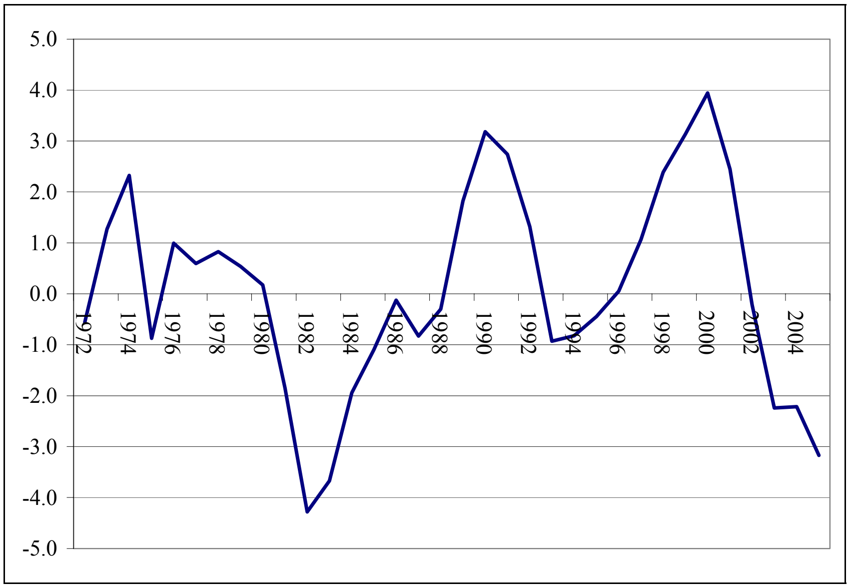
Note: Volatility of nominal revenues is calculated by multiplying the average absolute deviation of the output gap by the short-term elasticities, while volatility of tax ratios is calculated by multiplying the average absolute deviation of the output gap by the short-term elasticities minus 1.

66. As noted earlier, the standard deviation of the difference between personal income tax revenues and its conditional mean—where the conditional mean is determined by the fitted values from a regression of personal income tax revenues on wage income as a percent of GDP—has increased substantially in the last 15 years. This indicates an increasing margin of error imbedded in the forecasting of personal income tax revenues and social contributions. To illustrate the impact of this increased margin on tax revenue projections, consider an increase of 2 percent in wages. Based on an estimated personal income tax revenue elasticity of about 1.25 (from the OECD as mentioned above), we would expect personal income tax revenues and social contributions to grow by 2½ percent. The actual rate of increase in personal income tax revenues and social contributions, using the estimated increased volatility in recent years (that is, the deviation of the rate of growth from its expected value in Table 5), would vary between 1.3 and 3.7 percent—a margin of 2.4 percentage points. The same increase in wage income 20 years ago would have led to an increase in personal income tax revenues and social contributions between 1.8 percent to 3.2 percent, a smaller margin of 1.4 percentage points.[47]

67. A formal econometric analysis shows that business cycle fluctuations account for a significant part of the increase in tax revenue volatility. An estimate of the magnitude of this effect, however, varies between 0.05 and 0.08 depending on the specification of the estimating equations. The different specifications imply that, for example, a one percent increase in the output gap volatility would lead to an increase in the volatility of tax revenue that varies between 0.05 and 0.08 percent. (See Appendix for details)

[47] The implications of the above for the overall balance are worth noting. The OECD estimates the overall budget elasticity at around 0.6 percent for the Netherlands, implying that a 1 percentage point widening of the output gap changes the fiscal balance (as a share of GDP) by 0.6 percentage point of GDP. Over the past 30 years, the output gap has varied within an interval of around ±4 percent of GDP and has changed year-on-year by 1¼ percent, on average, in absolute terms (see Figure 5). On this basis, the fiscal balance can be expected to change by ¾ percentage points of GDP from year to year and vary within an interval of around ±2½ percent of GDP due to business cycle fluctuations.

