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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[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

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[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.

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[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

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[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

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[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**:

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

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[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

[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

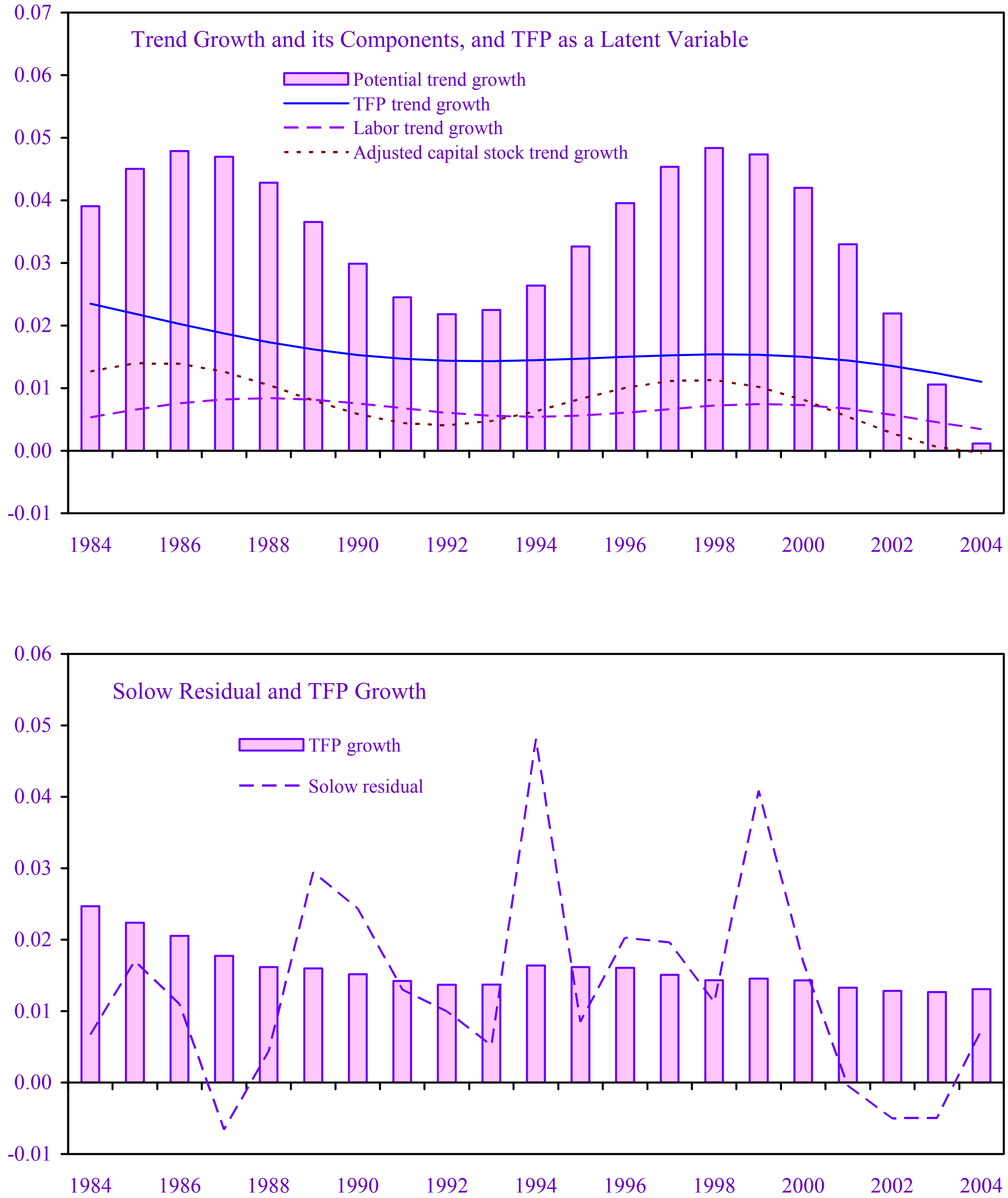
26. **This chapter investigated the determinants of trend growth and TFP growth in the Netherlands.** The estimation was based on a rigorous statistical methodology, which resulted in production function factor elasticity estimates closely aligned with actual factor shares in the national accounts. Estimated 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,

