



**Ministry of Finance  
of the Czech Republic**

# **Working Paper**

# **Modelling the Czech Pension System**

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# Modelování českého penzijního systému

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## Abstrakt

Výzkumná studie pojednává o důchodovém systému České republiky a přístupu MF ČR k projektování budoucích důchodových výdajů. V první části shrnuje hlavní rysy českého penzijního systému optikou současné legislativy; charakterizuje jednotlivé druhy důchodů, které spadají do důchodového pojištění v České republice: starobní důchody, invalidní důchody (plné i částečné) a pozůstalostní důchody (vdovské, vdovecké a sirotčí).

Druhá část představuje modelový aparát vytvořený a používaný Ministerstvem financí pro tvorbu dlouhodobých projekcí výdajů jednotlivých částí důchodového systému. Tento model se skládá ze tří stavebních bloků. V rámci prvního bloku jsou kalkulovány počty jednotlivých vyplácených důchodů na základě pravděpodobnostního přístupu. Ve druhém bloku je kalkulována výše jednotlivých nově přiznaných důchodů s využitím důchodové formule definované zákonem o důchodovém pojištění. Třetí blok spojuje informace z předchozích dvou bloků, což umožňuje vyčíslit průměrný důchod a celkové výdaje za všechny typy důchodů v jednotlivých letech projekce. Studie rovněž v grafické podobě prezentuje hlavní výsledky získané aplikací prezentovaného modelu.

Tato studie vznikla v souvislosti s působením českých zástupců v pracovní skupině pro fiskální dopady stárnutí populace (AWG) při EPC. V této skupině byla studie, včetně výsledků projekcí, oponována na jednom z jejích pravidelných zasedání dne 17. října 2005.

# Modelling the Czech Pension System

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\* This study is the result of work of the Department for Financial Policies, Fiscal Forecasting and Economic Modelling Unit of the Ministry of Finance Czech Republic.

The model described was used for making long term pension projections, which are part of the long term budgetary exercise carried out by the AWG under EPC. This study and results of the model were examined by the AWG on October 17, 2005.

## **Abstract**

This study deals with the pension system of the Czech Republic and sheds light on the approach of the Czech Ministry of Finance to projecting future pension expenditures. The first part summarises key features of the Czech pension system embedded in the present legislation; it describes all types of pension benefits granted under the provisions of the Pension Insurance Act: old age pension, disability pensions (full and partial disability pension) and survivor's pensions (widow's/widower's and orphan's).

Second part of the paper presents the pension model that has been built and used by the Ministry of Finance of the Czech Republic to make long-term projections of spending on all the different pension benefits. This model consists of three main building blocks. The first block calculates the number of pensions on the basis of a probabilistic approach. The second block computes the level of new pension benefits using the pension formulae, stipulated by the Pension Insurance Act. The third block combines the information from the previous two blocks, which allows to calculate an average pension benefit and spending on all pension benefits in the projection horizon. The study also contains charts with some of the most important projection results.

The creation of this study was motivated by participation of Czech delegates in the Ageing Working Group (AWG) attached to the EPC under European Council. The study and results of the model were examined by the AWG on October 17, 2005.

# 1 Key characteristics of the pension system

The pension system consists of two pillars – a mandatory PAYG state system with defined benefits and voluntary fully funded private system with defined contributions. There is no occupational pension scheme (usually referred to as the second pillar) in the Czech pension system.

## 1.1 Mandatory PAYG state system

The first pillar is a mandatory basic pension insurance scheme, based on the pay-as-you-go financing and defined benefits (DB). It covers all economically active persons and it does not contain any special pension scheme for any economic sector. The only exceptions are so-called armed forces (e.g. soldiers, policemen, custom officers, fire-fighters), whose pension insurance is administered by the particular ministries in charge. All others are administered by Czech Social Security Administration.

The basic pension insurance covers the whole population regardless of the actual economic activity of a person. A wide range of so-called non-contributory periods allows gaining pension entitlement at the time of person's non-activity at the labour market (one does not have any income from which the contribution is derived). So the system does not exclude those, whose career has been interrupted for many reasons. The are following non-contributory periods:

- Study period– high school or college/university studies from 18 years of age. A person can have up to 6 years of this non-contributory period at the most.
- Unemployment period while a person is in the evidence of the employment office and while he/she is eligible for unemployment benefits plus 3 years without eligibility for unemployment benefits at the most.
- Childcare period is accepted up to a child's age of 4 years. This period is acceptable for both parents, but not at the same time.
- Period of care for a disabled and care of old relatives aged 80 and higher.
- Military service.

Besides the solidarity of economically active persons with non-active ones, there is another type of solidarity within a generation – income solidarity. This solidarity is achieved through the formulae used to calculate pension benefits. It leads to higher replacement rates for lower-income persons compared to those with higher income. It prevents certain population groups from falling into poverty.

Main and the only source of income of the state pension system are pension insurance contributions. Currently the contribution rate amounts to 28 % of the gross income.<sup>1</sup> This contribution rate is aggregate<sup>2</sup> and is not distributed among particular subsystems of pension insurance.

Self-employed pay the same contribution rate. However, their calculation base represents 50 % of the difference between incomes and expenses, but the base must amount to at least a half of the average gross monthly wage in the national economy.<sup>3</sup>

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<sup>1</sup> Contributions are partly paid by employee (6,5 %) and partly by employer (21,5 %).

<sup>2</sup> There are no special rates for different pension benefits.

<sup>3</sup> The calculation base has been gradually rising from 35 % of the difference between incomes and expenses in 2003 up to 50 %, which will be reached by 2006.

The state pension system covers three main benefits – old-age pension, disability pension and survivor’s pensions:

(1) To be entitled to an old age pension a person has to reach an insurance period of at least 25 years and a retirement age specified by a law; or at least 15 years of insurance and the age of 65. Non-contributory periods are also included in the insurance period. Additional working activity, while receiving the old age pension after the statutory retirement age, is allowed under a condition that working contract lasts one year at the most<sup>4</sup>.

A person can retire up to 3 years prior the statutory retirement age if he/she has at least 25 years of insurance period; but he/she obtains permanently reduced early old age pension. Retirement in ages higher than the statutory retirement age is awarded by additional bonuses.