Figure 5. Output Gap in the Netherlands



The role of pension funds

68. The unique feature of the Dutch pension system may have contributed to the increased volatility in tax revenues. Thus, while the above analysis suggests that greater economic fluctuations played a role in increasing tax revenue volatility, they may not have been the sole explanations. Other factors that have received at least some recognition in the literature include the dynamics related to the premiums for the Dutch private pension system (see van Ewijk and van de Ven, 2003). The Dutch system, highly acclaimed as it rightly should be, relies on private pension schemes as complements to public pensions. It has two distinct characteristics that have important implications for tax revenues. First, unlike several other European countries—such as Belgium, Denmark, Finland, Sweden, and United Kingdom—that have private pension schemes with "defined contributions," the Dutch pension system for the most part has a "defined benefit" structure. Pension systems set-up as "defined benefit" schemes are usually more susceptible to swings in asset holdings as all pensioners are in principle guaranteed a certain pension benefit independent of developments in asset holdings. Second, with the sole exception of Denmark, the Netherlands is the only country that allows income tax deduction of pension contributions. This means that changes in pension contributions that may follow changes in the funds' asset holdings will have a direct impact on tax receipts.

69. There is empirical evidence that large fluctuations in the value of their assets have led Dutch pension funds to change pension premia with some frequency since the mid-1990s. The share of equities in the pension funds' investment portfolios increased from 10 percent in 1990 to more than 40 percent in 2005. This higher share of equities led to large increases

in pension assets during the late 1990s, while exerting significant downward pressure in the early part of the decade following the stock price declines. Separately, since "defined benefits" are linked to wage growth (albeit conditionally in a number of cases), in a period of rising incomes pension funds have raised contributions with an eye to keeping pension assets above higher pension liabilities, with similar consequences for tax revenues.

70. An analysis for the past thirty years shows a clear negative relationship between tax ratios and pension premia. Such a relationship has been most marked over the past decade, which may in turn reflect increases in coverage of private pension schemes (Table 6). Fluctuations in pension premia affect tax revenues primarily through the deductibility of pension contributions in personal and corporate income taxes. But indirect channels, through the impact of pension premia on households' disposable income and private consumption and indirect taxes, can also play a role.

Table 6. Tax Ratios' Correlation with Pension Premiums in the Netherlands

	1975–84	1985–94	1995–03	1975–03
Direct taxes and social contributions	-47.6	-23.9	-79.7	-42.7
- Corporate income tax	19.9	-38.0	-78.4	-15.4
- Personal income tax and social contributions	-52.5	-17.9	-45.5	-33.1
Total taxes	-40.1	-17.9	-80.7	-45.3

Source: Quarterly data from OECD Economic Outlook 78.

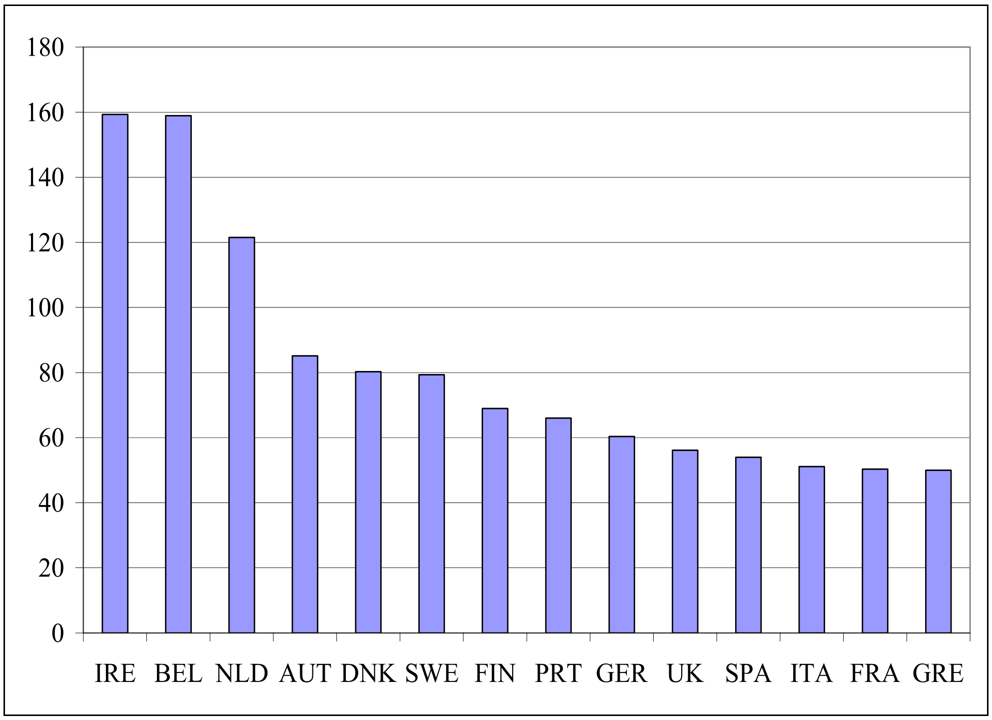
71. A formal econometric analysis shows that the higher volatility in pension premia is important when explaining the increased personal income tax volatility. Firstly, as noted above, the analysis suggests that the conditional mean of the personal income tax revenue can be modeled either as an autoregressive factor or as a lagged function of wage income (see Appendix for details). Secondly, the empirical analysis provides evidence that the conditional variance of personal income tax revenue around its conditional mean is not constant. Against this background, the analysis supports the hypothesis that the time-varying conditional variance is sufficiently explained by pension premia fluctuations. The positive parameter value for pension premia volatility in the conditional variance function of the personal income tax revenue implies that increasing pension premia have contributed to increased tax revenue volatility.

