

Denmark: Selected Issues

This Selected Issues paper for Denmark was prepared by a staff team of the International Monetary Fund as background documentation for the periodic consultation with the member country. It is based on the information available at the time it was completed on November 26, 2008. The views expressed in this document are those of the staff team and do not necessarily reflect the views of the government of Denmark or the Executive Board of the IMF.

The policy of publication of staff reports and other documents by the IMF allows for the deletion of market-sensitive information.

Copies of this report are available to the public from

International Monetary Fund • Publication Services
700 19th Street, N.W. • Washington, D.C. 20431
Telephone: (202) 623-7430 • Telefax: (202) 623-7201
E-mail: publications@imf.org • Internet: <http://www.imf.org>

Price: \$18.00 a copy

International Monetary Fund
Washington, D.C.

INTERNATIONAL MONETARY FUND

DENMARK

Selected Issues

Prepared by Allan Brunner and Jay Surti (both EUR)

Approved by Franek Rozwadowski

November 26, 2008

Contents	Page
I. Demographic Changes and Fiscal Sustainability in Denmark.....	3
A. Overview and Conclusions	3
B. Demographic Changes	5
Population Ageing	5
The Immigrant Population	7
C. When is Fiscal Policy Sustainable?.....	13
D. A Baseline Forecast.....	14
The Effective Labor Force	14
The Capital Stock and Real GDP.....	16
A Baseline Forecast of the Fiscal Accounts.....	18
E. Effects of Recent Policy Changes and Proposals	22
The Effects of the Welfare Agreement	22
Other Policy Changes and Policy Proposals	24
 Figures	
1. Ratio of Working-Age to Elderly Population, 2008–50	6
2. Population Distribution, 2008, 2025, and 2050	6
3. Composition of Population, by Ancestry, 1981–2050	7
4. Composition of Working-Age Population, by Ancestry, 2008–50	9
5. Composition of Elderly Population, by Ancestry, 2008–50	9
6. Labor Force Participation Rates, by Age and Ancestry, 2006	10
7. Unemployment Rates, by Age and Ancestry, 2006	11
8. Public Consumption for Men, by Age, 2005	12
9. Public Transfers for Men, by Age, 2005	12
10. Various Measures of the Labor Force, 2008–50	16
11. Real GDP and Effective Labor Force, 2008–50	18
12. The Effects of the Welfare Agreement on the Old-Age Dependency Ratio	23

Tables

1. Change in Importance of Immigrant Population, by Age and Educational Attainment	8
2. Baseline Projections of the Structural Balance, 2008–50	21
3. Effects of the Welfare Agreement on Fiscal Sustainability, 2008–50	25

References	26
------------------	----

II. Labor Market Reforms, Changing Demographics, and the Danish NAIRU	27
A. Overview	27
B. An Evolving Inflation-Unemployment Trade-Off	27
C. What May Have Lowered the NAIRU?	30
Labor Market Reforms	30
The Role of Demographic Factors	31
D. Specification and Estimation of Macro Wage Equation	33
Trend Properties of the Data	33
Specification of the Wage Equation and Estimated Path of the Wage-NAIRU	37

Figures

1. Trend Inflation and Unemployment, 1967–2007	28
2. Real Wage Inflation and Unemployment, 1968–2007	29
3. Trend Unemployment Rates: Actual and Demographically Adjusted	32
4a. Trends in Unemployment and Price and Wage Inflation, 1967–2007	35
4b. Trends in Real Wage and Productivity Growth, 1967–2007	36
5. Wage NAIRU and Trend Unemployment, 1967–2007	39
6. Slope Estimate of the Wage Phillips Curve, 1967–2007	40
7. Evolution of the Wage Phillips Curve, 1975–2007	40

Table

1. Descriptive Statistics for Trend Characteristics of the Data	34
---	----

References	41
------------------	----

I. DEMOGRAPHIC CHANGES AND FISCAL SUSTAINABILITY IN DENMARK¹

A. Overview and Conclusions

1. **Like most developed countries, Denmark is facing significant demographic changes.** Over the next few decades, the over-65 population will jump from 16 percent to 25 percent of the total population. At the same time, the working-age population will shrink from 65 percent to 57 percent. As a consequence, the ratio of working-age to elderly individuals will plummet from 4:1 to just over 2:1.
2. **This demographic shift will have several impacts on the economy.** First, all else equal, the decline in the relative size of the labor force will result in relatively fewer goods produced. This effect will be particularly strong, because a large portion of the current baby-boomers are in their peak earning years, and their retirement will have a dramatic effect on productivity and on overall production. Second, the increase in the elderly population could have a substantial impact on the demand for goods and services, especially for health services and old-age care. Finally, and most importantly for this paper, the demographic shift is likely to have an important impact on public finances. Much of old-age spending in Denmark is facilitated by the state—either through the provision of public goods (medical services and old-age care) or through transfer payments (primarily pensions). As the population ages and the demand for public spending increases, the government's intertemporal budget constraint will come under pressure, and taxes may need to rise or per capita spending may have to fall to maintain fiscal sustainability.
3. **Moreover, Denmark may face additional demographic challenges from immigration.** The accession treaties that ushered the new member states into the European Union call for unrestricted labor mobility across all countries by end-2010. The treaties allowed member countries to temporarily place restrictions on inward migration from new member states. Denmark has imposed a relatively restrictive policy—requiring that immigrants prove they have a job that meets wage and working condition standards before getting a work permit—which will have to be relaxed. At the same time, Denmark has been quite welcoming to refugees and asylum seekers.
4. **Although the economic challenges of ageing have been studied extensively, issues associated with fiscal pressures and sustainability have received relatively little attention.** This paper is an attempt to bridge this gap, using a calibrated model to look at the case of Denmark. The underlying model is a Ramsey growth model, where rational, forward-looking individuals produce goods and divide their income between consumption and saving,

¹ Prepared by Allan D. Brunner (EUR).

which adds to the future capital stock. Aggregate consumption is distributed among individuals according to their age-related needs, using private and public transfer schemes. In this model, the public transfer schemes are financed with non-distorting taxes on income, so there are no indirect effects on economic growth.

5. **The main conclusions of the paper are as follows:**

- Demographics will have a significant adverse effect on the labor market, on real GDP, and on public finances. In the baseline scenario – which is calibrated on policies in place at the end of 2005 – *the fiscal sustainability gap is estimated at about 4 percent of GDP*. This is somewhat greater than estimates made by the authorities and by the European Commission (2005). The main differences appear to be related to more optimistic assumptions about health care and old-age care expenditures.
- The 2006 Welfare Agreement and the 2007 Jobs Plan go a long way towards putting fiscal policy on more solid ground. *Together, these policy initiatives improve the fiscal balance by about 4 percentage points by 2005*. However, since the Agreement is not fully phased in until 2027, many pension recipients continue to be “grandfathered in”, and a sustainability gap of about 2 percentage points remains.
- The estimated sustainability gap is larger than estimates by the Ministry of Finance, owing mostly to the Ministry’s assumption of “healthy ageing,” which proposes that a 70-year-old in 2050, for example, will require less health care and old-age care than an 70-year-old today.
- Recent policy changes have widened the gap a bit, but *some recent proposals by the Labor Market Commission would likely close the gap*. However, these proposals have not been received warmly by some of Denmark’s social partners.
- Finally, it is important to recognize that this study is based on many assumptions, and the main conclusions are quite sensitive to some of them.

6. **The paper is organized as follows.** Section II discusses the demographic changes underway in Denmark and provides a preview of how they will directly affect the supply of labor and the demand for public sector benefits. Section III examines in more detail how the demographic shifts will affect the labor force, real GDP, and public finances. Section IV examines the effects of recent policy changes – including the Welfare Agreement and Jobs Plan, and recent tax and expenditure changes – and discusses the possible effects of the recent proposals made by the Labor Market Commission.

B. Demographic Changes

7. **This section reviews recent and projected demographic changes.** The focus is on ageing and immigration. An ageing population is a feature of many developed countries, largely driven by decreases in fertility rates and declines in old-age mortality rates. Denmark’s ageing “problem” is not as severe as in some other countries, where fertility rates have dropped further. Indeed, many countries—most notably, Spain, Italy, Greece, Japan, and Germany—are ageing much faster and will end up with significantly larger elderly population shares—see IMF (2001).

8. **Immigration interacts with population ageing in several ways.** Immigrants, on average, tend to be younger than the average native population. This can be an advantage, if immigrants move quickly into productive employment, providing a boost to the labor force and to a net positive contribution to public finances. On the other hand, immigration can be a burden, if immigrants end up in low-skill, low-wage jobs or are unable or unwilling to participate in the domestic labor market.

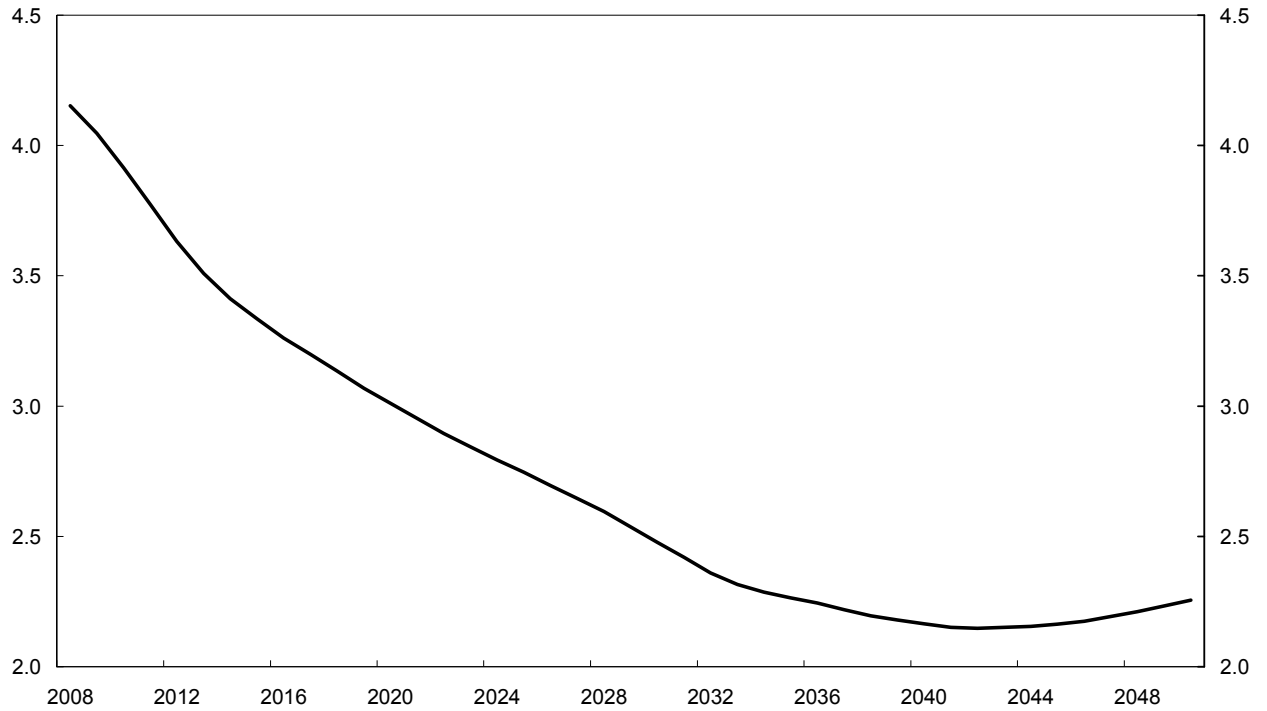
Population Ageing

9. **Denmark’s population is ageing.** As shown in Figure 1, the ratio of working-age to elderly individuals is expected to fall from 4:1 today to just over 2:1 in 2050. The decline reflects a fall in the working-age population (WAP) – currently defined as individuals between 16 to 64 years of age – and a sharp rise in the elderly population – 65 years of age and above.

10. **Figure 2 provides a snapshot of this trend.** It shows the age distribution for three selected years—2008, 2015, and 2050. The distribution in 2008 (the solid line) shows that the 2008 distribution has several modes; the largest mode corresponds to cohorts in the early 40s, while somewhat smaller clusters of individuals are in their early 60s and in their pre-teens. It is also interesting to note that the distribution drops off sharply for elderly individuals.

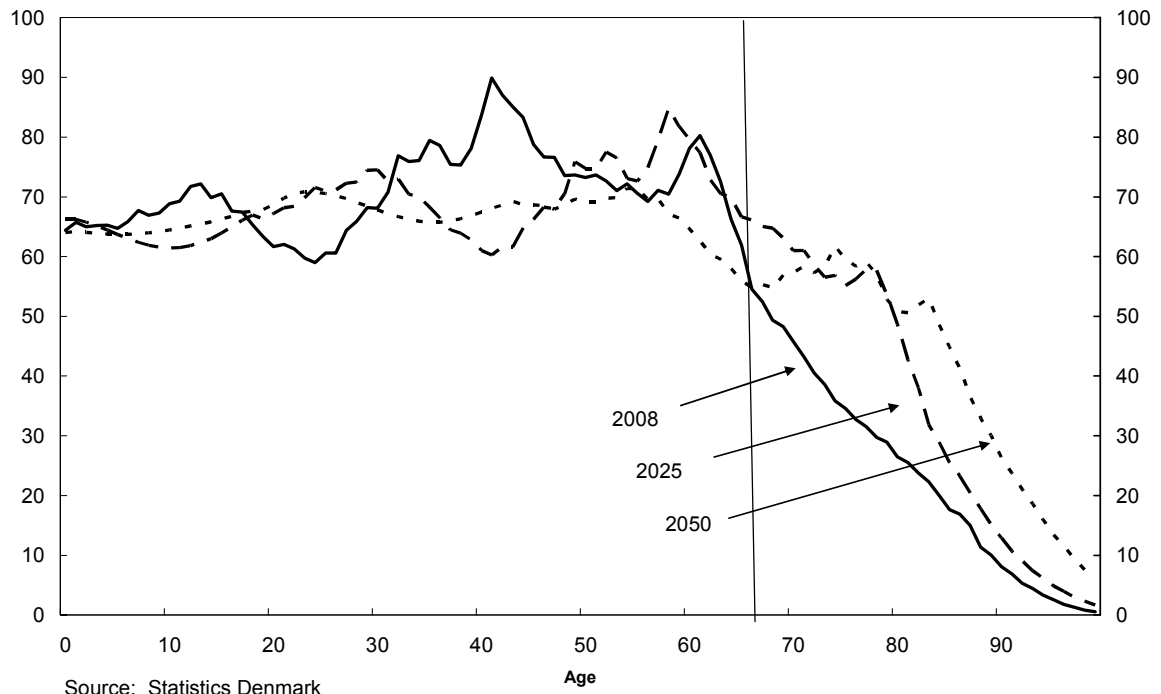
11. **As the distribution shifts to the right, from 2008 to 2025, the largest group of cohorts are pushed into their 60s,** while the younger group moves into employment, and the older group moves into retirement. The number of individuals in the working-age population (16-64) declines over this period, while the number of 65+ year-olds increases markedly. The share of the elderly in the overall population becomes even larger by 2050, when the largest group of cohorts has moved into old-age.