(2) Disability pensions occur in two forms. (i) Full disability – when a person has experienced a decline in his/her working capacity of at least 66 %; (ii) partial disability – a decline of at least 33 %. The required insurance period is at least 5 years<sup>5</sup> (it is derived from the ten year period prior to the occurrence of disability).

Disability pension usually belongs to a person until he/she reaches entitlement for the old age pension.<sup>6</sup> Subsequently a person is transferred from the disability pension scheme to the old age pension scheme.

(3) Survivor’s pensions are paid out to a widow/widower or an orphan (dependent child) if a deceased person has met conditions for eligibility for the old age or disability pension or he/she died due to job-relating injury. After one year of receiving the survivor’s pension, the widow/widower must meet other conditions stipulated by the law, otherwise the entitlement lapses (the entitlement continues when the widow/widower cares for a dependent child or disabled child, parents or relatives aged 80 and higher; or when a widow/widower is disabled or he/she has reached the age 58). The entitlement is also renewed when at least one of these conditions is met within 5 year from the last entitlement termination. Orphan’s entitlement to survivor’s pension lasts until he/she is dependant but not beyond the age of 26.

## **1.2 Voluntary fully funded private system**

This pillar (known as the third pillar) is voluntary, supplementary, fully funded and state-subsidized pension scheme based on defined contribution (DC). It also includes life insurance as a product of commercial insurance companies. The insurance can be contracted by any Czech or other EU citizen aged 18 and over, who participates in the state pension system or the public health insurance scheme in the Czech Republic. Besides the state subsidy any employer can support his employees with additional contribution to employee’s fund. Both, employer’s and employee’s contributions are subject to additional tax allowances.

## **1.3 Recent reforms**

Since 1989 onwards the pension system has undergone many reforms, many of which were taken soon after the political changes. For example:

- All economically active persons started to acquire future pension entitlements due to removing the discrimination of self-employed persons. The pension system became uniform in the sense of entitlements.
- Administration of the pension insurance and the sickness insurance merged in the Czech Social Security Administration.

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<sup>4</sup> After that year the contract can be renewed, but again for one year only.

<sup>5</sup> Applies for persons above the age 28. Younger people are required to reach shorter insurance period.

<sup>6</sup> Respectively, until he/she reaches the retirement age qualified by the law.

- Rules for pension indexation were introduced.
- Pension contributions were established. These contributions became revenue of the state budget.
- In 1994 the Act on the State-subsidized Supplementary Pension Insurance Schemes<sup>7</sup> was passed introducing the two-pillar pension system.
- In 1995 the new act on Pension insurance<sup>8</sup>, with effect from the year 1996, was approved. It brought several important measures: gradual rise in retirement age; wage development was taken into the consideration in the assessment of the pension level; equal treatment of men and women in pension entitlements, especially in survivor's pensions.

After 1995 some more measures were taken to stabilize the current pension system:

- Revenues and expenditure of the state pension system were detached from the state budget, however only in accounting sense – revenues and expenditure are still a part of the state budget but possible excess of revenues over expenditures cannot be used to finance other spending. The accounting separation has allowed monitoring the balance of the pension system and using the possible assets to increase benefits or to cover pension deficits only.
- Solidarity with non-active people was decreased by restrictions in the crediting of non-contributory periods.
- The third pillar was encouraged by an amendment of State-subsidized Supplementary Pension Insurance Act, strengthening the safety (more stringent conditions set for the pension plans) and encouraging private deposits (introducing tax allowances for participants, an increase in the state contribution).
- It has been decided on gradual increase of the minimum calculation base for pension contributions paid by self-employed persons.
- Indexation became regular, taking place in January every year. Its rules became also stricter. Decision about the indexation is based upon final statistics and not upon estimates of key indicators only (as was the case before). It is allowed to make an exceptional indexation (not at regular date) in case of substantial price increase.<sup>9</sup>

Recent measures – since 2003

- Increase in retirement age has been prolonged so that the age limit will reach 63 years for men and childless women. The age limit remains differentiated for women according to number of their children<sup>10</sup> (see following graph).

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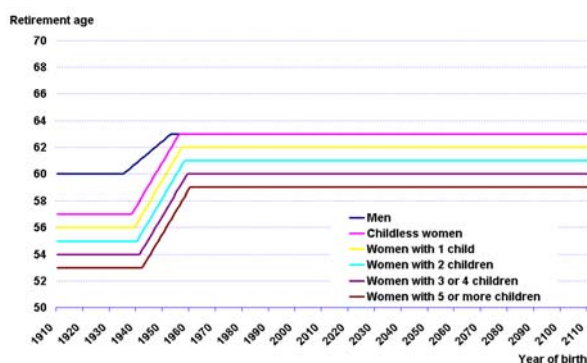
<sup>7</sup> Act No. 42/1994, on State-subsidized Supplementary Pension Insurance Schemes.

<sup>8</sup> Act No. 155/1995, on Pension Insurance.

<sup>9</sup> If the aggregate consumer price index rises by at least 5 % since the last indexation took place.

<sup>10</sup> The retirement age is different for men and women and for both is rising gradually – 2 months per year for men and 4 months per year for women – up to the age of 63 for men and childless women and up to 59-62 for women (it differs according to number of children: 1, 2, 3 or 4 and 5 and more).

**Figure 1: Retirement age by the year of birth**



- Conditions for the early retirement became stricter. There used to be two types of early retirement schemes: (i) Early retirement for labour market reasons with a temporarily reduced old age pension – a person receives the reduced pension until he/she reaches the retirement age, then he/she receives the regular pension. This scheme was cancelled; (ii) early retirement with a permanently reduced old age pension – a person receives reduced pension all the time. This option was preserved.
- An additional working activity, while receiving the old age pension, was made easier by abolishing some conditions that had to be met (e.g. formerly a retired person could work only for two years from his/her retirement in case that his/her income did not exceed an income limit set by the law). Now the only condition is, that a working contract can last one year at the most.<sup>4</sup>

## 1.4 Basis for pension calculations

The basic act that determines calculation of pension benefits is the Pension Insurance Act (No. 155/1995). Pensions<sup>11</sup> consist of two main parts:

- **Flat rate component** is the same for all pensions regardless of the insurance period acquired and earnings achieved.
- **Earnings related component** derived from the insurance period and earnings achieved. It is calculated as a percentage of personal calculation base, which takes into consideration person's income up to 30 years<sup>12</sup> prior his/her retirement.