Other factors

72. Closer global integration and the enlargement of EU are likely to have had an impact on the location decisions of corporates, with implications for tax revenue volatility. The impetus to corporates changing locations to book profits in order to minimize tax burdens would have been provided by the increasing tax competition between countries. This factor is of course likely to have had an impact on corporates originating not just from the Netherlands, but also from the other EU countries. In addition, larger and more volatile transaction flows and asset price swings, following in part greater global integration, may amplify tax revenue fluctuations as wealth positions of households and private firms change more rapidly. This is particularly so since the Dutch economy relies heavily on trade—and to

a larger extent than most other European countries (see Figure 6). The recent marked boom-and-bust cycle in the stock markets has also likely had an effect on tax revenues from stock options and capital gains.

Figure 6. Trade Openness of EU Economies
(Exports and imports relative to GDP, In percent)



73. Fluctuations in mortgage interest payment deductions for income taxes may also have affected tax revenue volatility. In the Netherlands, interest payments on mortgage loans are (for the most part) deductible, and, as a result, increased volatility in mortgage interest payments may affect the volatility of tax revenues. The volatility of foregone income tax revenue is affected by the volatility of mortgage debt (and relatedly house prices) and mortgage rates. Of course, increases in house prices are generally associated with decreasing mortgage interest rates, and vice versa. If these two effects do not cancel each other out, the net effect can lead to increased volatility in the income tax revenues relative to the tax base.

74. Changes in house prices also affect wealth, which ultimately can affect the volatility of indirect tax revenues. A CPB (2006) study shows that housing wealth in the Netherlands has been growing steadily since 1995, with the exception of the period between 2000 and 2003, where the growth rate of house prices declined slightly, and even turned slightly negative in 2003. The CPB study also finds that durables consumption is related to housing wealth (and asset wealth). They estimate the marginal propensity to consume out of housing wealth for durable goods to be 0.1 percent. Their findings also show an asymmetry: the impact of house price gains on durables consumption is not significant, while the impact of

losses is significant and twice as large. They therefore conclude that households tend to cut down spending on durables when facing a drop in wealth more strongly then they step up spending when they experience a housing wealth gain. This asymmetric affect of housing wealth on consumption may have increased the volatility observed in indirect taxes.

75. Fiscal policy is another factor that may have affected the volatility of tax revenues. A change in tax regime—for instance a shift from direct taxation to more indirect taxation as occurred in 2001—can lead to a sudden change in the tax revenues as percent of GDP, followed by a period of adjustment with increased volatility. In addition, policy induced volatility in the tax system can also influence volatility of tax revenues as a share of GDP. One possible example of this was the past practice under the fiscal framework whereby the government used ex post deviations of tax revenues from a pre-establish nominal reference levels for discretionary tax changes. As these nominal deviations may have reflected deviations in economic growth from its projected path (i.e., not necessarily a change in the tax ratio), the discretionary tax changes may have increased the volatility of tax revenues as a share of GDP. However, it is difficult to measure the impact of that fiscal policy on tax revenue volatility, as this requires a data series for tax policy changes over the sample period, which currently is not readily available.

D. Concluding Remarks

76. The above analysis shows that tax revenue volatility has increased substantially over the last decade in the Netherlands. This appears particularly to be the case for corporate taxes, but volatility in personal income taxes and indirect taxes has also increased substantially. Increased volatility is generally not reflected in other EU countries, where on average volatility has been more or less constant, or if anything, there has been some decline.