Figure 1. Denmark: Ratio of Working-Age to Elderly Population, 2008-2050



Source: Statistics Denmark

Figure 2. Denmark: Population Distribution, 2008, 2025, and 2050 (Thousands)

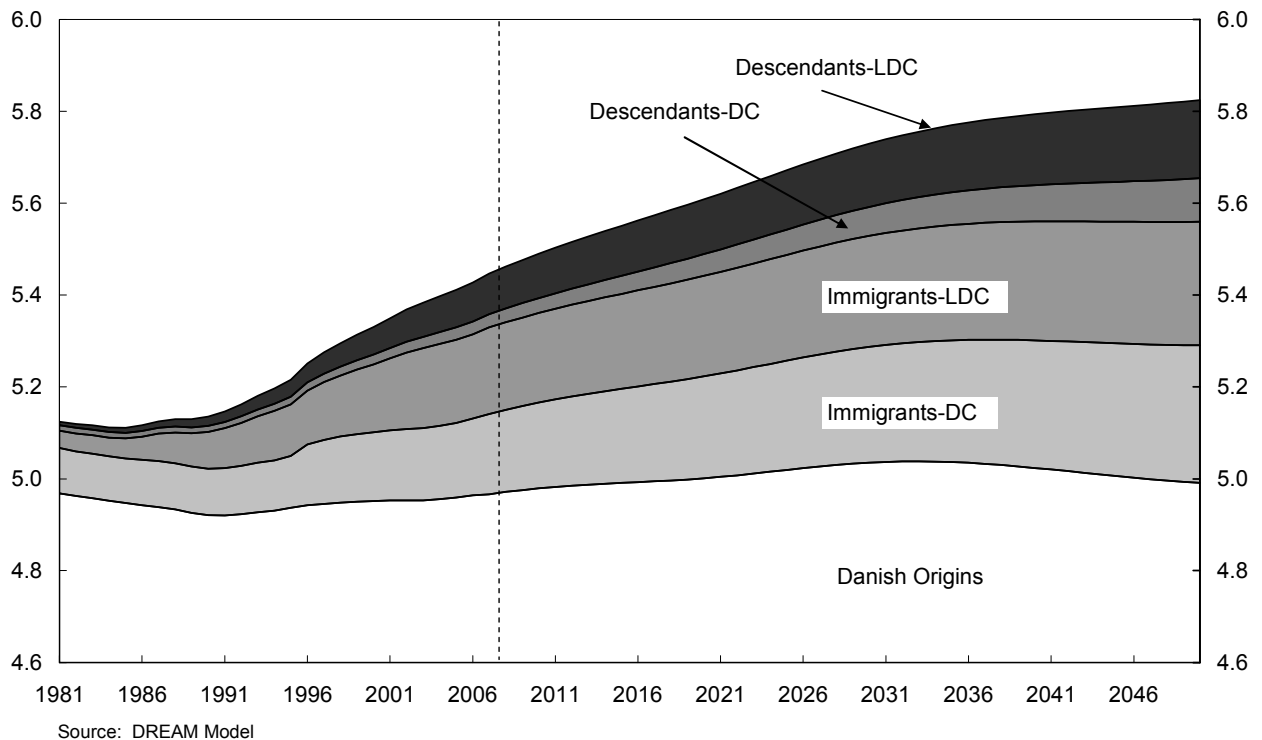


Source: Statistics Denmark

The Immigrant Population

12. **The population is projected to increase by about 360 thousand (a 6½ percent change) from 2008 to 2050**, with almost all of the increase expected to come from new immigrants or from the descendants of immigrants. Figure 3 shows the actual and projected population over the 1981-to-2050 period, decomposed into 5 ancestral categories: (i) individuals with Danish origins (born in Denmark from Danish parents), (ii) immigrants from developed countries (DC), (iii) immigrants from less developed countries (LDC), (iv) descendants of immigrants from developed countries, and (v) descendants from immigrants from less developed countries. As the figure illustrates, the population with Danish origins is expected to be relatively stagnant over the next several decades, while the number of immigrants is projected to increase by more than 50 percent, and descendants are projected to more than double (albeit from a much smaller level).

Figure 3. Denmark: Composition of Population, by Ancestry, 1981-2050
(Millions)



13. **Whether these trends in the immigrant population will mitigate or exacerbate the challenges of ageing depends on how the immigrant population differs from the native population.** The remainder of this section compares these population segments on the

basis of age, educational attainment, employment activity, and net contributions to public finances.² The comparisons can be summarized as follows:

- The share of non-natives in the working age population has increased steadily in recent years. As shown in Table 1, the share of immigrants in the WAP has increased almost 4 percentage points from 1991 to 2006. This increase is concentrated among the relatively young—especially among those under 45 years old. In addition, the table indicates that new immigrants have been relatively unskilled, with immigrants pushing up the share of total individuals without a high school education (labeled “Basic”).

Table 1. Denmark: Change in Importance of Immigrant Population, by Age and Educational Attainment (Change from 1991 to 2006, percentage points)

Age	Educational Attainment							Total
	Basic	GUS	VUS	VS	SHE	MHE	LHE	
25-29	9.4	5.3	2.8	1.8	0.7	0.6	2.7	4.2
30-34	10.1	10.9	0.3	2.1	1.1	1.1	-0.1	4.4
35-39	8.9	12.0	0.4	2.9	2.0	2.8	1.7	5.3
40-44	6.3	5.0	-0.3	2.8	2.6	2.7	2.3	4.6
45-49	4.2	4.0	0.2	2.4	1.3	2.0	0.7	3.9
50-54	3.1	0.2	-0.3	2.0	2.7	1.0	1.2	3.1
55-59	1.9	5.7	-1.9	2.1	4.0	1.7	2.7	2.7
60-64	1.0	4.4	-2.7	2.0	2.8	0.7	4.2	2.2
Total (25-64)	4.8	8.2	0.8	2.2	2.0	1.6	1.6	3.7

Basic=8th grade education or less; GUS=general upper secondary; VUS=vocational upper secondary; VS=vocational school; SHE, MHE, and LHE=short-, medium-, and long-cycle higher education, respectively.

Source: Statistics Denmark

- Non-natives are expected to become a larger share of the working-age population. As seen in Figure 4, from 2008 to 2050, the number of immigrants and descendants in the working age population will increase by more than 185,000 individuals, while the native population falls by more than 400,000. As a result, the share of non-natives in the WAP is projected to increase from about 10 percent in 2008 to about 16 percent in 2050.

² Unfortunately, earnings data by ancestral categories were not available. Instead, it is assumed that, after adjusting for differences in experience and education, workers earn the same average wage regardless of ancestry.

- However, non-natives will also make up a larger share of the elderly population. As illustrated in Figure 5, the elderly population is expected to rise sharply for all ancestral categories, but elderly immigrants from less developed countries are expected to increase more rapidly. As a result, the share of non-natives in the elderly population is seen to increase from 4 percent in 2008 to about 10 percent in 2050.

Figure 4. Denmark: Composition of Working-Age Population, by Ancestry, 2008-2050
(Millions)

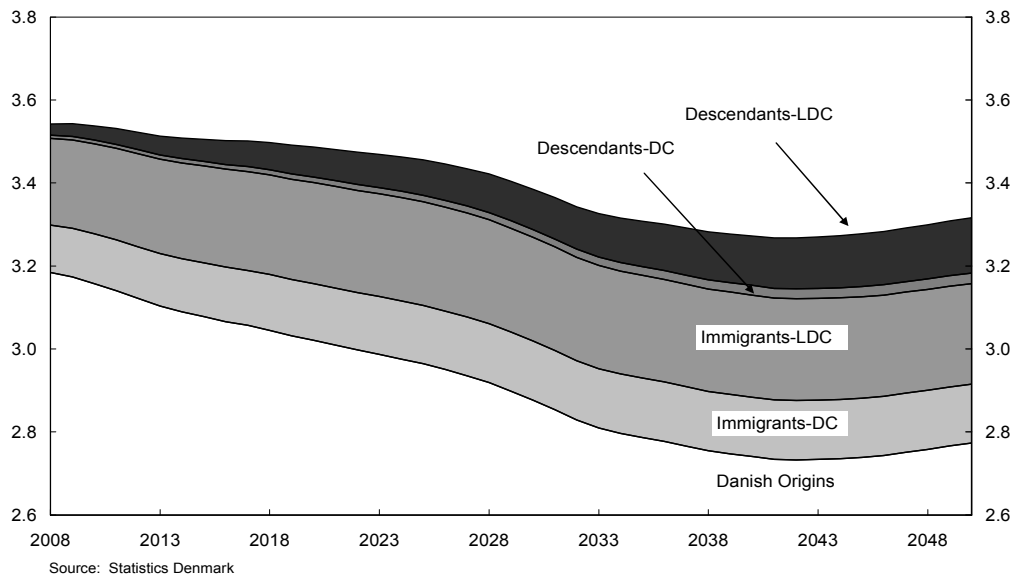
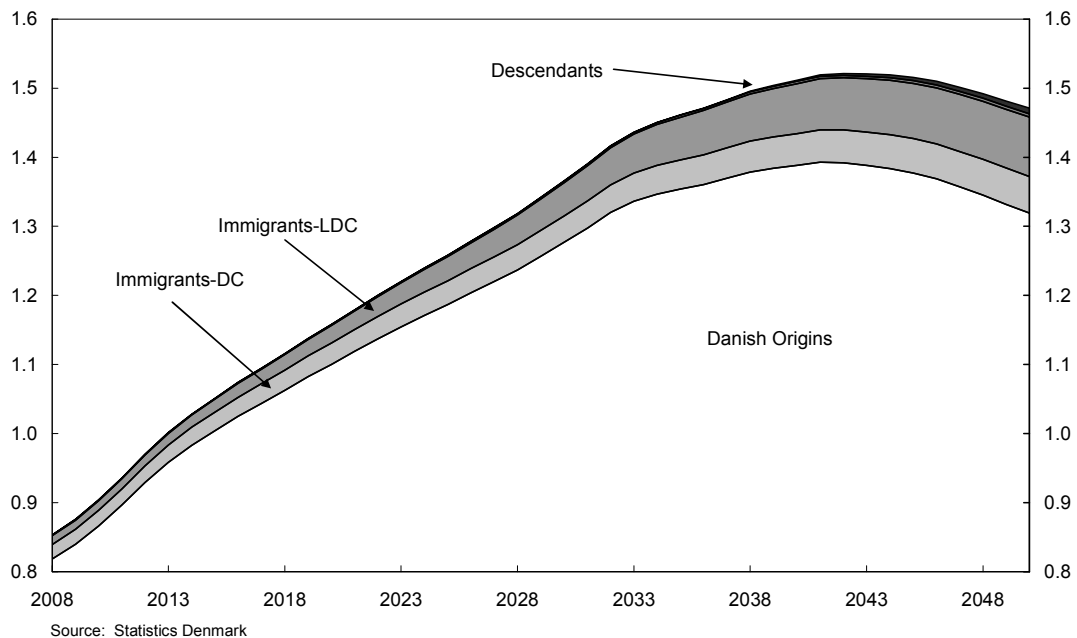
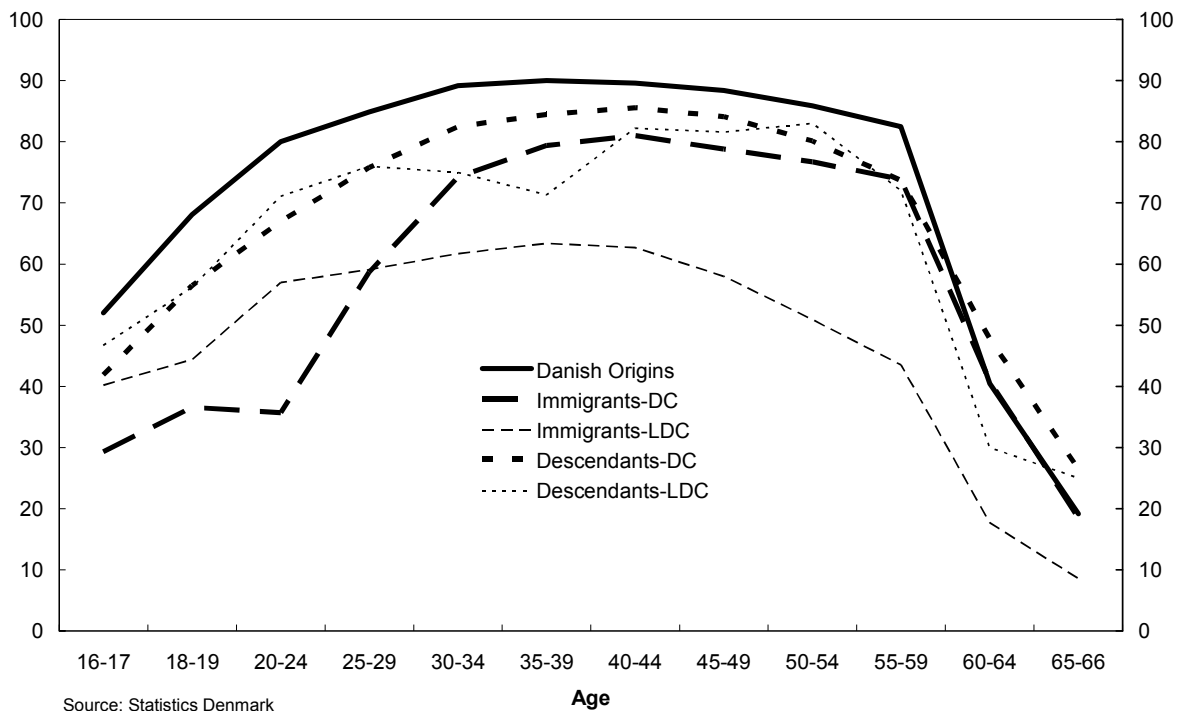


Figure 5. Denmark: Composition of Elderly Population, by Ancestry, 2008-2050
(Millions)



- Economic activity varies considerably across ancestral categories.³ As illustrated in Figure 6, labor force participation rates (LFPRs) are quite high for native Danes (the solid line), particularly because labor force participation among women is about the same as for men. LFPRs for immigrants from less developed countries are uniformly below those of other categories, reflecting differences in characteristics such as job skills, language, or culture. LFPRs for immigrants from developed countries are lower for younger individuals, but are nearly the same as for native Danes for individuals over 40 years old. Descendants from both developed and less developed countries also have nearly the same participation rates as native Danes for all age groups, suggesting that assimilation in the labor market occurs quickly in Denmark.