Pensions from the state pension system are neither income tested nor means tested, except for the early old age pensions and partial disability pensions.

Minimum amount of a pension is set by both the flat rate component (which is the same for everyone) and the minimum earnings related component. Another instrument that also prevents people from the poverty is the institute of the subsistence level.<sup>13</sup> Both these instruments are set by the government and are revaluated on irregular basis.

Pension indexation proceeds on a regular basis (every January) as mentioned above. Indexation decision is made by the government, but the minimum amount is guaranteed by the law. The minimum set by the law represents an inflation growth (measured by the aggregate consumer price index) plus at least a third of the growth in real average wage.<sup>14</sup>

<sup>11</sup> Concerning old age pension, disability pensions and also survivor's pensions.

<sup>12</sup> But it goes back to the year 1986 at the most. So the period used for calculation the assessment base is lengthening. The 30-year period will be achieved in 2015.

<sup>13</sup> A person whose income is lower than the subsistence level has a claim for social support benefits.

<sup>14</sup> Using statistics of the Czech Statistical Office.



The basic elements for calculation of the pension (for persons that reach the entitlement for a relevant pension) are the following:

#### **1.4.1 Old age pension**

Flat rate component is currently CZK 1400 per month and is the same for all pensioners.

Earnings related component amounts to 1.5 % of person's calculation base for every completed year of acquired insurance period. Minimal earnings related component is now CZK 770 per month; maximal amount is not determined.

When a person retires later, he is awarded by a bonus: 1.5 % of person's calculation base for every additional completed 90 calendar days.

Early retirements<sup>15</sup> are subject to penalization, which is 0.9 % of person's calculation base for every period of 90 calendar days before the statutory retirement age. But resulting earnings related component must not be lower than CZK 770.

#### **1.4.2 Disability pensions**

Flat rate component is the same as in case of the old age pension.

Earnings related component is calculated similarly as in case of old age pension.

It amounts to 1.5 % for fully disabled and 0.75 % for partially disabled persons of their calculation base for every completed year of acquired insurance period.

The only difference is in the acquired insurance period, because some people may become disabled before he/she reaches the necessary insurance period. For this purpose it is presumed, that a disabled person has already reached the retirement age. Then total insurance period = insurance period really acquired until he/she became disabled + insurance period he/she would acquire if he/she worked since the disability occurred until the retirement age.<sup>16</sup>

If a person becomes disabled before his/her age of 18, earnings related component amounts to 45 % of calculation base.<sup>16</sup>

#### **1.4.3 Survivor's pensions**

##### **1) Widow's/widower's pension**

Flat rate component is the same as in case of the old age pension.

Earnings related component amounts to 50 % of earnings related component of a spouse's old age or full disability pension at the time he/she died; or of the spouse's partial disability pension if he/she did not acquire necessary insurance period for full disability pension or did not meet conditions for the old age pension.

##### **2) Orphan's pension**

Flat rate component is the same as in case of the old age pension.

Earnings related component calculation is the same as in case of the widow's/widower's pension, but the rate is 40 % only (instead of 50 %).

##### **3) Widow's/widower's/orphan's pension in concurrence with old-age/disability pension.**

Flat rate component is the same as in case of an old age pension (however, the recipient receives flat rate component for one of the both pensions only).

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<sup>15</sup> A person can retire 3 years prior the retirement age at the most.

<sup>16</sup> For this period of inactivity is used a general calculation base, which is determined by the government upon an average gross income.

Earnings related component consists of full earnings related component of the higher pension (be it old-age/disability pension or survivor's pension) and 50 % of earnings related component of the lower pension.

## **2 Description of the pension model of the Czech Ministry of Finance**

### **2.1 The pension model**

The pension model has been built in the Ministry of Finance, which maintains, updates and uses the model. The model is a semi-aggregated simulation model written and run under the GAMS application.

It enables to make long-term projections and simulate the impact of changes in all the relevant parameters of the current system. Outputs of the model were used in convergence programmes and several reports.

### **2.2 Sources of data**

Most data come from the Czech Social Security Administration, which is in charge of collecting social security contributions and disbursing all pension benefits. The model makes use of the information on:

- the number of pensions disaggregated by type of pension, age and gender
- the number of new pensions (by type of pension, age and sex),
- average pension (by type of pension, age and sex)
- average newly granted pension (by type of pension, age and sex)
- matrix of the number of new pensions (by type of pension) for a given combination of assessment basis (average earnings during the assessment period) and contribution period.

Apart from the above mentioned data running the model requires a population projection (disaggregated by single age and sex), assumption on the growth rate of an average wage, evolution of the parameters of the pension formulae and indexation rule.

### **2.3 The structure of the model**

The model makes distinction among various pension benefits (old-age, disability and survivors'), sexes (males, females) and generations (the year of birth).

In accordance with the Czech legislation the model explicitly differentiates several types of pensions:

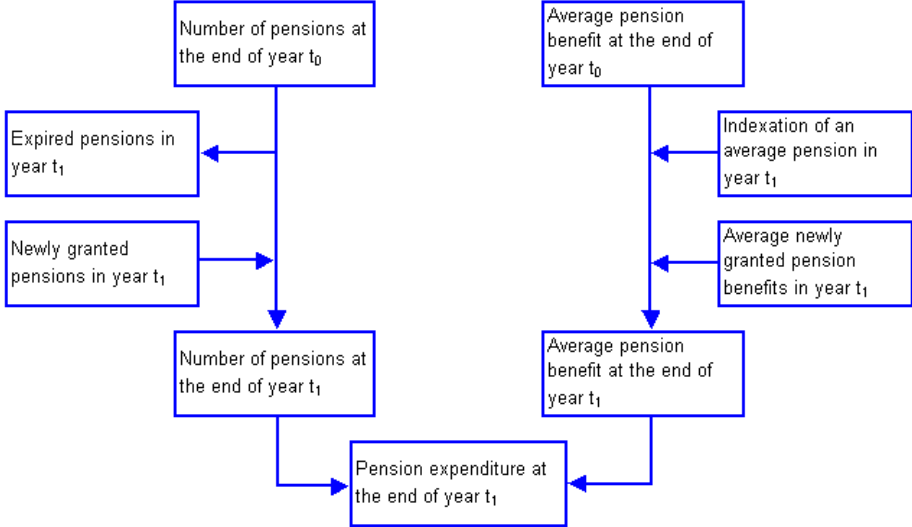
- Old-age pensions (including early retirement old-age pensions that can be granted up to three years prior to statutory retirement age)
- Full disability pensions (working capacity reduced by more than 66 % percent)
- Partial disability pensions (working capacity reduced by more than 33 % percent)
- Widow's/widower's pensions solo
- Widow's/widower's pensions in concurrence with other pensions (disability, old-age)
- Orphan's pensions

The distinction between males and females is important since males and females differ in their earnings profiles, length of their career and contribution periods. These differences result in different level of pension benefits. It is also important to apply cohort approach since the cohorts (generations) are not homogenous. Generations (identified by the year of birth) differ in some important characteristics, e.g. mortality rates (impacts for instance the number of survivors' pensions or the average lengths of receiving an old-age pension), disability rates (impacts the number of disability pensions) and affiliation with a generation is also decisive for determination of the statutory retirement age.

The model works with the number of pensions, not with the number of pensioners. The number of pensioners is somewhat lower than the number of pensions since some pensioners may be entitled to receive more (two) pension benefits. According to the Czech pension legislation recipients of disability or old-age pensions may under given conditions receive widow's /widower's pension at the same time. Thus, the number of pensioners can be obtained by subtracting the number of widow's /widower's pensions in concurrence with other pensions from the total number of pensions.

The model consists of three main building blocks. The first block calculates the number of pensions and flow of new pensions. The second one computes the level of new pension benefits. The third block combines the information on the stock and flow of pensions with the projection of new pension benefits, which gives the evolution of an average pension benefit and spending on all pension benefits in the projection horizon.

**Figure 2: Simplified diagram of the model structure**



**2.3.1 Block 1 – number of pensions**

The number of pensions is calculated on the basis of the cohort methodology. The computation rests on the idea, that there is a certain probability that an individual of given age and sex and from given cohort retires, becomes disabled or becomes orphan/widow/widower. The approach can be illustrated on the example of (full) disability pensions.

The conditional probability ( $P$ ) of becoming disabled for a person of age  $a$  and sex  $s$  can be expressed on the basis of disability rates ( $DR$ ) as<sup>17</sup>:

<sup>17</sup> Assuming an upper limit on disability rate equal to 1.0.

$$P_t^{a,s} = \frac{DR_{t+1}^{a+1,s} - DR_t^{a,s}}{1 - DR_t^{a,s}} \quad (1)$$

Denoting a particular generation by a superscript  $g$  (where  $g = t - a$ ), the equation (1) can be rewritten as:

$$P_t^{g,s} = \frac{DR_{t+1}^{g,s} - DR_t^{g,s}}{1 - DR_t^{g,s}} \quad (1a)$$

The disability pensioner can change its status since he/she can stop receiving disability pension due to renewed working capacity or becoming entitled to old-age pension. After the statutory retirement age the recipient of disability pension can ask the Czech Social Security Administration to calculate his/her old-age pension and he/she will get the higher pension. As a result disability pensions almost disappear behind the statutory retirement age. The conditional probability that a person ceased to be disabled can be expressed as follows:

$$P_t^{a,s} = 1 - \frac{DR_{t+1}^{a+1,s}}{DR_t^{a,s}} \quad (2)$$

or

$$P_t^{g,s} = 1 - \frac{DR_{t+1}^{g,s}}{DR_t^{g,s}} \quad (2a)$$

The probabilities were calculated for full and partial disability pensions and old-age pensions in the years 2001-2003. Disability rate can then be projected on the basis of a three-year average exit/entry probability as:

$$DR_{t+1}^{g,s} = DR_t^{g,s} \cdot (1 - P_t^{g,s}) + P_t^{g,s} \quad (3)$$

Or in accordance with (2a):

$$DR_{t+1}^{g,s} = DR_t^{g,s} \cdot (1 - P_t^{g,s}) \quad (4)$$

In the case of old-age pensions the probabilities were also calculated on the basis of equations (1) and (2). However, the obtained probabilities were adjusted in order to reproduce the average new pension benefit in the year 2003. An average new pension benefit is weighted average of all new pensions granted in different ages (in the model up to three years prior to retirement age and up to three years after the retirement age) with weights given by the number of newly provided pensions. Application of non-adjusted probabilities would somewhat overestimate the average new pension benefit compared to 2003 data.

The number of disability pensions ( $DPen$ ) in year  $t$  is determined as a product of the cohort size ( $Pop$ ) and the sex and cohort specific disability rate ( $DR$ ):

$$DPen_t = \sum_{g,s} DR_t^{g,s} \cdot Pop_t^{g,s} \quad (5)$$

The same approach has been applied to determine the number of partial disability pensions and old-age pensions.