77. There are several reasons why volatility could have increased in the Netherlands and the paper has explored these: the business cycle fluctuations appear to be somewhat greater in the recent periods, reflecting possibly both greater fluctuations in global activity and trade, as well as in asset prices; the tax deductibility of mortgage interest payments could also have imparted some effect; and the location decisions of corporates likely also played some role. The tax deductibility of pension premia also appears to have been a key factor, and the paper presented significant empirical evidence that tends to support this.

78. One policy implication relates to how higher tax volatility might affect the so-called signal value within the fiscal framework. The commendable Dutch fiscal framework includes a fiscal deficit signal value of 2½ percent of GDP, which triggers corrective measures if the fiscal deficit exceeds this value to avoid breaching the 3 percent Maastricht limit. This signal value was adopted at a time when budgetary uncertainties, including those relating to tax revenues, were somewhat less. The higher tax revenue volatility witnessed in recent years suggests that consideration could be given to a somewhat more conservative signal value.

APPENDIX I: Factors Determining Tax Revenue Volatility: Pension Contributions and Business Cycle

79. The objective of our empirical analysis is to determine whether fluctuations in pension premiums and the business cycle explain the increased volatility of personal income tax revenues in the Netherlands.[48] We use a basic linear auto-regressive conditional heteroskedastic (ARCH) framework introduced by Engle (1982) and extended by Bollerslev (1986), which have often been used in the financial literature, to estimate the volatility of the tax revenues and pension premiums. [49] This framework has the advantage that it allows us to simultaneously estimate the parameter values for the explanatory variables for the conditional variance.[50]

Empirical framework

80. The general specification of an ARCH-framework is based on an observed time series y_t, which can be written as the sum of a predictable part and a stochastic part,

$$y_t = \mathrm{E}\left[y_t \middle| \Omega_{t-1}\right] + \varepsilon_t, \qquad (1)$$

with Ω_{t-1} denoting the relevant information set available at time t-1. In this framework the conditional variance of the residuals, ε_t, is time varying: $\mathrm{E}\left[\varepsilon_t^2 \middle| \Omega_{t-1}\right] = V_t$. This feature of the ARCH-framework enables us to capture any structural element in the conditional variance of our observed variable, the personal income tax revenues. Engle (1982) formulated an ARCH-function for V_t to describe the conditional variance of y_t at time t as[51]

$$V_t = \beta_1 + \beta_2 \varepsilon_{t-1}^2, \qquad (2)$$

where, given the non-negativity condition imposed on V_t, the parameters have to satisfy the following conditions: $\beta_1 > 0$ and $\beta_2 \geq 0$. If $\beta_2 = 0$, then the conditional variance is constant and the time series is homoskedastic.

[48] Personal income tax revenue, hence forth, is for the sake of simplicity defined as personal income tax revenue and social contributions.

[49] Longstaff and Schwartz (1992), Ball and Torous (1999), Chan and others (1992), and Koedijk and others (1997).

[50] Several methodologies have been used in literature to obtain estimates of volatility, such as the "historical volatility" approach. This approach uses historical data to calculate volatility data. The disadvantage of this method is that it does not provide current information on the volatility.

[51] This specification can be extended in line with Bollerslev (1986) to a generalized linear autoregressive conditional heteroskedastic (GARCH) framework by including the lagged conditional variance, V_t.

81. We analyze the conditional variance of the personal income tax revenue in the Netherlands by assuming two functional forms for the conditional mean of the personal income tax revenue**.** We model the conditional mean as an autoregressive process of order one, and alternatively, we also model it as a function of wage income as percent of GDP. An important condition in this context that we have to test is whether the parameter value for the conditional mean of the personal income tax revenue is significantly different from one. A parameter value of one would simply imply that all changes in personal income tax revenue as a percent of GDP comes from a stochastic process. In this regard, we empirically test whether the conditional variance of the personal income tax revenue—that is the conditional variance of the stochastic process, as the conditional variance of mean is zero—is homoskedastic or not.

82. If the conditional variance is time-varying, we have to test whether the dynamics of the pension premiums and the business cycle play a significant role in explaining this variance. From a theoretical stand-point we would expect that the variability of the pension premiums to affect the conditional variance of personal income tax revenues, and not the level of it. In addition, we would expect this effect to be positive, i.e. an increase in the variability of the pension premiums would lead to higher volatility in the personal income tax revenues. Since the volatility of the pension premiums is not a measured time series, we model an autoregressive process for the pension premiums to capture its conditional variance. The conditional variance of the pension premiums is then incorporated in the ARCH-specification for the personal income tax revenues. This is an extension of the standard ARCH-specification, as it includes beside the lagged squared residual term another independent variable as an explanatory variable.