Figure 6. Denmark: Labor Force Participation Rates, by Age and Ancestry, 2006

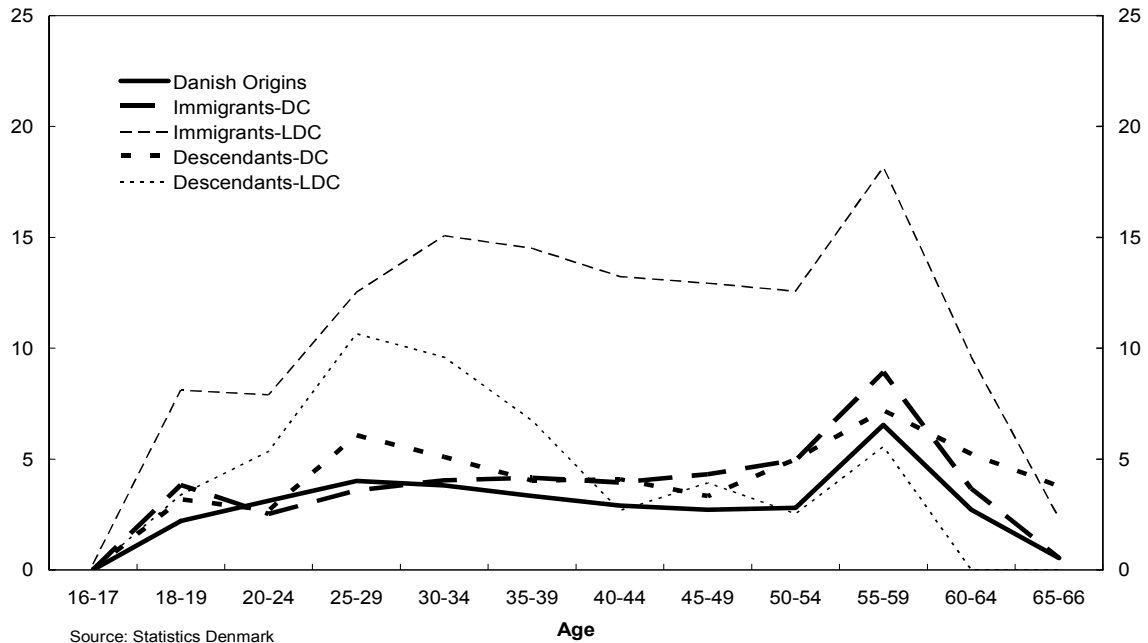


- Unemployment rates also show a great deal of variation across ancestral categories—Figure 7. The patterns are similar to those for labor force participation rates. Unemployment rates are relatively low for native Danes, and quite high for immigrants from less developed countries. Descendants from lesser developed

³ Data on labor force participation rates and unemployment rates by age and ancestry are available from 1991 to 2006. There is some variation in labor market activity patterns across time. However, I focus on 2006, which represents that largest number of immigrants and descendants, as a share of the total population.

countries have relatively high unemployment rates when young, but are nearly indistinguishable from other categories for those older than 40 years old. Finally, the unemployment rates for other groups are nearly the same as for native Danes.

Figure 7. Denmark: Unemployment Rates, by Age and Ancestry, 2006



- Finally, ancestral categories place different demands on the public sector. Figures 8 and 9 show the distribution of public consumption and public transfers, respectively, for men in 3 different ancestral categories.⁴ For public consumption, immigrants under the age of 30 have a slight tendency to consume smaller amounts of public benefits, which Schou (2005) attributes to lower consumption of education. Differences among the groups are negligible for older individuals. It is also quite striking that public consumption rises drastically after age 70, reflecting the need for medical care and long-term care. Immigrants from less developed countries receive considerably more government transfers, likely reflecting lower participation in the labor market, as discussed earlier. As pointed out by Schou, however, this tendency fades in old age, because fewer immigrants tend to receive public pensions.

⁴ These data were compiled by the DREAM model (www.dreammodel.dk) based on microdata. Because of insufficient data for certain groups, descendants are assumed to have the same demands for public benefits as native Danes, and all individuals older than 70 years old are assumed to place the same demands on the public sector.

Figure 8. Denmark: Public Consumption for Men, by Age, 2005
(Thousands of DKR)

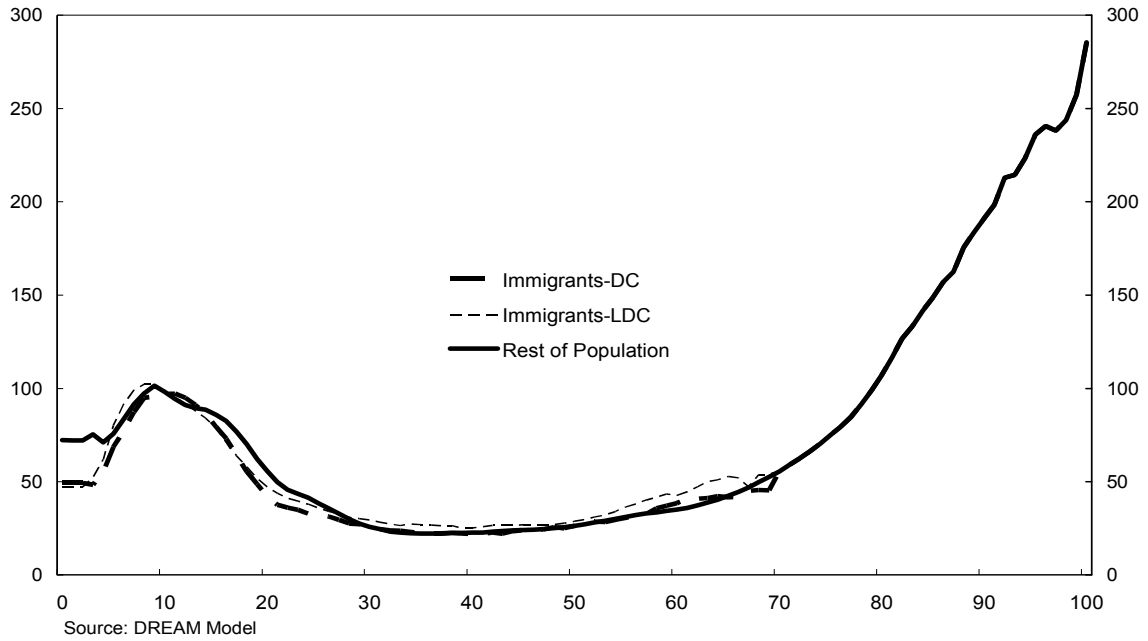
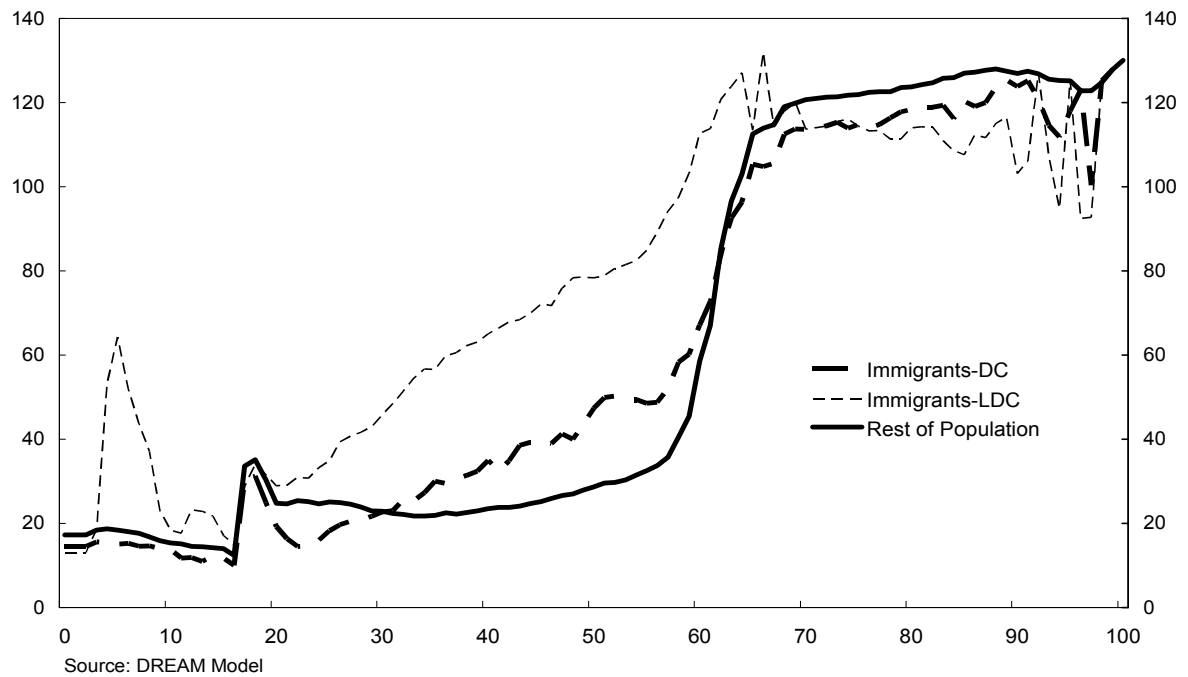


Figure 9. Denmark: Public Transfers for Men, by Age, 2005
(Thousands of DKR)



C. When Is Fiscal Policy Sustainable?

14. **There are several ways to evaluate whether current fiscal policies are sustainable.** All criteria start with an equation describing public debt evolution:

$$b_{t+1} = (r_t - \gamma_t)b_t - ps_t$$

where b_{t+1} is the debt-to-GDP ratio, r_t is the real interest rate, γ_t is the growth rate of real GDP, and ps_t is the primary surplus. Repeated substitution of the equation produces the debt ratio for time $t+s$:

$$\frac{b_{t+s}}{R_{t+s}} = b_t - \sum_{k=0}^{s-1} \frac{ps_{t+k}}{R_{t+k}}$$

where

$$R_{t+s} = \prod_{i=0}^{s-1} (1 + i_{t+i} + \gamma_{t+i})$$

This relationship simply states that the discounted value of future debt—the left-hand side of the equation—is equal to current debt minus the sum of discounted future primary surpluses—the right-hand side of the equation.

15. **As discussed in Blanchard et al. (1990), there are many debt paths that satisfy the above intertemporal budget constraint (IBC) over s periods.** The most common definition of debt sustainability – and the one used in this paper and by the Danish authorities – is a scenario where the debt target at time $t+s$ is the current debt ratio (b_t). However, the IBC also allows for the debt ratio to rise to a higher but stable level (a somewhat less restrictive definition) or to converge to zero at time $t+s$ (a more restrictive definition).⁵ The definition can be made operational by setting a debt target for time $t+s$ ($\bar{b}_{t+s} = b_t$) and then calculating the change in the primary surplus (Δps) in each time period between t and $t+s$ that satisfies the sustainability definition. In other words, Δps must satisfy the following equation:

$$\frac{\bar{b}_{t+s}}{R_{t+s}} = \frac{b_t}{R_{t+s}} = b_t - \sum_{k=0}^{s-1} \frac{ps_{t+k} + \Delta ps}{R_{t+k}}$$

⁵ Note that if one is willing to make forecasts of the primary surplus out through infinity, then there is no need to set a debt target, since the discounted value of that target goes to zero as s approaches infinity.

D. A Baseline Forecast

16. **This section of the paper develops a baseline scenario for the macro economy and the fiscal sector in Denmark from 2008 to 2050.** The baseline scenario is based on government policies that were in effect at the end of 2005. This counterfactual scenario allows for an analysis of the effects on fiscal sustainability of both past and prospective policies: (a) the 2006 Welfare Agreement and the 2007 Jobs Plan, (b) recent changes in tax and expenditure policies, and (c) recent proposals by the Labor Market Commission.

17. **The model's production function has three inputs – technology, labor, and capital.** Technology is assumed to evolve exogenously. The capital stock is endogenous, and adjusts optimally to demographic changes. The labor force is also exogenous, based on Danish official forecasts. A key feature of the model in this paper, however, the labor force in this model is disaggregated by age, educational attainment, and ancestry. This allows for a rich analysis of the effects of demographic changes on the labor force and, therefore, on real GDP.

The Effective Labor Force

18. **Goods are produced at time t using capital, labor, and labor-augmenting technology as follows:**

$$Y_t = K_t^\alpha (E_t \bar{L}_t)^{1-\alpha}$$

where Y_t is real output, K_t is the real capital stock, E_t is the average level of labor efficiency, \bar{L}_t is demographically-weighted level of employment, and α represents capital's share of output.

19. **The demographically-weighted labor force is constructed as follows:**⁶

$$\bar{L}_t = \sum_{i=1}^{10} \sum_{j=1}^7 \sum_{k=1}^5 \omega_{ijk} N_{ijkt}$$

where N_{ijkt} is the population at time t , disaggregated by:

⁶ Using a weighted sum over population segments implies that groups are perfectly substitutable. That is, after adjusting for differences in productivity, a 55-year-old individual with a basic education is perfectly substitutable for a 20-year-old individual with a Ph.D. Borjas (2003) and Ottaviano and Peri (2006) find evidence that this assumption is correct for U.S. workers. However, some preliminary work (not presented here) suggests that Danish workers are much more substitutable.

- *age* (i) = 16-19, 20-24, 25-29, 60-64;
- *education* (j) = basic, general upper secondary, vocational upper secondary, vocational, short-cycle higher, medium-cycle higher, and long-cycle higher; and
- *ancestry* (k) = Danish origin, immigrant from a developed country, immigrant from a less developed country, descendant from a developed country, and descendant from a less developed country;

and where population segments are weighted (ω_{ijk}) to reflect differences (across age, education, and ancestry) in labor force participation, unemployment rate, and productivity. Specifically, the demographic weights are calculated as:

$$\omega_{ijk} = \text{LFPR}_{ik} * (1 - \text{UR}_{ik}) * W_{ij}$$

where LFPR_{ik} is the labor force participation rate (across age and ancestry groups), UR_{ik} is the unemployment rate (across age and ancestry groups), and W_{ij} is the average hourly wage (across age and education groups).