Under the current legislation the statutory retirement age is gradually increased from the present 61 years for men and 57 for women with two children to 63 for men and 61 for the women with two children. Thus the model must take account of the rise in retirement age. It is done by splitting the probability profile for the given generation ( $g$ ) in a convenient point

(depending on the type of pension) and shifting it outwards by the difference between the statutory retirement age ( $RA$ ) valid for the given generation  $g$  and the statutory retirement age for the generation reaching the statutory age in the base year (in 2003 generation of men born in 1942 has retirement age equal to 61 years, i.e.  $2003 = 1942 + 61$ , whereas the generation of women born in 1946 reached the statutory retirement age,  $2003 = 1946 + 57$ ).

$$P_{g+a+(RA^{g,m}-RA^{1942,m})}^{g,m} = P_{1942+a}^{1942,m} \quad (6a)$$

$$P_{g+a+(RA^{g,f}-RA^{1946,f})}^{g,f} = P_{1946+a}^{1946,f} \quad (6b)$$

Somewhat different approach from the one outlined in equations 1 to 5 has been used to calculate the number of survivors' pensions. The probability of receiving widow's/widower's pension ( $P$ ) depends on the marital status, probability of spouse to die in a given year and compound probability of the couple to die within the same year. This can be formally expressed as:

$$P_t^{g,f} = \left( \varepsilon_t^{g,m} - \varepsilon_t^{g,m} \cdot \varepsilon_t^{g,f} \right) \cdot \frac{MPop_t^{g,f}}{Pop_t^{g,f}} \quad (7)$$

Superscript  $f$  and  $m$  denotes female and male population respectively,  $\varepsilon$  stands for mortality rate and  $MPop$  is the number of married population. The same relation holds for male. Since married couples are not necessarily of the same age,  $\varepsilon$  of the other sex should be viewed as an average mortality rate of the other sex around the given age  $a (= t - g)$ .

The number of widow's pensions ( $WPen$ ) can be derived from equation (7) and the assumption on the ratio of married population in a given starting age ( $a_0 = t_0 - g$ ). Before the age  $a_0$  an assumption was made (on the basis of fairly stable mortality rates) that the profile of widow's/widower's pension is the same as in the base year. The ratio of widow's pensions after age  $a_0$  (55 for women and 58 for men<sup>18</sup>) is calculated as follows:

$$\frac{WPen_t^{g,f}}{Pop_t^{g,f}} = \frac{WPen_{t-1}^{g,f}}{Pop_{t-1}^{g,f}} + \varepsilon_t^{g,m} \cdot \left( \frac{MPop_{t_0}^{g,f}}{Pop_{t_0}^{g,f}} - \frac{WPen_{t-1}^{g,f}}{Pop_{t-1}^{g,f}} \right) \quad (8)$$

The equation 8 is used to calculate the total number of widow's/widower's pension. It is further split into the solo pensions ( $WsPen$ ) and pensions in concurrence ( $WcPen$ ) with other pensions (old-age and disability) according to the probability that the person is a recipient of old-age or disability pensions, which is given by the fraction of population that receives old-age ( $OPen$ ) or disability pensions ( $DPen$ ).

$$WsPen_t^{g,s} = WPen_t^{g,s} \cdot \left( 1 - \frac{OPen_t^{g,s} + DPen_t^{g,s}}{Pop_t^{g,s}} \right) \quad (9)$$

$$WcPen_t^{g,s} = WPen_t^{g,s} - WsPen_t^{g,s} \quad (10)$$

The number of orphan's pensions is projected simply on the basis of the existing profile (age and sex specific ratio of orphan's pensions to population) since mortality rates for those aged less than 26 are not subject to any major changes. With respect to their limited importance this seems to be a good approximation.

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<sup>18</sup> After this age the entitlement for widow's/widower's pension is permanent (i.e. till the end of one's life) as opposed to the age before when the entitlement is only temporary (it lasts a year).

Figures 2 to 9 show the cross-sectional profiles of old-age pensions, full disability pensions, partial disability pensions and widow's/widower's pensions. Figures portray not only the result of cohort methodology but also the method used to model the gradual rise in the statutory retirement age. The rise in retirement age leads to the postponement of the retirement but at the same time the number of substitute pensions (full and partial disability pensions) increases since disability is related to age. Shift in the curve for the widow's/widower's pensions is driven by the falling mortality rates.

However, the rise in the number of disability pensions due to increase in retirement age means that the fraction of population retiring (due to old age) will shrink. The model assumes that the share of old-age pensioners in the residual population (population less the number of full disability pensions,  $Pop - DPen$ ) is kept in line with the profile for the generation reaching the statutory retirement age in the base year, for men that is:

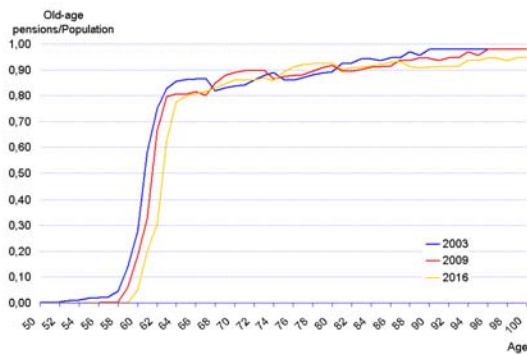
$$\frac{OPen_{t+(g-1942)}^{g,m}}{Pop_{t+(g-1942)}^{g,m} - DPen_{t+(g-1942)}^{g,m}} = \frac{OPen_t^{1942,m}}{Pop_t^{1942,m} - DPen_t^{1942,m}} \quad (11)$$

The profile of old-age pensions is then adjusted by the shift in the disability profile:

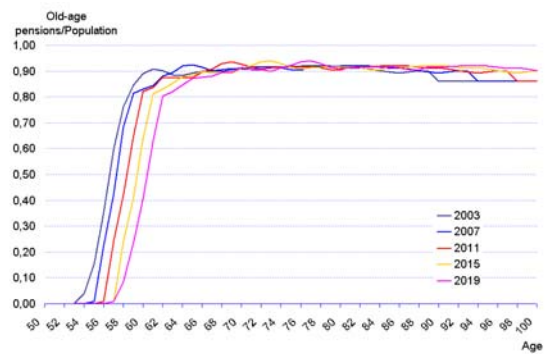
$$\left( \frac{OPen_{t+(g-1942)}^{g,m}}{Pop_{t+(g-1942)}^{g,m}} \right)^{adjusted} = \frac{OPen_{t+(g-1942)}^{g,m}}{Pop_{t+(g-1942)}^{g,m}} \cdot \frac{1 - DPen_{t+(g-1942)}^{g,m} / Pop_{t+(g-1942)}^{g,m}}{1 - DPen_t^{1942,m} / Pop_t^{1942,m}} \quad (12)$$

The following figures show cross sectional profiles for years 2003, 2009 and 2016 for men and 2003, 2007, 2011, 2015, and 2019 for women. The years were not chosen randomly but they reflect the calendar year, in which the statutory retirement age increases by one additional year. It is apparent that the process takes longer for women despite the faster speed (rise by 2 months a year for men compared to 4 months for women). It is a result of the much higher increase in statutory age for women. Beyond 2016 and 2019 respectively the profile should be more or less stable (except for survivors' pensions where the profiles are shifted due to declining mortality rates). However, minor changes might result due to the applied cohort component approach.