83. To empirically asses the role of business cycle in the dynamics of the personal income tax revenue in the Netherlands we model the conditional variance of the personal income tax revenue as a function of the output gap volatility as an explanatory variable. The output gap volatility series is calculated as the absolute deviation from its conditional mean.

84. As a result, our empirical specification for the personal income tax revenues, y_t, in an ARCH-framework, can be formulated as follows:

$$y_t = \alpha_1 + \alpha_2 y_{t-1} + \varepsilon_t \tag{3}$$

and, alternatively,

$$y_t = \alpha_1 + \alpha_2 w_t + \varepsilon_t\,, \tag{4}$$

where the conditional variance are modeled as follows:

$$V_t^T = \beta_1 + \beta_2 \varepsilon_{t-1}^2 + \beta_3 V_{t-1}^P\,, \tag{5}$$

$$V_t^T = \beta_1 + \beta_2 \varepsilon_{t-1}^2 + \beta_3 V_{t-1}^G\,, \tag{6}$$

and,

$$V_t^T = \beta_1 + \beta_2 \varepsilon_{t-1}^2 + \beta_3 V_{t-1}^P + \beta_4 V_{t-1}^G, \qquad (7)$$

with w_t denoting wage income as a share of GDP, V_t^T and V_t^P representing the conditional variances of, respectively, the personal income tax revenues and pension premiums, and V_t^G representing the output gap volatility.

Time series properties of the data

85. Our sample covers the period of 1970—2005 and includes quarterly data on GDP, output gap, personal income tax revenues, pension premiums, and wage income from the OECD and Statistics Netherlands. The descriptive and time series statistics for the variables used in this empirical analysis are presented in Table 1 and Figure 1. Both series, the log of personal income tax revenues (as percent of GDP) and the pension premiums (as percent of wages), show some structural events around 1980 and 1990.[52] Time series analysis of the variables indicates a high degree of non-normality and non-stationarity in their levels. First differencing makes both series stationary, as shown by the ADF-statistics.

86. We conduct a formal test for conditional heteroskedasticity in the context of ARCH models based on the Lagrange Multiplier (LM) principle for both series. For this purpose we assume that the conditional mean of the corresponding time series are adequately described by an autoregressive model, where the autoregressive order is determine by the Akaike criterion. The corresponding LM-test is obtained from a regression of the squared residuals as an autoregressive model, where the null hypothesis of conditional homoskedasticity is formulated as the parameter values for the autoregressive terms being zero. We also applied the LM-test for conditional homoskedasticity on the residuals from the regression of the personal income tax revenues on wage income as a share of GDP. The LM-test results for both regressions show that there is evidence for the presence of ARCH(1) in the series for personal income tax revenues.[53, 54] Note that the hypothesis of conditional homoskedasticity for pension premiums is not rejected.

[52] Further study is required to determine what is driving these turnarounds.

[53] We also carried out a sign-and-size-biased test to check whether positive and negative shocks have an asymmetric impact on the conditional variance. The test showed no asymmetric effect.

[54] Based on a formal test for outliers (OL) OL's were detected in 1995 and 2001 reflecting tax-regime changes. An outlier robust estimation technique, the Generalized M (GM) estimation technique, in the context of a simple AR(1) model was used, because, as noted by Franses and van Dijk (1999), if the OL's are neglected, the LM test rejects the null hypothesis of condition homoskedasticy too often when it is in fact true.

Estimation results[55]