20. **Note that three important assumptions are made based on available data:**

- The average hourly wage rate is a good proxy for relative productivity;
- Individuals across immigration categories (k) earn the same wage, after adjusting for age (i) and education (j);
- Individuals across educational categories (j) have the same labor force participation and unemployment rates, after adjusting for age (i) and ancestry (k).

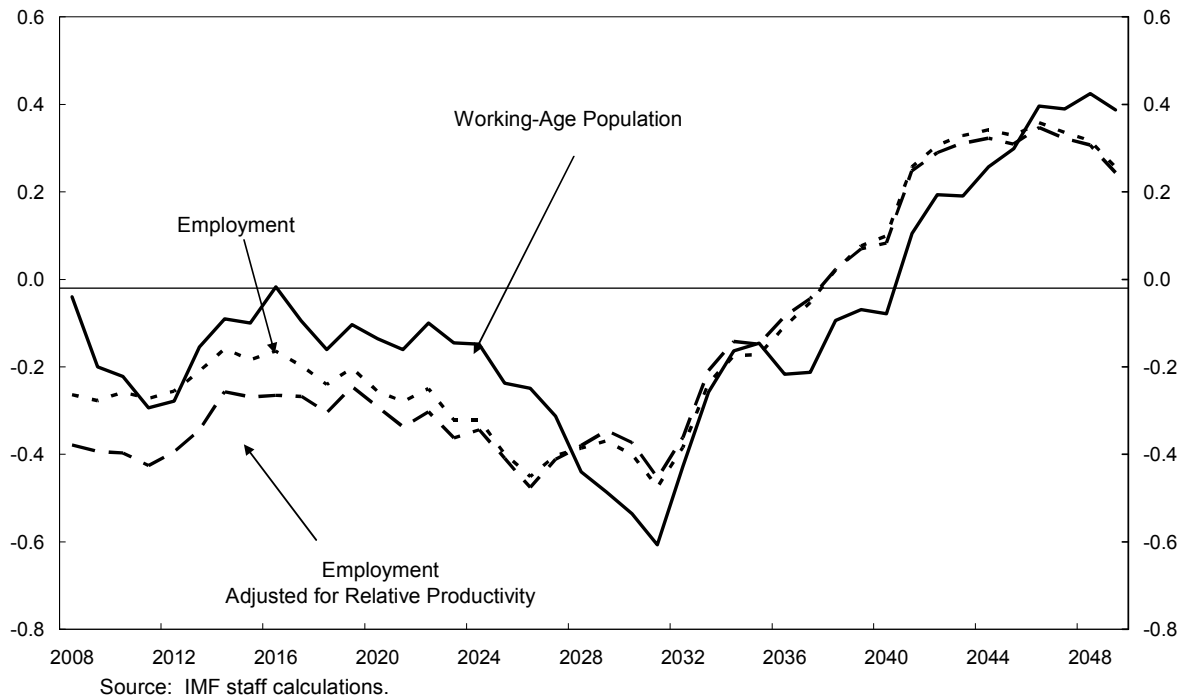
In addition, it is assumed that average labor efficiency (E_t) grows 2.2 percent per year, which is consistent with the average growth rate during the 1980s and 1990s but somewhat faster than the average growth rate in recent years.⁷

21. **Figure 10 shows three measures of the growth rate of the projected Danish labor force through 2050.** The solid line shows the growth rate of the working-age population.

⁷ Since labor's share of output is 0.55, the growth rate in labor efficiency is equivalent to a 1 percent rate of growth in total factor productivity (TFP).

The short-dashed line shows the growth rate of employment—the working-age population adjusted for differences in labor force participation and unemployment rates across the demographic categories. Finally, the long-dashed line plots the growth rate of employment adjusted for demographic differences in productivity, as proxied by earnings. The figure indicates that both types of adjustment are important in Denmark: Through 2030, the increased importance of immigrants—who tend to have lower rates of economic activity and lower earnings – and the large shift into retirement of middle-aged people—which tend to have relatively high earning power—will significantly and adversely affect the effective labor force. After 2030, when immigration ratios and relative productivity stabilizes, the demographically-adjusted employment growth rate rises rapidly and then levels off.

Figure 10. Denmark: Various Measures of the Labor Force, 2008-2050
(Percent change)



The Capital Stock and Real GDP

22. **The final step in calculating real GDP is to forecast the real capital stock.** The growth model predicts that the capital stock grows in line with the effective labor force. More specifically, the equilibrium capital-to-effective-labor ratio is:

$$\frac{K}{E_t \bar{L}_t} = \left[\frac{K}{Y} \right]^{1/(1-\alpha)} = \left[\frac{(1-\tau^k)\alpha}{r+\delta} \right]^{1/(1-\alpha)}$$

where τ^k is the average tax rate on capital income, r is the real interest rate, and δ is the depreciation rate of capital.

23. **This equilibrium relationship suggests two approaches for pinning down the optimal capital-to-effective-labor ratio:**

- The capital-to-output ratio has fluctuated between 2.8 and 2.9 over the last 25 years, averaging 2.83. Using the formula above, this implies that the optimal capital-to-effective-labor ratio should be about 6.6.
- The average effective tax rate on capital is about 30 percent.⁸ Using national accounts data, α and δ are estimated to be about 0.45 and 0.045, respectively. The real return on capital is assumed to be about 6 percent. Using the formula above, the optimal capital-to-effective-labor ratio should be about 7.4.
- This first calibration is likely more accurate, since more parameters are directly observable. In the baseline scenario, I will assume that the long-run ratio is 6.6 for Denmark. As it turns out, the qualitative nature of the conclusions are not affected if a higher ratio is used.

24. **An important implication of this analysis is that the growth rate of the capital stock should fall somewhat over the next several years**, since the effective labor force is expected to also slow over that time period. This paper assumes that the capital stock adjusts very slowly to these changes, consistent with adjustment rates presented in Barro and Sala-i-Martin (2004).

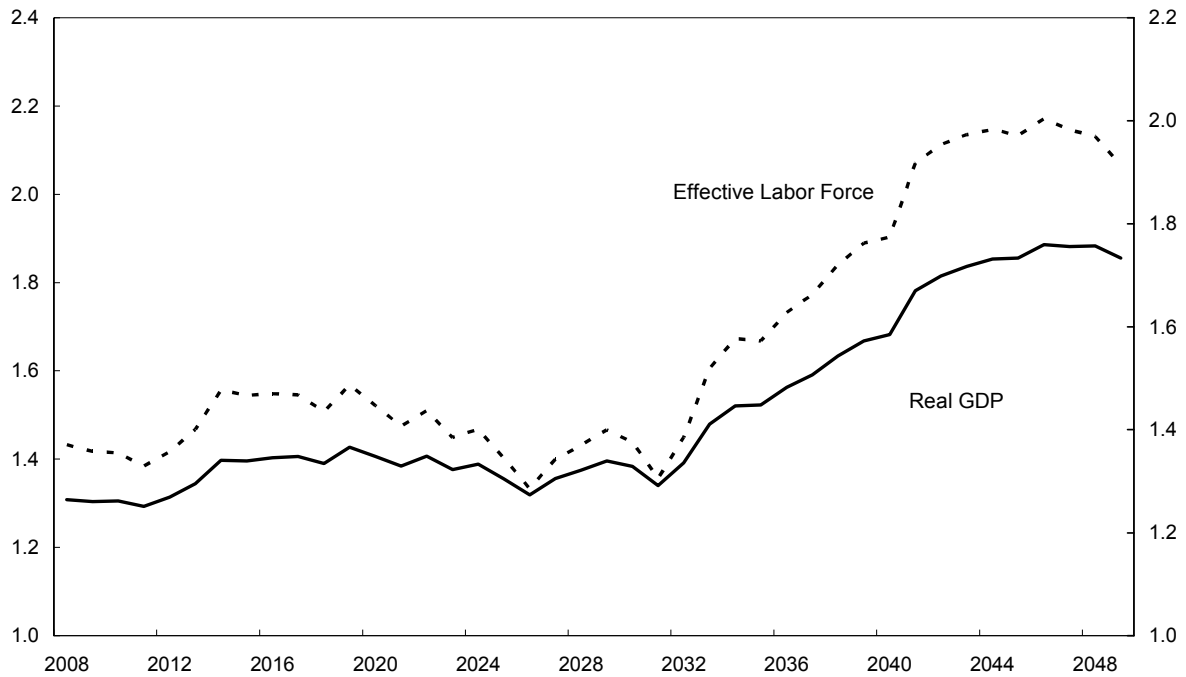
25. **Using the estimates for the effective labor force in the previous section and the assumptions for the capital stock above, it is straightforward to compute estimates of GDP using the production function discussed above.** Figure 11 shows the outcome of this exercise. Over the next few years, GDP (the bold line) is projected to grow at a 1¼ percent rate, much slower than in recent years, owing to a slowdown in the effective labor force (the dashed line). However, after 2030, the effects of the ageing population start to wane and the immigrant population stabilizes. As a consequence, real GDP growth rebounds toward the end of the forecast horizon.

26. **This baseline forecast for real GDP is subject to a number of uncertainties.** First, labor efficiency has been growing very slowly in recent years. Most analysts seem to view this as a largely cyclical phenomenon, and this paper assumes that efficiency growth will

⁸ A review of the literature shows a wide range of estimates for the average effective tax rate on capital for Denmark—from 15 to nearly 50 percent.

rebound after the current downturn is over. If efficiency growth continues to languish, however, then the estimates shown in Figure 11 will be too high. Finally, there is a great deal of uncertainty regarding the projected inflow of immigrants after Denmark lifts restrictions on immigration from new member states, in line with EU requirements.

Figure 11. Denmark: Real GDP and Effective Labor Force, 2008-2050
(Percent change)



Source: IMF staff

A Baseline Forecast of the Fiscal Accounts

27. **Finally, this section makes some rough calculations of future public sector revenues and expenditures.** The focus is on calculating the *direct effects* of demographic changes on public expenditures. If public expenditures (as a percent of GDP) are expected to rise over time in an unsustainable way, then either average tax rates will also have to increase or benefit levels will need to be lowered, in order to satisfy the government's intertemporal budget constraint (IBC). This will lead to *indirect effects*. If tax rates on capital are increased and capital is relatively mobile, then capital accumulation is likely to slow sharply. Tax bases would also slow, requiring even higher taxes to satisfy the IBC. Alternatively, if tax rates on

labor are increased and labor is relatively immobile, then the effects on output could be small or even negligible.⁹

28. **Nominal revenues are assumed to be constant over time, as a percent of nominal GDP.** This is the same assumption made by the Danish authorities, and it is consistent with the thrust of the government's aim to freeze taxes, on average, at least through 2015.

29. **Nominal expenditures for spending category s for year t (X_{st}) can be written as:**

$$X_{st} = P_{st} * \rho_{st} * \sum_{i=1}^{10} \sum_{k=1}^5 \psi_{sik} N_{ikt} \quad (t \geq 2008)$$

where P_{it} denotes the nominal price index for spending category s at time t relative to some base year; ρ_{st} is the real cost index of providing public services in category s for time t relative to the base year; ψ_{sik} represents per capita real expenditures in category s for persons in demographic categories i and k (age and ancestry) for a given base year; and N_{ikt} is the number of persons in demographic categories i and k at time t .

30. **This equation suggests a simple, straightforward way of projecting fiscal expenditures, using available data:**

- The first step is to use data on per capita expenditures (ψ_{sik}) for spending category s and for various age (i) and ancestral (j) categories for 2005 – illustrated in Figures 7 and 8 – and multiply by the number of persons (N_{ikt}) in each of the demographic categories over the forecast horizon.
- Summing up over all demographic categories and multiplying by the real costs of these expenditures in a given year (ρ_{st}) yields an estimate of total real expenditures for spending category s in year t .
- Finally, nominal expenditures (X_{st}) are calculated by multiplying real expenditures by the appropriate price index (P_{st}).

⁹ Indeed, one way to interpret the calculations in this version of the note is that tax increases will be levied on labor and that labor is perfectly immobile.

It is also assumed that the real cost of all spending categories (ρ_{st}) rises with the level of overall labor productivity (real wages) in the total economy and that P_{st} grows over time at the rate of overall inflation. The specific assumptions are:

- Inflation is expected to be 3.1 percent in 2009, 2.3 percent in 2010, 2.1 percent in 2010 and 2011, and 2 percent thereafter; and
- Labor productivity growth is assumed to grow at a constant rate of 1.8 percent over the forecast horizon.

Nominal GDP is simply real GDP times the nominal price index. Note that assumptions for labor productivity and overall inflation are the same as above.

31. **Table 2 presents the outcome of this simple projection exercise.** Overall, total government expenditures increase by about 15 percentage points of GDP during 2018-2050, much more than the official estimates provided to EC committee on ageing (about 3½ percentage points of GDP). The largest contributors to this increase are health care (4.9 percentage points) and pension expenditures (about 4 percentage points). Increases in “other social spending” and “other transfers” account for the rest of the increase. The baseline scenario also indicates a 3.9 percentage point gap in fiscal sustainability. That is, there would need to be an increase in the fiscal balance of 3.9 percent of GDP in each period from 2008 to 2050 to keep the debt to GDP ratio at the 2008 level.