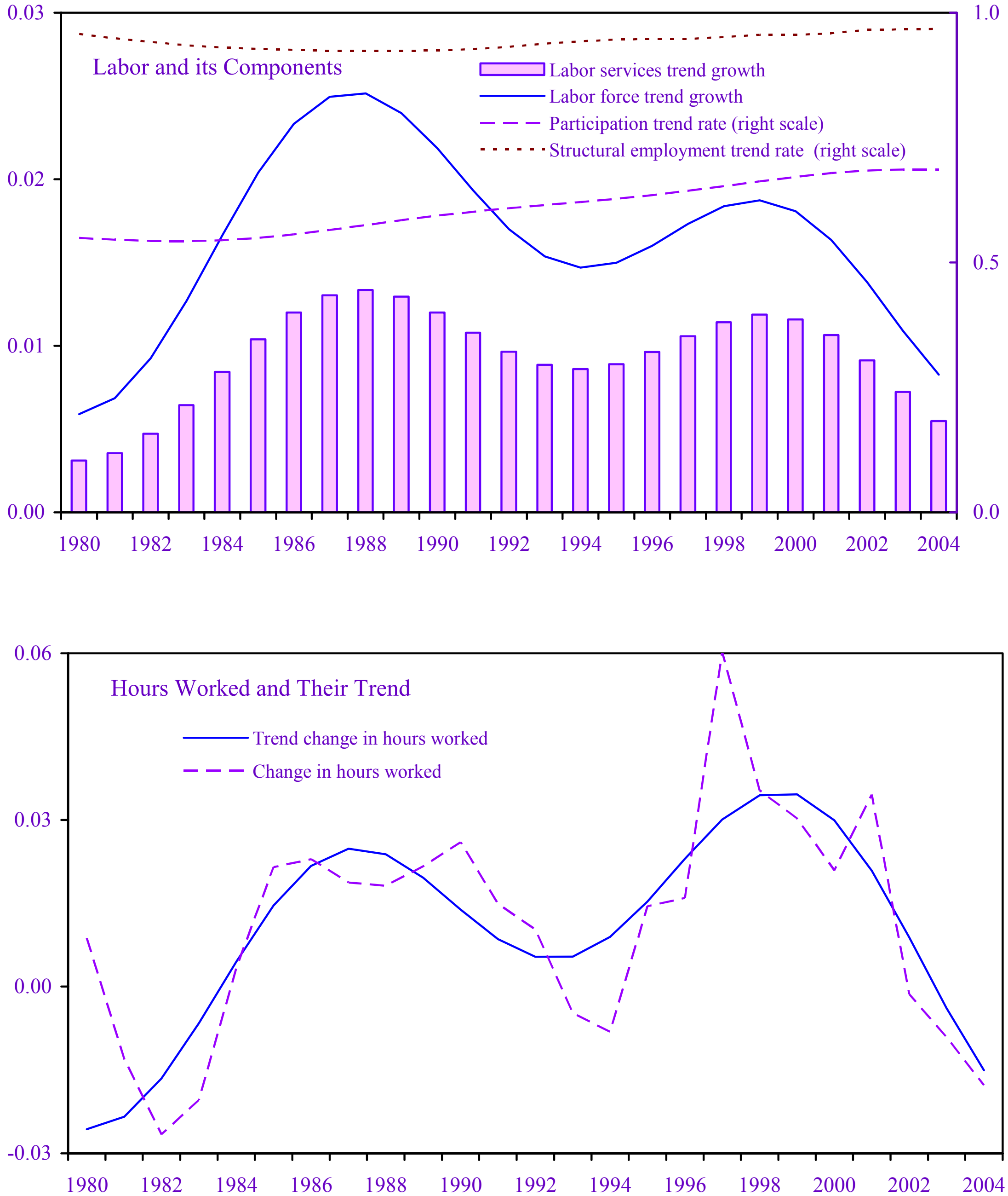
and continuing to open up good and service markets. Without those measures, the Dutch trend growth rate may become stuck at historically low levels in circumstances in which it will also be pulled down by population aging.

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	$\Delta FGLS^{\tau}$	Variables	Lags	$\Delta FGLS^{\tau}$
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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