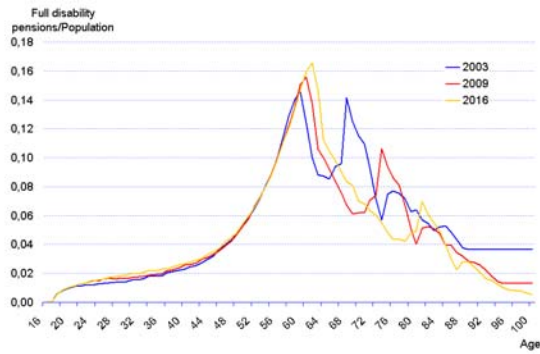
**Figure 3: Cross sectional profile of old-age pensions - male**



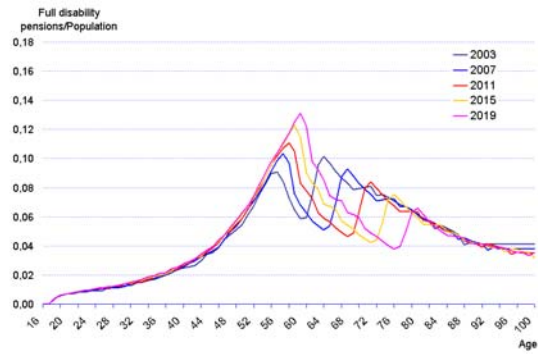
**Figure 4: Cross sectional profile of old-age pensions - female**



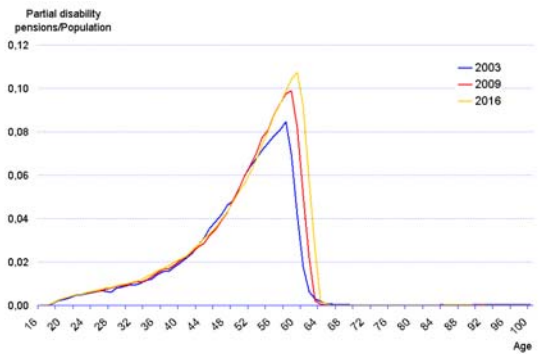
**Figure 5: Cross sectional profile of full disability pensions - male**



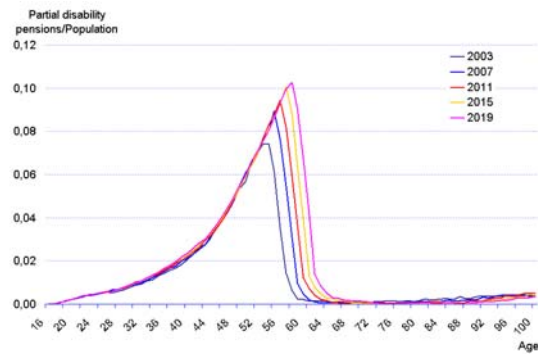
**Figure 6: Cross sectional profile of full disability pensions - female**



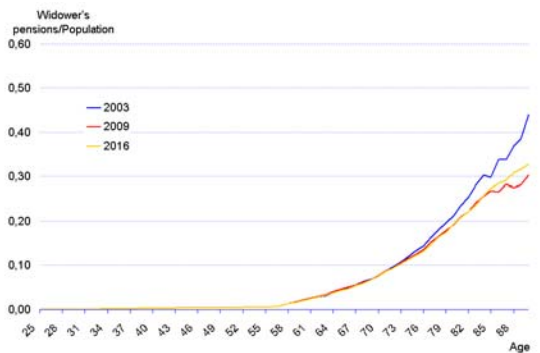
**Figure 7: Cross sectional profile of partial disability pensions - male**



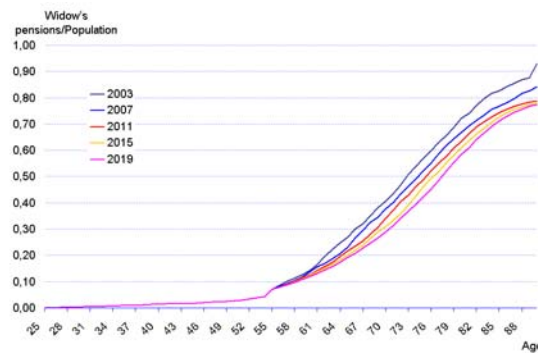
**Figure 8: Cross sectional profile of partial disability pensions - female**



**Figure 9: Cross sectional profile of widower's pensions - male**



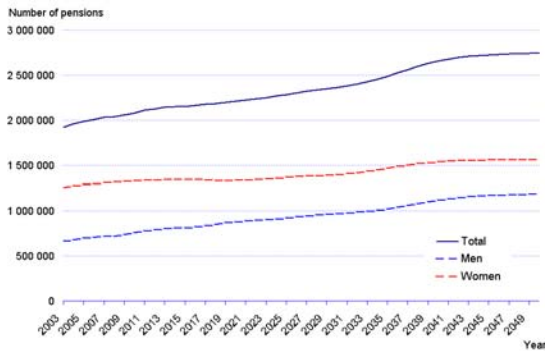
**Figure 10: Cross sectional profile of widow's pensions - female**



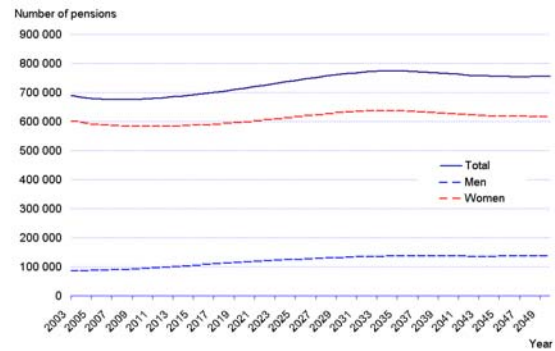
It is interesting that around 40 % of old-age pensions are granted before the statutory retirement age (Figure 3 and 4). Although there is strong penalty embedded in the system for the early retirement (the penalty exceeds an actuarially fair reduction as measured by implicit tax), people tended to retire before the statutory age. This may result from the fact that before 2004 people could use another early retirement scheme due to labour market reasons. This scheme was rather generous since the penalty (reduction in the benefit) was applied for those years before statutory retirement only. It follows that data may be somewhat biased towards early retirement by this latter early retirement scheme that was abolished in 2003. Nevertheless, data up to 2003 are the only data that were available at the time of making the projection.