Table 2. Denmark: Baseline Projections of the Structural Balance, 2008-2050
(Percent of GDP)

	2008	2015	2020	2030	2040	2050	Change 2008 to 2050
Revenues	52.6	52.6	52.6	52.6	52.6	52.6	0.0
Expenditures (excluding interest)	46.9	50.5	53.0	58.3	61.4	61.6	14.7
Public Consumption	26.3	28.1	29.6	32.6	34.4	34.8	8.5
Education	5.7	5.9	6.0	6.1	6.5	6.4	0.7
Health Care	9.5	10.6	11.5	13.3	14.1	14.4	4.9
Other Social Expenditures	5.7	6.3	6.8	7.8	8.4	8.6	2.9
Other Public Consumption	5.4	5.4	5.4	5.4	5.4	5.4	0.0
Transfer Incomes	16.1	17.8	18.9	21.3	22.5	22.3	6.2
Unemployment Benefits	2.0	2.0	2.1	2.1	2.1	2.2	0.2
Sickness and Maternity Leave	1.2	1.2	1.2	1.3	1.3	1.3	0.1
Educational Aid	0.6	0.7	0.8	0.8	0.8	0.8	0.2
Cash Benefits	0.5	0.6	0.6	0.6	0.6	0.6	0.1
Early Retirement Spending	3.6	3.6	3.7	4.1	3.8	3.6	0.0
Old Age Pensions	4.5	5.6	6.2	7.5	8.5	8.4	4.0
Other Transfers	3.7	4.1	4.4	5.0	5.4	5.4	1.7
Other Expenditures	4.5	4.5	4.5	4.5	4.5	4.5	0.0
Primary Structural Balance	5.7	2.1	-0.4	-5.7	-8.8	-9.0	-14.7
Sustainability Gap	--	3.9	3.9	3.9	3.9	3.9	
Sustainable Primary Balance	5.7	6.1	3.5	-1.8	-4.9	-5.1	-10.8
<i>Memo item:</i>							
Gross Debt (w/o adjustment)	20.0	-5.6	-8.9	25.0	104.7	197.1	177.1
Gross Debt (with adjustment)	20.0	-33.6	-57.5	-66.8	-31.3	20.0	0.0

Source: IMF calculations.

32. **A number of underlying assumptions need to be studied more carefully.** First, health care costs could be over- or under-estimated. On one hand, many countries, including Denmark, are experiencing sharp increases in relative prices for health care. If demand pressures continue to put upward pressure on the costs of health care, the overall costs of ageing would be higher than shown in Table 2. On the other hand, these calculations could be biased upwards, since I assume that the health of a 70-year-old in 2040—and her associated health care costs—will be the same as a 70-year old in 2005. Education costs could be understated, if more young people seek education to be employable in a high-tech, competitive global economy. Also, if workers will be spending more years in the workplace, they might need more education later in life, in response to sectoral economic shifts.

33. **Finally, as mentioned earlier, these calculations do not account for the effects that higher taxes might have on the labor-leisure choice or the savings-consumption choice.** Indeed, higher government expenditures due to ageing are likely to lead to higher taxes, lower employment rates, slower capital accumulation, and slower economic growth. In this case depending on tax policy choices, ageing costs as a percent of GDP could be even higher than the calculations in Table 2 suggest.

E. Effects of Recent Policy Changes and Proposals

34. **This section of the paper examine the effects on fiscal sustainability of two recent changes in fiscal policy** – the 2006 Welfare Agreement and some recent changes in tax policy – and a recent proposal by the Labor Market Commission to bring forward the increases in age limits that are in the Welfare Agreement.

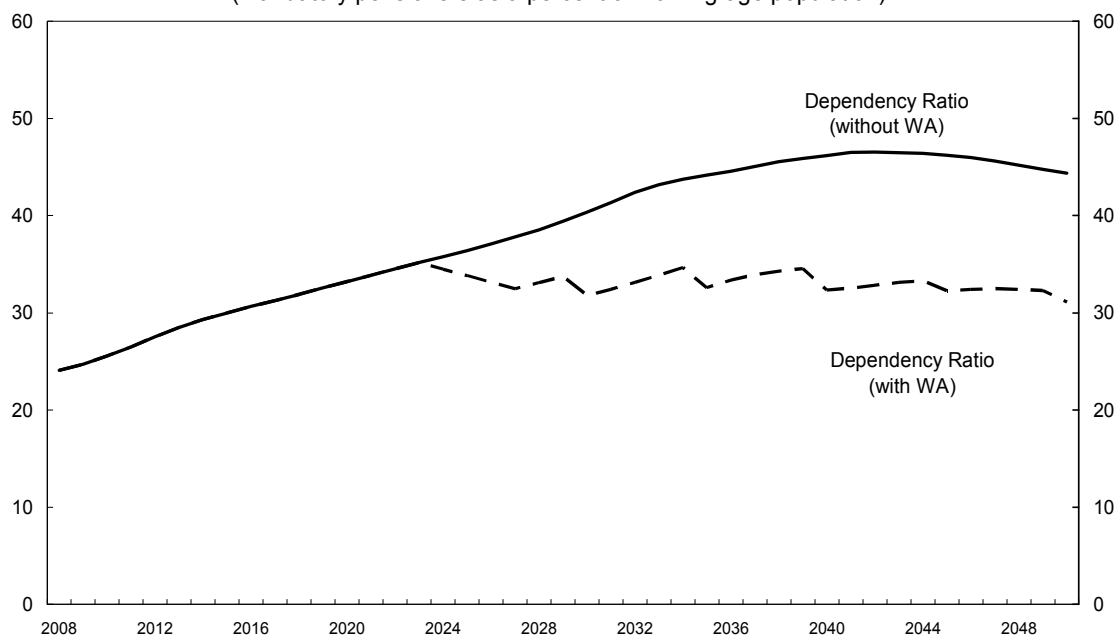
The Effects of the Welfare Agreement

35. **The most important features of the Agreement are an initial increase in retirement ages, and, thereafter, an indexation of retirement ages to longevity.** The current retirement age for voluntary early retirement pensions (VERP) and old-age pensions (OAP) is 60 and 65, respectively. Given current life expectancies, a new pensioner in 2008 can expect to spend between 17 to 22 years in retirement, significantly longer than previous cohorts. Moreover, life expectancies are projected to increase further—about $\frac{1}{2}$ of a year every 10 years, putting substantial pressures on pension expenditures and effectively reducing the relative size of the working-age population. The Welfare Agreement raises the age limit for VERPs from 60 to 62 years starting in 2019, and the age limit is then indexed to the life expectancy of 60 year-olds thereafter, according to a specified formula. The age limit for OAPs will increase from 65 to 67 starting in 2024, and, thereafter, will be the VERP age limit plus 5 years.

36. **These changes have a dramatic effect on the old-age dependency ratio (Figure 12),** both increasing the number of individuals in the work force and by reducing the number of pensioners. In terms of the economic model, there are a number of important effects. First, the labor force in each period is augmented by the number of individuals that would have been in retirement without the Welfare Agreement requirements. Although this has the effect of increasing various tax bases, I assume that these increases have no distributional effects, and revenues as a percent of GDP are unchanged. Second, the reduction in the number of pensioners reduces transfer incomes. As a consequence, income transfers as a percent of GDP fall because the level of transfers will decrease (the numerator) and the level of GDP will increase (the denominator).

37. **As shown in Figures 6 and 7, labor force participation rates and employment rates drop sharply as individuals get close to retirement age.** The 2007 Jobs Plan strengthens work incentives for individuals as they approach retirement, offering tax incentives to stay in full time work and some retirement benefits for those who shift from full- to part-time work. The authorities (2007 Convergence Program) estimate that the combined effects of the Welfare Agreement and the Jobs Plan will not only add more workers to the labor force, but their employment rate and average hours worked will increase substantially.

Figure 12: Denmark: The Effects of the Welfare Agreement on the Old-Age Dependency Ratio
(Mandatory pensioners as a percent of working-age population)



Source: Ministry of Finance and IMF staff calculations

38. In order to simulate the effects of these two policy changes, I make the following adjustments to the baseline scenario:

- The labor force will increase significantly following the phasing in of the Welfare Agreement in 2019, as the age limits on retirement are gradually increased. All affected individuals are assumed to be pushed into the labor market as a result of the policy change. In reality, there will likely be some slippages, as some people elect to be out of the labor force or move into sickness or disability schemes.
- In addition, I also assume that the employment prospects of older workers will be improved by the Jobs Plan. In particular, labor force participation rates and employment rates for workers 60 to 70 years old are assumed to rise gradually, starting in 2009 and eventually yielding job performance on par with 55 to 60 year olds in 2008.

One important difference between these assumptions and those made by the Ministry of Finance is that they not include any effects from “healthy ageing”. In contrast, the Ministry of Finance (and some other studies) assume that a 70-year-old in 2050, for example, will be healthier than a 70-year-old today, and will require less health care and old-age care. This assumption is quite controversial – for example, the DREAM Model does not make these assumptions either.

39. **The simulated impact of these assumptions on the fiscal accounts are shown in Table 3.** There are several important features of these results. First, total expenditures in 2050 drop by more than four percentage points – from 61.6 to 57.3 percent of GDP.¹⁰ Not surprisingly, most of this drop comes from a decrease in pension expenditures, which account for about 2½ percentage points of the total decline. The rest of the decline is due to an increase in GDP, which lowers most other expenditure categories when expressed as a percent of GDP. Second, although pension expenditures fall sharply, the overall effects of ageing are not completely offset. This is because, although longevity has been rising for several years now, the increase in age limits does not start until 2019, and they essentially “grandfather” a large number of retirees that retire before 2019. In addition, those individuals that retire between 2019 and 2027 (when the Welfare Agreement is fully effective) still have longer retirements than today’s retirees. Third, the estimated costs of ageing with respect to health care and old age care are still substantial – increasing 7 percentage points from 2008 to 2050. Finally, it is important to note that the effects of the Welfare Agreement and the Jobs Plan – while substantial – are not enough to attain fiscal sustainability. Indeed, as the table shows, the fiscal sustainability gap is about 2 percent of GDP (compared to about 4 percent of GDP without the policy changes).

Other Policy Changes and Policy Proposals

40. **More recently, the authorities have initiated a number of new policy changes, which will be phased in over the next few years.** First, there was a cut personal income taxes, but this change was about offset by an indexation of energy taxes and a cancellation of a planned cut in the labor market contribution. Second, the continued tax freeze has led to a significant fall in some taxes, particularly property taxes. Third, new objectives to address energy and global warming challenges have also deteriorated long-term public finances (although these initiatives may yield some benefits in later years). Finally, there are announced initiatives to boost public consumption (including the recent wage hikes) and public investment. These initiatives are also hard to evaluate, since they have a negative effect on the fiscal balance in the short run, but could boost national income in the future, depending on the impact of public investment on the capital and the response of private investment. *The authorities have estimated that the overall effect of these policy changes is an increase in the sustainability gap of about ¾ percent of GDP.*

¹⁰ This estimate is somewhat less than the estimate provided by the Ministry of Finance in their 2007 Convergence Program. Indeed, the Ministry is more optimistic on almost all aspects of the calculation (discussed further above). In contrast, this estimate is much more in line with projections made by the DREAM Model and the Economic Council.

Table 3. Denmark: Effects of the Welfare Agreement on Fiscal Sustainability, 2008-2050
(Percent of GDP)

	2008	2015	2020	2030	2040	2050	Change 2008 to 2050
Revenues	52.6	52.6	52.6	52.6	52.6	52.6	0.0
Expenditures (excluding interest)	46.9	50.4	52.9	55.9	57.4	57.3	10.4
Public Consumption	26.3	28.1	29.5	31.9	33.2	33.6	7.3
Education	5.7	5.9	5.9	6.0	6.2	6.2	0.5
Health Care	9.5	10.6	11.4	12.9	13.5	13.8	4.3
Other Social Expenditures	5.7	6.2	6.7	7.6	8.1	8.2	2.6
Other Public Consumption	5.4	5.4	5.4	5.4	5.4	5.4	0.0
Transfer Incomes	16.1	17.8	18.9	19.5	19.6	19.2	3.1
Unemployment Benefits	2.0	2.0	2.1	2.2	2.3	2.3	0.3
Sickness and Maternity Leave	1.2	1.2	1.2	1.3	1.3	1.3	0.1
Educational Aid	0.6	0.7	0.8	0.7	0.7	0.8	0.1
Cash Benefits	0.5	0.6	0.6	0.6	0.7	0.7	0.1
Early Retirement Spending	3.6	3.6	3.7	4.1	4.0	3.7	0.1
Old Age Pensions	4.5	5.6	6.2	6.0	6.1	6.0	1.6
Other Transfers	3.7	4.1	4.3	4.4	4.5	4.4	0.7
Other Expenditures	4.5	4.5	4.5	4.5	4.5	4.5	0.0
Primary Structural Balance	5.7	2.2	-0.3	-3.3	-4.8	-4.7	-10.4
Sustainability Gap	--	2.1	2.1	2.1	2.1	2.1	
Sustainable Primary Balance	5.7	4.3	1.8	-1.2	-2.7	-2.6	-8.3
<i>Memo item:</i>							
Gross Debt (w/o adjustment)	20.0	-6.1	-9.7	14.3	61.3	112.1	92.1
Gross Debt (with adjustment)	20.0	-21.0	-35.6	-33.7	-9.1	20.0	0.0

Source: IMF staff calculations.

41. **Finally, the Labor Commission recently released a number of proposals to improve fiscal sustainability and boost labor supply over the long run.** The most important of these proposals (from a fiscal standpoint) is to bring forward the planned increases in age limits on pensions. Other proposals include a reduction in the duration of unemployment benefits from 4 years to 2 years, an increase the frequency of contact between the unemployed and the employment centers, a shift the focus of active labor market programs from education to on-the-job training, and an improvement in the recruitment of foreign labor. Based on an alternative simulation, bringing forward the age limits has a substantial effect on fiscal sustainability – about 2 percentage points of GDP. *In other words, if this proposal alone was implemented, the fiscal gap would be about ¾ of GDP.* The other proposals made by the Labor Commission are more difficult to evaluate in this framework, but it is likely that they would close the gap, and this is indeed the view taken by the Labor Commission itself.

REFERENCES

- Barro, Robert J., and Xavier Sala-i-Martin, 2004, *Economic Growth*, 2nd Edition, Cambridge, MA: The MIT Press.
- Blanchard, Olivier, Jean-Claude Chouraqui, Robert P. Hageman, and Nicola Sartor, 2004, “The Sustainability of Fiscal Policy: New Answers to an Old Question”, *OECD Economic Studies*, No. 15 (Autumn): 7-36.
- Borjas, George J., 2003, “The Labor Demand Curve *Is* Downward Sloping: Reexamining the Impact of Immigration on the Labor Market,” *Quarterly Journal of Economics*, November:1335-74.
- European Commission, 2005, “The Economic Impact of Ageing Populations on the EU25 Member States,” Economic Papers #236.
- International Monetary Fund, 2001, *World Economic Outlook*, Washington, DC.
- Ottaviano, Gianmarco I.P., and Giovanni Peri, 2006, “Rethinking the Effects of Immigration on Wages,” NBER Working Paper #12497.
- Schou, Poul, 2006, “Immigration, Integration, and Fiscal Sustainability,” *Journal of Population Economics*, 19:671-89.