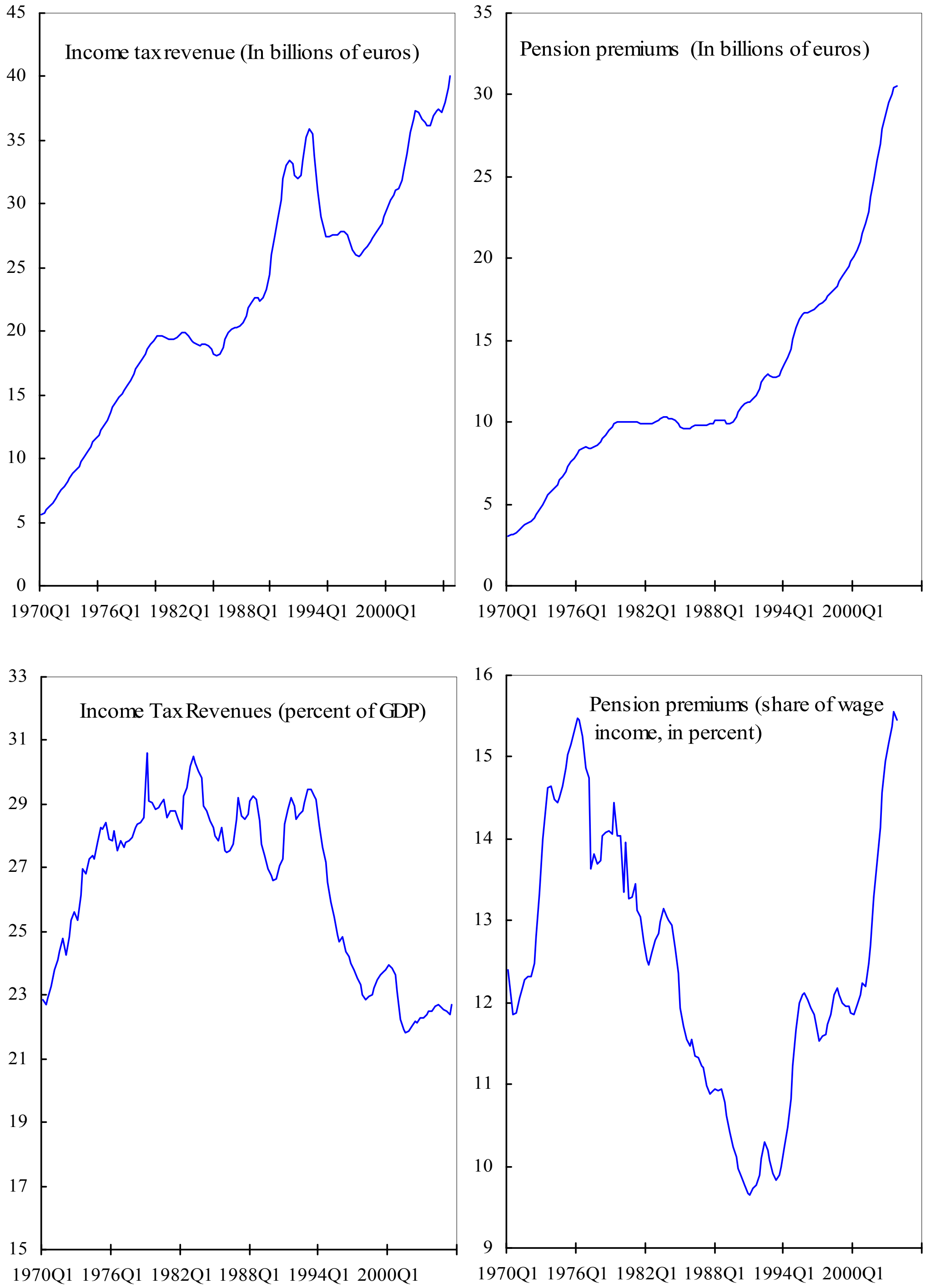
87. The formal estimation results support the hypothesis that the volatility of personal income tax revenue is affected by developments in pension premiums and the business cycle. Tables 2–7 provides the estimation results for the ARCH-specification for the personal income tax revenue as specified in Equations (3)—(6). The results show that the conditional mean of personal income tax revenues can be model as, both, an autoregressive process or as a function of wage income, with elasticities varying between 0.9—1.0 and 1.0—1.10, respectively. This means that the mean of the personal income tax revenues can be projected based on its lagged value or on the projected wage income. The larger than unity tax revenue elasticity in the case of personal income tax revenue, reflects the progressive nature of the tax system in the Netherlands.