The most important output of the block 1 is the numbers of all the different pension types. They are shown in the Figures 10 to 13.

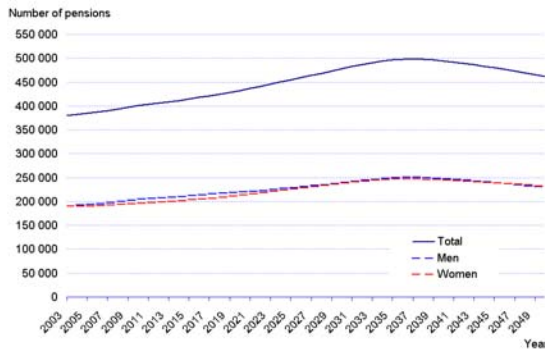
**Figure 11: Number of pensions – old-age pensions**



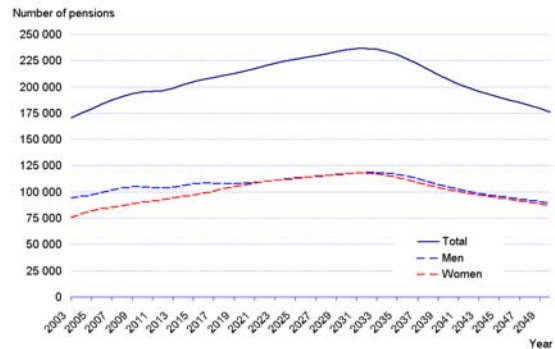
**Figure 12: Number of pensions – widow's/widower's pensions**



**Figure 13: Number of pensions – full disability pensions**



**Figure 14: Number of pensions – partial disability pensions**



The number of new pensions ( $NPen$ ) in generation  $g$  and sex  $s$  is consistent with the stock of pensions ( $Pen$ ), from which it is computed with the use of the probability of survivorship derived from sex and generation specific mortality rate ( $\varepsilon$ ):

$$NPen_t^{g,s} = Pen_t^{g,s} - Pen_{t-1}^{g,s} \cdot (1 - \varepsilon_t^{g,s}) \quad (13)$$

There is no such straightforward relationship in the case of disability pensions since a disability benefit is withdrawn when the working capacity is restored. Thus the number of new pensions computed according to (13) would be underestimated and spending on disability benefits and an average benefit would be lower (under the assumption of indexation lower than the wage growth). The model assumes a fixed relationship between the number of



new pensions and the stock of pensions in a given age ( $a$ ) and the ratio was calibrated on the basis of 2003 data<sup>19</sup>.

$$NPen_t^{g,s} = k_{g+a}^{g,s} \cdot Pen_t^{g,s} \quad (14)$$

$$k_{g+a}^{g,s} \equiv k^{a,s} = NPen_{2003}^{a,s} / Pen_{2003}^{a,s} \quad (15)$$

### 2.3.2 Block 2 – determination of newly granted pension benefit

This block enables to (i) assess the impact of the government decisions (pertaining to the indexation of the main parameters of the pension formulae) on the level of newly granted pensions in the short run and (ii) simulate the impact of changes in the pension formulae in the long run.

The changes in pension formulae are simulated in a matrix with two dimensions – assessment basis and contribution period. It is a matrix (281×40), which gives the number of pensions for a given combination of assessment basis (average earnings during the assessment period) and contribution period. It is possible to compute a pension benefit for each cell of the matrix on the basis of the pension formulae (equations 16, 17, 18 and 19). Weighing the pension benefits by the number of recipients gives the average newly granted pension. The matrix with 2003 data was used for the projection exercise and the structure was held constant in all years of the projection horizon.

$$NBen = FRC + ERC \quad (16)$$

$$ERC = \{ae \cdot rc_1 - \max(0, ae - rb_1) \cdot (rc_1 - rc_2) - \max(0, ae - rb_2) \cdot (rc_2 - rc_3)\} \cdot (cp_1 + cp_2 \cdot 0,8) / 365 \cdot ar \quad (17)$$

$$ae = \frac{\sum_{y=Y-1-\min(30, Y-1-1986)}^{Y-1} ye_y \cdot \prod_{t=y}^{Y-1} i_t}{\min(30, Y-1-1986) - ncp / 365} \quad (18)$$

$$i_t = w_{t+1} / w_t \quad (19)$$

*NBen* stands for newly granted pension benefit, *FRC* for flat rate component (currently CZK 1 400), *ERC* earnings related component, *ae* assessment basis (average earnings during the assessment period), *rc* reduction coefficient (currently 100 % up to CZK 8 400, 30 % up to 20 500 and 10 % over 20 500), *rb* reduction brackets (currently CZK 8 400 and CZK 20 500), *cp* contribution period up to the statutory retirement age in days (including non-contributory periods assessed as if contributory but only up to 80 %), *ar* accrual rate (1.5 %), *Y* year of retirement, *ye* yearly assessment basis in the last 30 years (but not before 1986) in present value calculated on the basis of index *i* derived from the growth rate of average wage in the economy (*w*) and *ncp* is for excluded non-contributory periods. In fact, the equation 17 is more complex since earnings related component furthermore reflects the early or late retirement (before and after the statutory retirement age). In case of early retirement the *ERC* is reduced by 0.9 % of the assessment basis for each 90 days before the statutory retirement age. In case of later retirement the *ERC* is increased by 1.5 % of the assessment basis for each completed 90 days after the statutory retirement age.

<sup>19</sup> That is, the model assumes a constant probability of restoring the working capacity.