II. LABOR MARKET REFORMS, CHANGING DEMOGRAPHICS, AND THE DANISH NAIRU¹

A. Overview

1. **Denmark's labor market performance during the last 15 years has been impressive.** The unemployment rate is 10 percent lower today than in 1994 and—barring the brief cyclical downturn of 2001–03—this decline has been uninterrupted. Surprisingly, this period saw no acceleration in wage and price inflation. This chapter argues that the simultaneously declining unemployment and non-accelerating wage rate of unemployment (NAIRU) reflect effects of both labor market reforms and favorable demographics, among other factors.

B. An Evolving Inflation-Unemployment Trade-Off

2. Denmark's unemployment rate—now at a 30 year low—has fallen by over 10 percent since 1994, yet wage and price inflation have been remarkably stable over this period (Figure 1). This represents a two-fold break from the past. First, unemployment rose as inexorably during the period between the first oil shock and mid-1994 as it declined thereafter. Second, the (negative) correlation between the acceleration of price inflation and the level of unemployment nearly vanished after 1994 while the correlation between the acceleration of real wages and unemployment became positive for the first time (Text table and Figure 2).

	Denmark: correlation between inflation acceleration and the unemployment rate		
	1967–2007	1967–1994	1995–2007
Price 1/	-0.29	-0.33	-0.02
Price 2/	-0.13	-0.14	-0.07
Real wage 1/	0.01	-0.01	0.11
Real wage 2/	0.15	0.04	0.82

Source: OECD and staff calculations.

1/ GDP deflator basis; 2/ CPI basis.

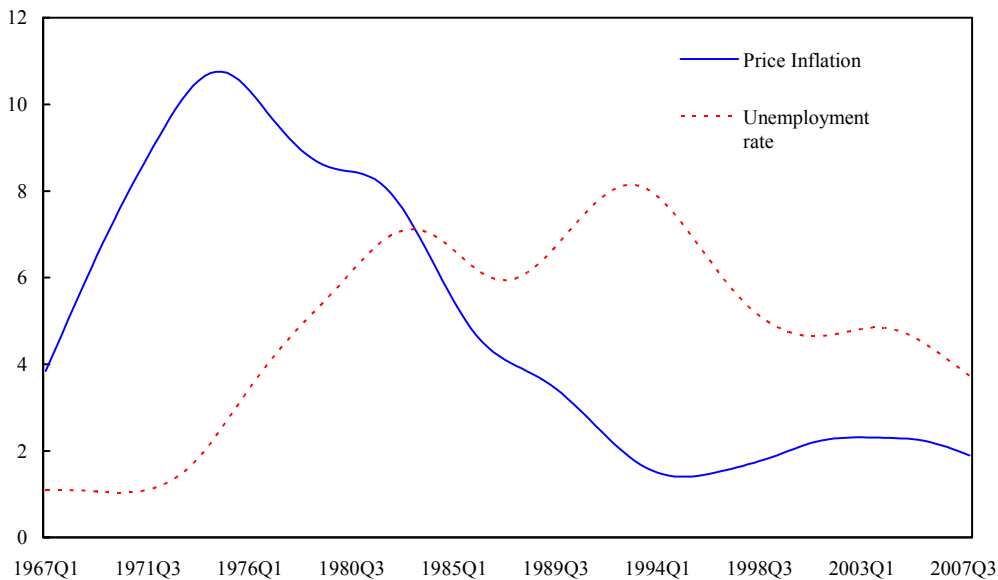
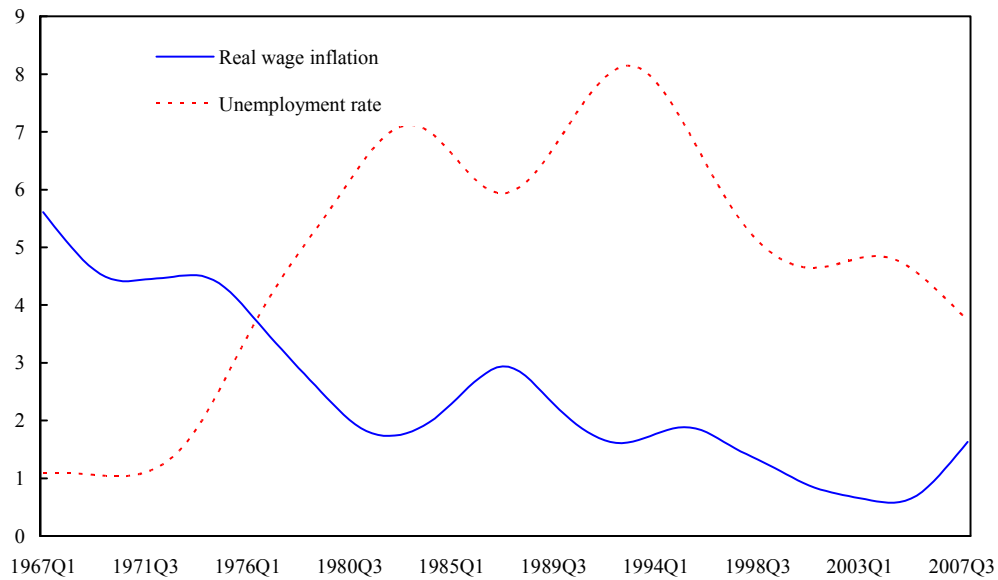
3. **The trend reversal in unemployment, and the trend-break in its correlation with inflation could reflect a decreasing NAIRU or a vanishing Phillips curve trade-off; in either case, the policy implications are important.**² Should the evidence suggest a time-varying NAIRU, this begs the question of what caused the trend in the NAIRU to reverse in the mid-1990s. On the other hand, if evidence points to a vanishing Phillips curve, this could

¹ Prepared by Jay Surti (EUR).

² A similar phenomenon of trend reversal in unemployment and a waning trade-off with inflation was noted in the U.S. during the 1990s, and instigated several studies of the robustness of the Phillips curve relation, the evolution of the NAIRU, and reasons for its apparent decline. Ball and Mankiw (2002) and Blanchard and Katz (1999) provide partial surveys of both, the underlying issues and the literature. King and others (1995) carried out an early empirical reassessment, followed by the studies of Gordon (1998) and Staiger and others (1997, 2001).

indicate that the channels by which demand impacts the level and volatility of inflation are not captured by the unemployment gap alone. Other macro-aggregates, financial indicators, (and models) may be better predictors of inflation (e.g., Stock and Watson, 1999), and, therefore, better guides to anti-inflationary policy. In the current environment, where unemployment rates have reached lows last seen before 1973 and are leading to the emergence of wage pressure, answers to these questions have an immediate policy relevance.

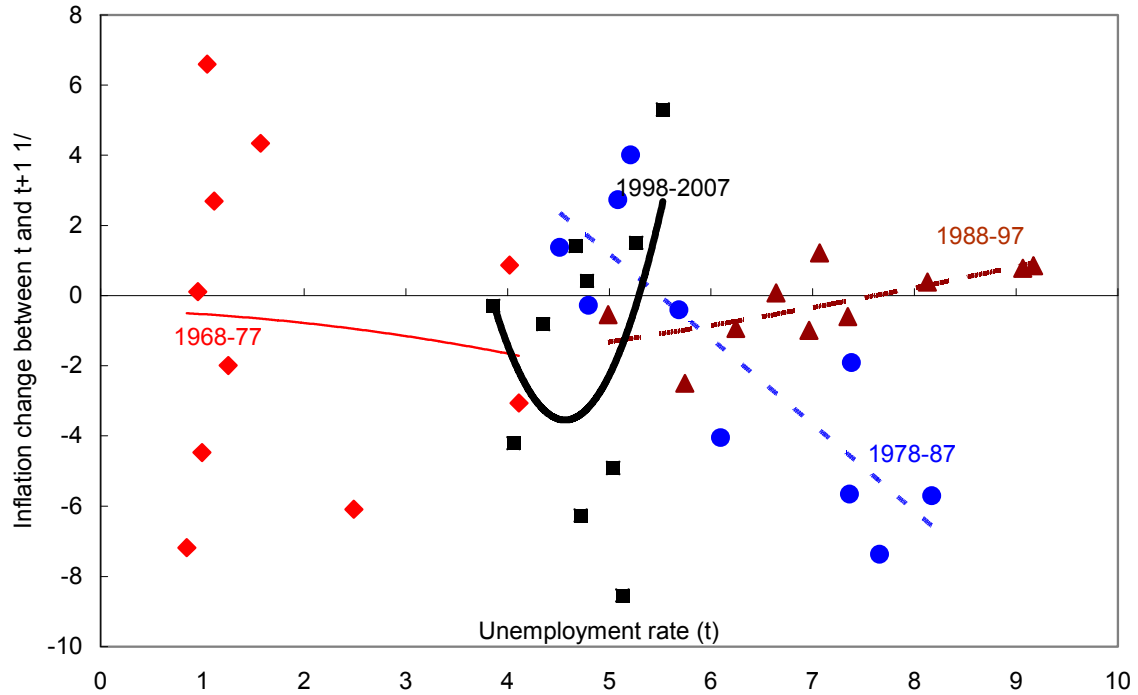
Figure 1. Denmark: Trend Inflation and Unemployment, 1967-2007
(Percent)



Source: OECD and own calculations.

Note: Price inflation is annual change in annual change in log GDP deflator; real wage is GDP deflator-deflated nominal wage.

Figure 2. Denmark: Real Wage Inflation and Unemployment, 1968-2007
(Percent)



Source: OECD and own calculations.

4. In subsequent sections, we assess the role of two sets of factors that could have led to a decline in the NAIRU and a flattening of the Phillips curve: the comprehensive labor market reforms beginning in the early 1990s, and favorably evolving labor market demographics. Subsequently, we utilize a simple varying-coefficients regression model to assess whether the apparently weakening relationship between inflation and unemployment is due to a declining NAIRU or a vanishing Phillips curve. Our analysis leads us to conclude that the NAIRU has declined, but evidence suggests a robust and stable Phillips curve.

C. What May have Lowered the NAIRU?

Labor market reforms

5. **Since 1992, several components of Denmark's unemployment insurance (UI) benefits system have been changed with a view to providing a greater incentive and opportunities to return to employment faster.**³

- The duration of UI benefits has been cut from 5 years to 4 years.
- Replacement rates—the ratio of income under UI schemes to income in employment—have been lowered, particularly for higher-skill classes and people at the higher end of the wage distribution.
- The focus on activation—consisting of temporary jobs in the private or public sector, retraining, or an education program for UI beneficiaries—has been gradually increased since the 1990s. Participation in activation schemes is now mandatory. Moreover, whereas in the past activation would take place after at least two years, this delay was shortened over the 1990s, and eventually eliminated. Under current rules, activation may now occur any time after an individual enters the UI benefits scheme. The likelihood of activation—low in the first year—is stepped up after 52 weeks, and stays high thereafter.
- Finally, the UI rules have been changed such that going through an activation program no longer guarantees a return to a period of income at UI replacement rates. Rather, post-activation, the unemployed revert to benefits under social assistance programs typically offering substantially lower replacement rates.

6. **Evidence suggests that these reforms have raised employment levels, and reduced unemployment duration (Table 3).**⁴ Compared to a decade earlier, the number of labor force participants registering as unemployed fell by over 280,000—or about 10 percent

³ For a comprehensive overview of the various reforms implemented in the last 15 years, see for e.g., Andersen and Svårer (2007).

⁴ A theoretical treatment of how unemployment duration may affect the hazard rate out of unemployment into employment—negative duration dependence—is contained in Blanchard and Diamond (1989); Blanchard and Katz (1999) reflect on macroeconomic implications of negative duration dependence, and consequently, of labor market reforms for the NAIRU. For Denmark, in a study of the labor market in the 1980s, Rosholm (2001) concluded available evidence as providing no support for the hypothesis of negative duration dependence, neither at long durations, nor when aggregate unemployment is high.

of the estimated 2007 labor force. Average unemployment duration—on a mid-point of range basis—fell from 120 days to 91 days over this period, with 80 percent of the unemployed returning to employment within 6 months in 2007 as compared to 70 percent a decade earlier. Recent studies of Danish labor market performance (Geerdsen, 2006; Rosholm and Svårer, 2004) have attributed a major share of these gains to the increased emphasis on activation programs and their intensified application to UI beneficiaries.

Activation is perceived to lower the benefit from remaining unemployed—for example having to work at lower wages than in regular employment rather than enjoying UI benefits “for free”. The

greater likelihood of activation, particularly after 12 months is an implicit *threat* which induces the unemployed to intensify efforts to move back to employment prior to entering this phase (the so-called *threat effect*). Rosholm and Svårer (2004) and Svårer (2007) estimate that the threat effect of active labor market programs has reduced unemployment duration for men by 10 percent.

Denmark: Unemployment duration		
1,000 persons	1997	2007
<i>Total</i>	697	413
<i>of which:</i>		
< 73 days	338	247
	48.5%	59.8%
73–146 days	136	80
	19.5%	19.4%
147–219 days	86	46
	12.3%	11.1%
220–292 days	60	24
	8.6%	5.8%
> 292 days	77	16
	11.0%	3.9%

Source: Statistics Denmark

7. **Intensified activation—by lowering the expected value of UI benefits to the employed—may also have lowered the hazard rate from employment into unemployment and moderated wage demand.**⁵ This so-called *wage effect* would simultaneously lower trend unemployment and weaken the inflationary response to labor market tightening implying a flatter Phillips curve as implied by the analysis.