88. The second part of our estimation result for both specifications show that pension premiums, business cycle, and a combination of these two play a significant role in determining the fluctuations in personal income tax revenues around its conditional mean. The parametric conditions for the ARCH-specification are satisfied, as all the estimated coefficients have the correct signs. In addition, a positive sign also supports our hypothesis that an increase in pension premiums or business cycle increases the volatility of personal income tax revenues. The estimate for the constant term is significantly different from zero. The parameter estimate for the lagged residual term, the pension premium volatility, and the volatility of the output gap are significantly different from zero. The semi-elasticities for the pension premium volatility imply that a one percent in crease in premium volatility leads to about 6 to 8 percent increase in personal income tax revenue volatility. The semi-elasticities for the output gap have a wider range of effect: the effect varies between 5 percent and 8 percent, depending on the functional form of the conditional mean and the conditional variance. To confirm our result, we regressed the squared residuals from both models for the conditional expectation of personal income tax revenue directly on the conditional variance of the pension contribution rates and the output gap volatility. With a *t*-value of 2.2 and 3.2, respectively, the results indicates that pension contributions and business cycle play a significant role in explaining the increased personal income tax revenue volatility.

89. The Akaike criterion discriminates in favor of the autoregressive model for the conditional mean and that the conditional variance is better explained by a combination of pension contribution and output gap volatility.

[55] We used the Berndt-Hall-Hall-Hausman (BHHH, 1974) numerical algorithm to find the quasi maximum likelihood parameter estimates for the ARCH-specification. To ensure that the estimates of the volatility are robust and that the algorithm converges to the global maximum we used different starting values. In addition, we used Bollerslev-Wooldrige’s procedure to obtain robust standard errors and covariance.

Figure 1. Netherlands: Time Series of Selected Variables



Source: OECD and Statistics Netherlands

Table 1. Time Series Properties of Personal income tax Revenues, Pension Premiums, and Wage Income

	Log of personal income tax revenues as percent of GDP	Log of pension premium (as percent of wages)	Log of wage income (as percent of GDP)
Normality tests			
Skewness	-0.46	-0.09	-0.09
Kurtosis	1.69	2.14	1.99
Jarque-Bera	15.31	4.34	6.23
Stationarity test: Augmented Dickey-Fuller (ADF)			
Level:			
5% level	-2.88	-2.88	-2.88
10% level	-2.58	-2.58	-2.58
ADF-statistic	-1.36	-1.68	-1.38
First difference			
1% level	-2.48	-3.48	-3.48
5% level	-2.88	-2.88	-2.88
ADF-statistic	-6.05	-4.14	-17.10
ARCH LM-test			
$\chi^2(1)$ 1/	5.69	4.87	26.49

1/The LM-test is asymptotically $\chi^2(q)$ distributed.

Table 2. ARCH-Specification Personal Income Tax Volatility: Estimation Results

Variables		Parameter values	*z*-Statistics
Part I, Conditional mean of the ARCH-specification, Equation (3): $y_t = \alpha_1 + \alpha_2 y_{t-1} + \varepsilon_t$			
Constant	α_1	-1.30	[-66.93]
y_{t-1}	α_2	0.93	[23.48]
Part II, Conditional variance of the ARCH-specification, Equation (5): $V_t^T = \beta_1 + \beta_2 \varepsilon_{t-1}^2 + \beta_3 V_{t-1}^P$			
Constant	β_1	0.001	[7.58]
ε_{t-1}^2	β_2	0.50	[3.24]
V_t^P	β_3	0.07	[6.45]
Adj. R^2		0.91	
ARCH-LM		4.58	

Variable descriptions:
y_{t-} = personal income tax revenue as percent of GDP.
ε_{t-1}^2 = the lagged squared residuals of Equation (5).
V_t^P = the conditional variance of the pension premiums.

Table 3. ARCH-Specification Personal income tax Volatility: Estimation Results

Variables		Parameter values	*z*-Statistics
Part I, Conditional mean of the ARCH-specification, Equation (4): $y_t = \alpha_1 + \alpha_2 w_t + \varepsilon_t$			
Constant	α_1	-0. 78	[-21.71]
w_t	α_2	1.02	[14.28]
Part II, Conditional variance of the ARCH-specification, Equation (5): $V_t^T = \beta_1 + \beta_2 \varepsilon_{t-1}^2 + \beta_3 V_{t-1}^P$			
Constant	β_1	0.001	[7.93]
ε_{t-1}^2	β_2	0. 95	[15.69]
V_t^P	β_3	0.06	[12.04]
Adj. R^2		0.16	
ARCH-LM		4.35	

Variable descriptions:
w_{t-1}= wage income as percent of GDP.
ε_{t-1}^2 = the lagged squared residuals of Equation (5).
V_t^P = the conditional variance of the pension premiums.