The role of demographic factors

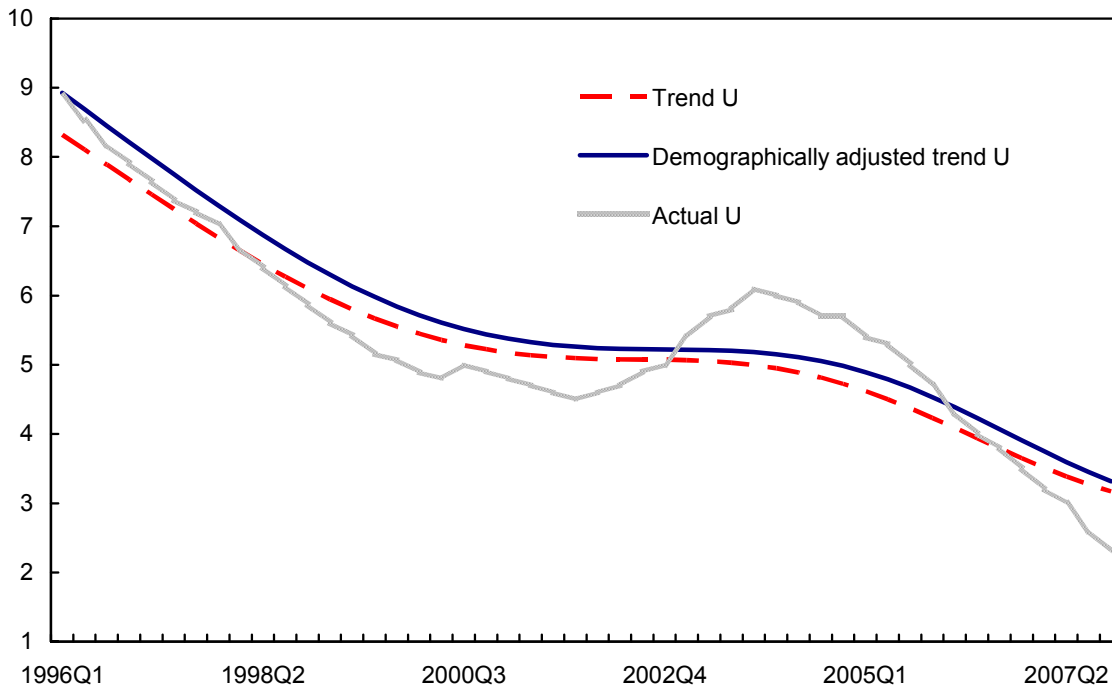
8. **The change in the Danish labor force’s composition has been favorable to lower trend unemployment and a weaker trade-off with inflation (Figure 3).** From 62 percent of the labor force in 1980, the share of the 30–59 age group increased to 65 percent by 1990, and further to 72 percent in 2007. There are a number of reasons why people in this age group may be expected to have lower unemployment rates than others in the labor force. On the supply-side, they have completed education—meaning they have more time to devote to full-time work⁶—and the fact that they have young children—or children in college—lowers their

⁵ Andersen and Svårer (2007).

⁶ Education costs in Denmark are not high as is the case in the U.S., otherwise paying off student loans would provide an additional incentive to stay employed, lowering their reservation wage.

reservation wage. On the demand-side, their experience—relative to younger age groups—and age—relative to older age groups—imply a favorable productivity differential relative to the population average. In order to test for whether demographic changes could have lowered trend unemployment, we run a simple test devised by Perry (1970),⁷ wherein we calculate a *demographically adjusted* unemployment rate by fixing population weights for age groups as in 1996. The results indicate that trend of actual unemployment is consistently below the trend of demographically adjusted unemployment, indicating that favorable demographics as potentially lowering trend unemployment by an average of about 30 basis over 1996-2007. As demographics have started changing unfavorably of late—with an increase in the proportion of 60 years and older people in the labor force—the gap between the two trend rates has fallen recently, and may be expected to close over the medium-term.⁸

Figure 3. Denmark: Trend Unemployment Rates: Actual and Demographically Adjusted
1996-2007



Source: Statistics Denmark and own calculations.

⁷ Ball (1997) applies Perry-weighting to assess the impact of unfavorably changing demographics on rising trend unemployment in the OECD countries during the 1980s.

⁸ See Chapter I of this Selected Issues Paper.

D. Specification and Estimation of Macro Wage Equation

9. **In choosing a specification, a natural starting point is to constrain expectations to not deviate systematically from the predictive implications of the trend properties of key data series.** Accordingly, we begin by examining the dynamic properties of prices, wages, unemployment, and productivity. Our objective is to determine their orders of integration, and to test for cointegration, which will subsequently guide the choice of specification for expected inflation.

*Trend properties of the data*⁹

10. **Analysis of key data series supports the hypothesis of cointegration of price inflation with nominal wage inflation less productivity growth.**¹⁰ Price inflation, nominal wage inflation, and unemployment show considerable trend variability (Figure 4a). The hypotheses of unit roots in these series cannot be rejected (Table 1). Real wage growth—regardless of the chosen price index—and labor productivity growth also exhibit considerable trend variability and the hypothesis of a unit root in these series cannot be rejected either (Table 1 and Figure 4b). However, decade-long changes in real wage growth are broadly in line with changes in labor productivity growth; they fall substantially in the late 70s—early 80s from the high averages of the earlier decade, hold steady during the late 80s—early 90s, and fall again in the last 10 years of the sample. Average real wage growth adjusted for productivity growth changes little over the four decades, and unsurprisingly, the hypothesis of a unit root in productivity growth-corrected-real wage growth is rejected. To summarize, price inflation and (nominal) wage inflation less productivity growth are $I(1)$, and real wage growth less productivity growth is $I(0)$.

⁹ Most data series are taken from the OECD's analytical database and are at quarterly frequency. The sole exception is data on the age composition of the labor force which was obtained from Statistics Denmark.

¹⁰ The estimated cointegrating vector being $(1, -0.8)$.

Table 1. Descriptive Statistics for Trend Characteristics of the Data

Series	Sample Mean				Unit root 3/
	67Q1- 76Q4	77Q1- 86Q4	87Q1- 96Q4	97Q1- 07Q4	
Price inflation 1/	8.4	7.4	2.5	2.1	Y
Price inflation 2/	7.8	8.4	2.7	2.0	Y
Nominal wage growth	12.9	9.8	4.5	3.1	Y
Nominal wage–Productivity growth rate	9.1	7.4	2.1	2.1	Y
Real wage growth 1/	4.5	2.3	2.0	1.0	Y
Real wage growth 2/	5.1	1.4	1.8	1.0	Y
Real wage–Productivity growth rate 1/	0.7	-0.1	-0.3	0.0	N
Productivity growth rate	3.8	2.4	2.4	1.0	Y
Real wage / Productivity, 1/	0.5	0.5	0.5	0.5	Y
Real wage / Productivity, 2/	0.5	0.5	0.5	0.5	Y
Unemployment rate	1.7	6.1	7.1	4.7	Y

Source: Own calculations.

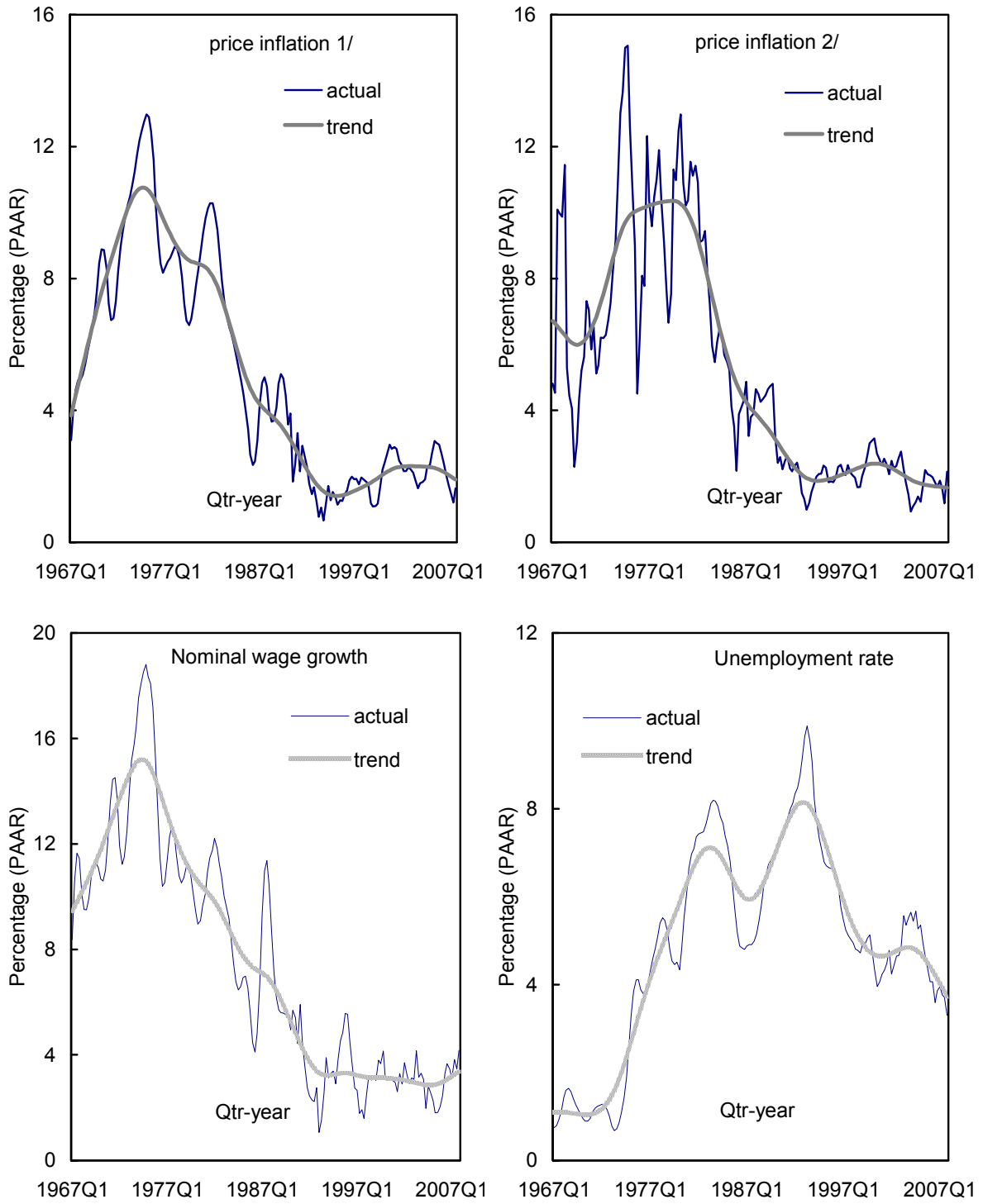
1/ GDP deflator basis.

2/ CPI basis.

3/ Y: cannot reject at 10%; Y: rejected at 10%, not at 5%; Y: rejected at 5%, not at 1%; N: rejected at 1%

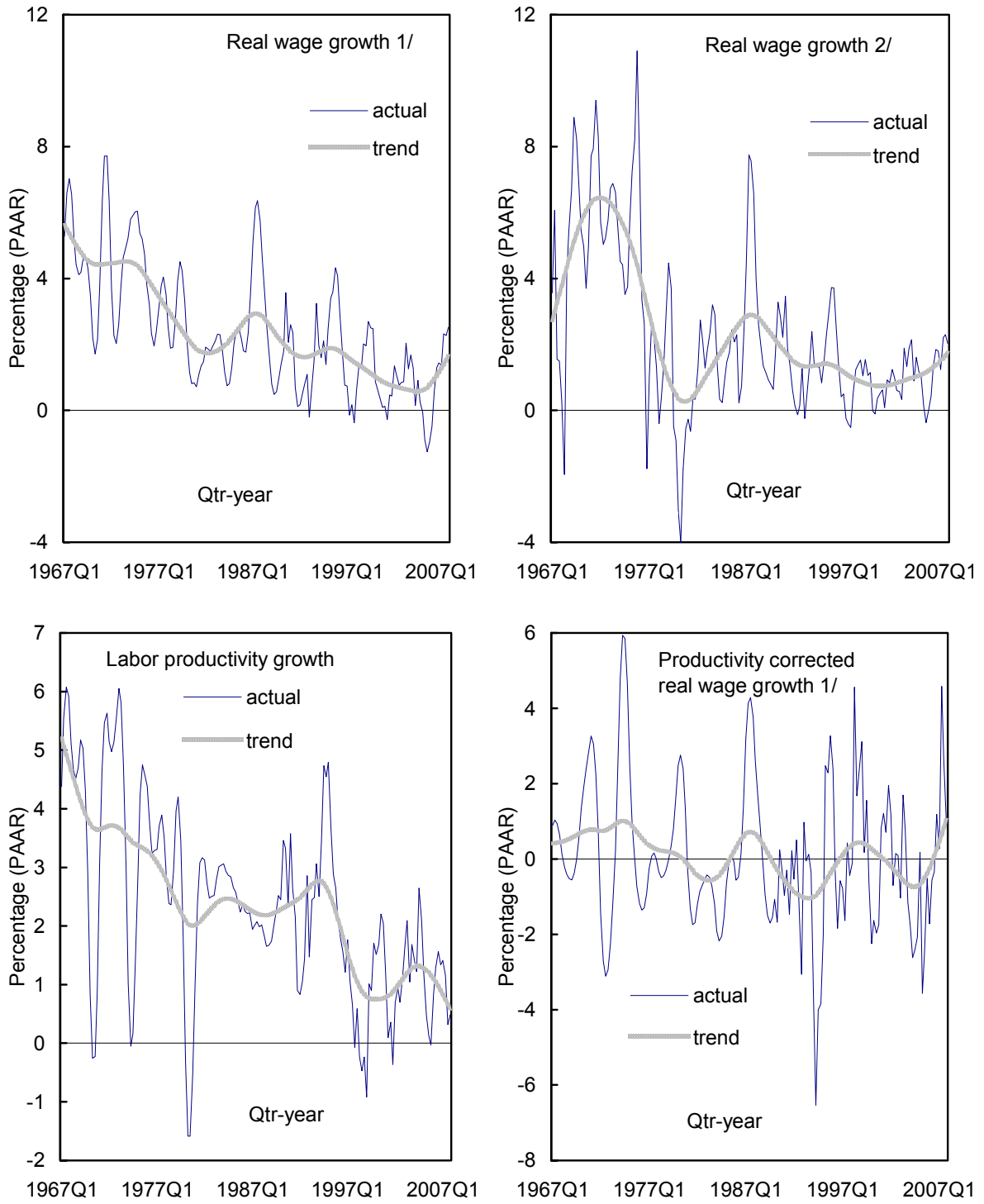
ADF test of null of unit root in level series; test for 1st differences rejected corresponding null for all series.

Figure 4a. Denmark: Trends in Unemployment and Price and Wage inflation, 1967-2007



Sources: OECD and own calculations.
 1/ GDP deflator basis.
 2/ CPI basis.

Figure 4b. Denmark: Trends in Real Wage and Productivity Growth, 1967-2007



Sources: OECD and own calculations.
 1/ GDP deflator basis.
 2/ CPI basis.

Specification of the wage equation and estimated path of the wage-NAIRU

11. **Nominal wage less productivity is cointegrated with price inflation; rational expectations implies that their difference be modeled as a stationary stochastic process.** In order to capture lag dynamics properly, expected price and real wage inflation ought to be modeled as a pair of dynamic equations with common lag structure and covariates.¹¹ In a small open economy context like Denmark, however, focus may more fruitfully be restricted to estimation of a expected wage inflation—satisfying the expectational constraint outlined above—and core price inflation. This is because headline price inflation (e.g., the percentage change in GDP deflator or the CPI), contains a larger-than-desirable amount of noise from trade prices, and prices of food and oil. However, as core price inflation entailed a substantial left-truncation of the data series, the present chapter focuses on estimation of a macro wage equation alone.

12. **The following equation is estimated**¹²

$$\begin{aligned} v_{t+1} &= \beta_u (u_t^{HP} - u_t^*) + \alpha_{\omega\pi}(L) \Delta\pi_t + \alpha_{\omega\omega}(L) v_t + \beta_u (u_t - u_t^{HP}) + \alpha_{\omega u}(L) \Delta u_t + \gamma_\omega Z_t + \varepsilon_{\omega t}; \\ u_t^* &= u_{t-1}^* + \eta_{\omega t}; \\ v_{t+1} &= \omega_{t+1} - \pi_t - \theta_t \end{aligned} \quad (1)$$

where

ω_t ; nominal wage inflation in period t ; π_t : price inflation (GDP deflator basis)
 θ_t ; (labor) productivity growth in period t ; Z_t : exogenous macro-financial covariates
 u_t^* ; (time-varying) wage – NAIRU; u_t^{HP} : HP-filtered unemployment rate

Equation (1) is the (real) wage Phillips curve—the dependent variable is the productivity corrected real wage—embedded in a state-space system, wherein the state variable—the

¹¹ Staiger and others (2001) discuss of the underlying rationale.

¹² The methodology is quite standard, and entails simultaneous estimation of the NAIRU and the Phillips curve via a Kalman smoother applied to a state-space model. See e.g., Gordon (1998), and Staiger and others (1997, 2001) for details.

wage-NAIRU is assumed to follow a unit root process.¹³ The variables u_t, u_t^{HP}, Z_t are treated as exogenous. The maximum likelihood estimate of the wage NAIRU is given by:

$$\hat{u}_t^* = u_t^{HP} - \frac{\hat{c}_t}{\hat{\beta}_u}; \hat{c}_t = MLE\left(\beta_u(u_t^{HP} - u_t^*)\right)$$

13. **Assuming a stable wage Phillips curve, the change in wage inflation appears procyclical, and the wage-NAIRU has fallen an estimated 3½ percent since 1990 (text table and figure 5).** Moreover, there is little difference between the wage-NAIRU resulting from the estimated wage equation (1), and the univariate (HP) trend in unemployment.

Estimated path of the wage NAIRU, 1970–2007		
	HP trend	NAWRU (S.E.)
1970	1.04	1.52 (0.20)
1980	6.29	6.26 (0.18)
1990	7.46	7.20 (0.18)
2000	4.65	4.63 (0.18)
2007	3.73	3.79 (0.25)
Phillips curve slope (S.E.)		-0.71 (0.14)
[p-value]		[0.00]
Regression S.E.		0.75

Source: Own calculations.

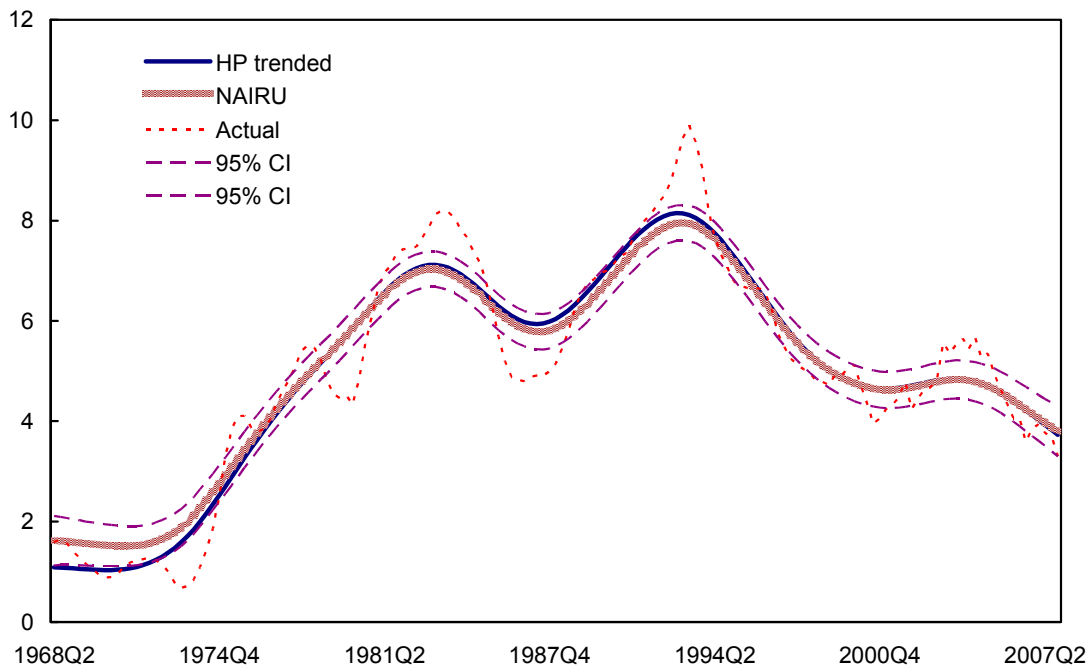
Note: The equation was estimated using 4 lags of change in inflation, 4 lags of the dependent variable, 2 lags of change in unemployment, exogenous variables including 2 lags each of global food and oil price inflation and of percent change in the trade-weighted exchange rate.

14. **Testing for a time varying Phillips curve indicated that the wage Phillips curve has been stable since 1994, although its slope exhibits greater time variation over the whole sample period (Figures 6 and 7).** While decennial curve-fitting of actual data on inflation acceleration against the rate of unemployment one period back (Figure 2) indicated

¹³ Alternative specifications of the NAIRU process; for e.g., an AR(1) specification did not yield materially different results.

that the *slope* of the Phillips curve itself may be time-varying, (1) assumes a temporally stable relationship. In this context, it was essential that the specification be extended to allow for the possibility of changes in the slope. Consequently, we estimated a variant of (1) with constant intercept, but time varying slope coefficient. Specifically, the slope coefficient, β_u , is modeled as a random walk.

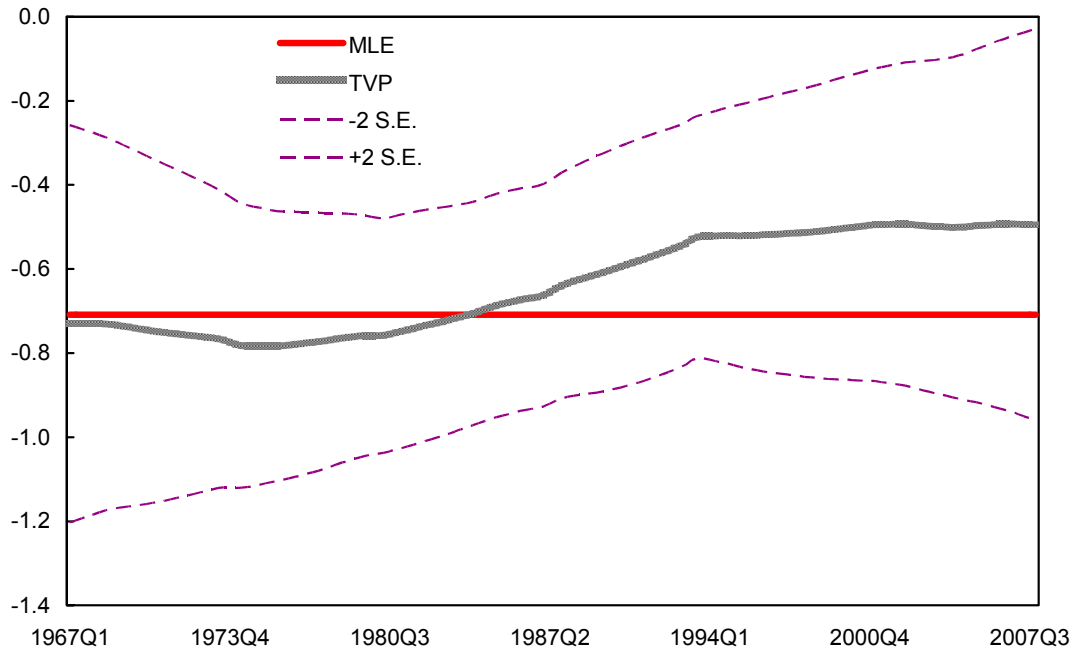
Figure 5. Denmark: Wage NAIRU and Trend Unemployment, 1967-2007
(Percent)



Source: Own calculations.

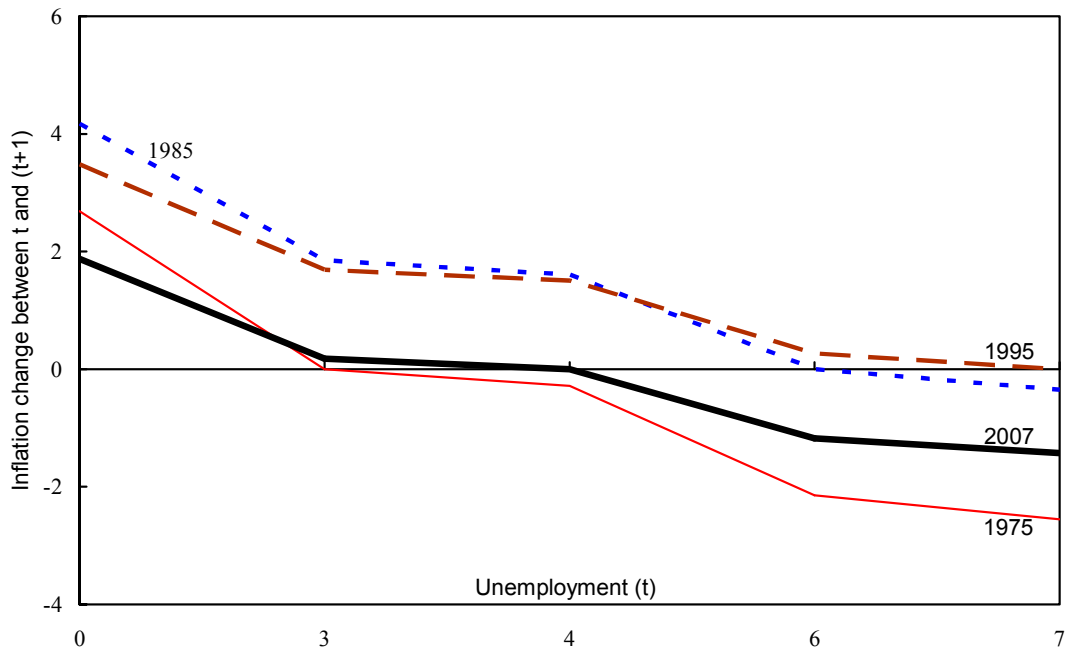
15. **The results above indicate that despite a stable Phillips curve, the secular decline in unemployment since the early 1990s has not led to accelerating inflation due to a falling NAIRU.** However, the current unemployment rate is far below the NAIRU, and the stability of the Phillips curve indicates that wage—and consequently, core price—inflation will be pushed up as a result. Recent data on these two variables confirm that this is indeed the case. Apart from this positive finding, the results also indicate that the unemployment gap—relative to the NAIRU—continues to be a useful guide to anti-inflationary policy.

Figure 6. Denmark: Slope Estimate of the Wage Phillips Curve, 1967-2007



Source: Own calculations.

Figure 7. Denmark: Evolution of the Wage Phillips Curve, 1975-2007



Source: Own calculations.

REFERENCES

- Andersen, Torben and Michael Svårer (2007), “Flexicurity—Labor Market Performance in Denmark”, *CESifo Economic Studies*, vol. 53, pp. 389–429.
- Ball, Laurence (1997), “Disinflation and the NAIRU”, in *Reducing Inflation: Motivation and Strategy* edited by Christina Romer and David Romer, pp. 167–94. Chicago, IL: University of Chicago Press for the NBER.
- _____ and N. Gregory Mankiw (2002), “The NAIRU in Theory and Practice”, *Journal of Economic Perspectives*, vol. 16, pp. 115–36.
- Blanchard, Olivier and Peter Diamond (1994), “Ranking, Unemployment Duration, and Wages”, *Review of Economic Studies*, vol. 61, pp. 417–34.
- Blanchard, Olivier and Lawrence Katz (1999), “What We Know and Do Not Know About the Natural Rate of Unemployment”, *Journal of Economic Perspectives*, vol. 11, pp. 51–72.
- Gordon, Robert J. (1998), “Foundations of the Goldilocks Economy: Supply-Shocks and the Time Varying NAIRU”, *Brookings Papers on Economic Activity*, 2, pp. 297–333.
- Jensen, P., Michael Rosholm, and Michael Svårer (2004), “The Response of Youth Unemployment to Benefits, Incentives, and Sanctions”, *European Journal of Political Economy*, vol. 19, pp. 301–16.
- King, Robert, James Stock, and Mark Watson (1995), “Temporal Instability of the Unemployment–Inflation Relationship”, *Economic Perspectives of the Federal Reserve Bank of Chicago*, pp. 2–11.
- Perry, George (1970), “Changing Labor Markets and Inflation”, *Brookings Papers on Economic Activity*, 3, pp. 411–48.
- Rosholm, Michael (2001), “Cyclical Variations in Unemployment Duration”, *Journal of Population Economics*, vol. 14, pp. 173–91.
- Rosholm, Michael and Michael Svårer (2008), “Estimating the Threat Effect of Active Labor Market Programmes”, *Scandinavian Journal of Economics*, vol. 110, pp. 385–401.

Svårer, Michael (2007), “The Effect of Sanctions on the Job Finding Rate: Evidence from Denmark”, IZA Discussion Paper 3015.

Staiger, Douglas, James Stock, and Mark Watson (1997), “How Precise are Estimates of the Natural Rate of Unemployment?”, in *Reducing Inflation: Motivation and Strategy* edited by Christina Romer and David Romer, pp. 195–242. Chicago, IL: University of Chicago Press for the NBER.

_____ (2001), “Prices, Wages, and the U.S. NAIRU in the 1990s” in *The Roaring Nineties* edited by Robert Solow and Alan Krueger, pp. 3–60. New York, N.Y.: Russell Sage Foundation/The Century Fund.

Stock, James and Mark Watson (1999), “Forecasting Inflation”, *Journal of Monetary Economics*, vol. 44, pp. 293–335.