Table 4. ARCH-Specification Personal Income Tax Volatility: Estimation Results

Variables		Parameter values	*z*-Statistics
Part I, Conditional mean of the ARCH-specification, Equation (3): $y_t = \alpha_1 + \alpha_2 y_{t-1} + \varepsilon_t$			
Constant	α_1	-1.29	[-10.46]
y_{t-1}	α_2	0.99	[76.35]
Part II, Conditional variance of the ARCH-specification, Equation (6): $V_t^T = \beta_1 + \beta_2 \varepsilon_{t-1}^2 + \beta_3 V_{t-1}^G$			
Constant	β_1	0.01	[5.19]
ε_{t-1}^2	β_2	0.60	[1.99]
V_t^G	B_3	0.04	[3.89]
Adj. R^2		0.97	
ARCH-LM		4.65	

Variable descriptions:
y_{t-1}= personal income tax revenue as percent of GDP.
ε_{t-1}^2 = the lagged squared residuals of Equation (5).
V_t^G = the "volatility" of the output gap.

Table 5. ARCH-Specification Personal income tax Volatility: Estimation Results

Variables		Parameter values	*z*-Statistics
Part I, Conditional mean of the ARCH-specification, Equation (4): $y_t = \alpha_1 + \alpha_2 w_t + \varepsilon_t$			
Constant	α_1	-0. 44	[-1.95]
w_t	α_2	1.10	[4.00]
Part II, Conditional variance of the ARCH-specification, Equation (6): $V_t^T = \beta_1 + \beta_2 \varepsilon_{t-1}^2 + \beta_3 V_{t-1}^G$			
Constant	β_1	0.02	[1.97]
ε_{t-1}^2	β_2	0.74	[4.81]
V_t^G	B_3	0.08	[3.12]
Adj. R^2		0.19	
ARCH-LM		4.40	

Variable descriptions:
w_{t-1}= wage income as percent of GDP.
ε_{t-1}^2 = the lagged squared residuals of Equation (5).
V_t^G = the "volatility" of the output gap.

Table 6. ARCH-Specification Personal Income Tax Volatility: Estimation Results

Variables		Parameter values	z-Statistics
Part I, Conditional mean of the ARCH-specification, Equation (3): $y_t = \alpha_1 + \alpha_2 y_{t-1} + \varepsilon_t$			
Constant	α_1	-1.01	[-0.43]
y_{t-1}	α_2	0.99	[64.38]
Part II, Conditional variance of the ARCH-specification, Equation (7): $V_t^T = \beta_1 + \beta_2 \varepsilon_{t-1}^2 + \beta_3 V_{t-1}^P + \beta_4 V_{t-1}^G$			
Constant	β_1	0.01	[7.74]
ε_{t-1}^2	β_2	0.39	[4.19]
V_t^P	β_3	0.07	[3.82]
V_t^G	B_4	0.05	[7.90]
Adj. R^2		0.97	
ARCH-LM		4.62	

Variable descriptions:
y_{t-1}= personal income tax revenue as percent of GDP.
ε_{t-1}^2 = the lagged squared residuals of Equation (5).
V_t^P = the conditional variance of the pension premiums.
V_t^G = the "volatility" of the output gap.

Table 7. ARCH-Specification Personal income tax Volatility: Estimation Results

Variables		Parameter values	*z*-Statistics
Part I, Conditional mean of the ARCH-specification, Equation (4): $y_t = \alpha_1 + \alpha_2 w_t + \varepsilon_t$			
Constant	α_1	-0. 89	[-21.71]
w_t	α_2	0.73	[3.43]
Part II, Conditional variance of the ARCH-specification, Equation (7): $V_t^T = \beta_1 + \beta_2 \varepsilon_{t-1}^2 + \beta_3 V_{t-1}^P + \beta_4 V_{t-1}^G$			
Constant	β_1	0.01	[9.16]
ε_{t-1}^2	β_2	0. 22	[4.53]
V_t^P	β_3	0.06	[10.66]
V_t^G	B_4	0.04	[1.88]
Adj. R^2		0.16	
ARCH-LM		4.37	

Variable descriptions:
w_{t-1}= wage income as percent of GDP.
ε_{t-1}^2 = the lagged squared residuals of Equation (5).
V_t^P = the conditional variance of the pension premiums.
V_t^G = the “volatility” of the output gap.

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