The above given description concerns old-age pensions. The same procedure is used for other pension benefits. Although the procedure is the same, there are however minor changes in the pension formulae (see description of calculation of pension benefits above).

It should be apparent from the equations above that the Czech pension system is very flexible and there are many parameters that can be used to steer the system. The government can easily adjust the level of new pensions by changing the parameters of the pension formulae. On the other hand, absence of any government decision would lead to gradual decrease in the level of newly granted pensions since the flat rate component and the reduction brackets would remain constant in nominal terms. In the projection exercise we assume that the monetary parameters of the pension formulae (flat rate component, reduction brackets) are indexed to average wage growth. All other parameters (reduction coefficients, accrual rate) remain unchanged. Under these assumptions the replacement rate remains in principle constant.

### 2.3.3 Block 3 – average pension and total pension spending

In the base year the average pension benefit (for all types of pensions) is reported for each age and sex by the Czech Social Security Administration. It then enters the equation computing total pension expenditure. Total spending on a given type of pension (equation 20) is a function of the average pension benefit ( $Ben$ ) from the previous year indexed in accordance with the pension legislation ( $ind$ ), the newly granted pension benefit ( $NBen$ ) calculated in the block 2 of the model, and the number of pensions ( $Pen$ ) and newly granted pensions ( $NPen$ ) from the block 1.

$$E_t = \sum_{g,s} (Pen_t^{g,s} - NPen_t^{g,s}) \cdot Ben_{t-1}^{g,s} \cdot (1 + ind_t) + NPen_t^{g,s} \cdot NBen_t^{g,s} \quad (20)$$

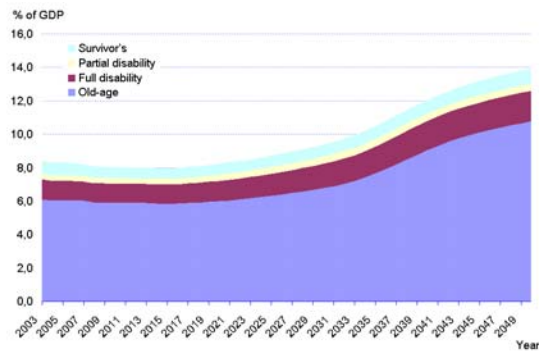
Total pension expenditure is simply a sum of the pension spending on all the pension types.

In the projection horizon the average pension benefit ( $Ben$ ) for a given generation  $g$  and sex  $s$  is calculated on the basis of the pension spending ( $E$ ) and the number of pensions ( $Pen$ ). The average pension is a weighted average of average pension from the previous period and the newly granted pension benefits:

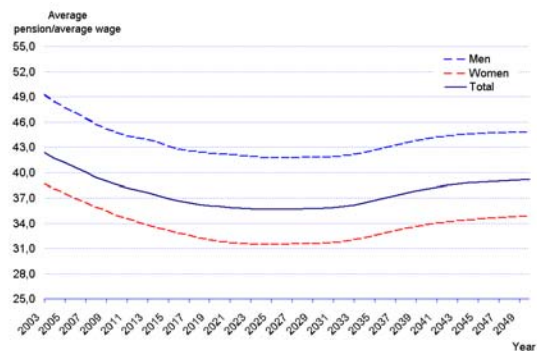
$$Ben_t^{g,s} = E_t^{g,s} / Pen_t^{g,s} = \frac{(Pen_t^{g,s} - NPen_t^{g,s})}{Pen_t^{g,s}} \cdot Ben_{t-1}^{g,s} \cdot (1 + ind_t) + \frac{NPen_t^{g,s}}{Pen_t^{g,s}} \cdot NBen_t^{g,s} \quad (21)$$

In the projection exercise the pension benefits are indexed as per legal minimum only, that is by CPI inflation and 1/3 of the average real wage growth. Although the indexation used to be more generous before 2003 (on average more than CPI inflation and 1/2 of the real wage growth), in 2003 the government committed themselves to index pensions to legal minimum only.

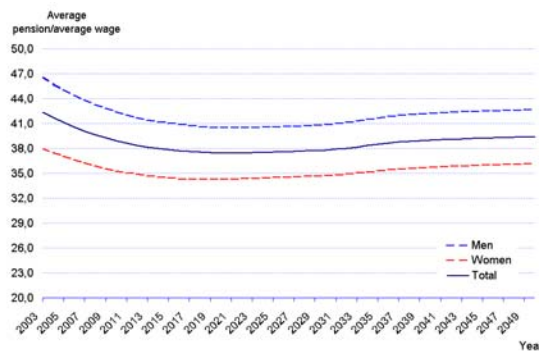
**Figure 15: Total spending disaggregated by type of benefits**



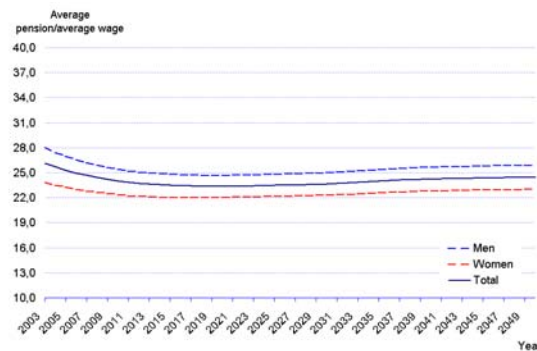
**Figure 16: Ratio of average pension to average wage – old-age pensions**



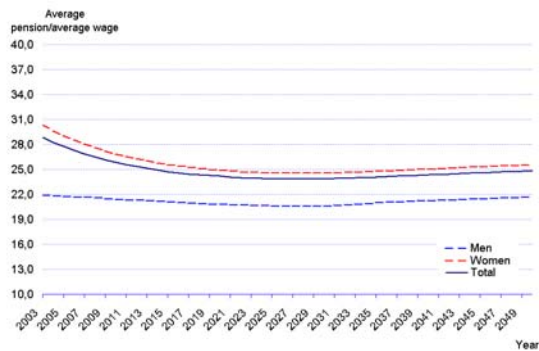
**Figure 17: Ratio of average pension to average wage – full disability pensions**



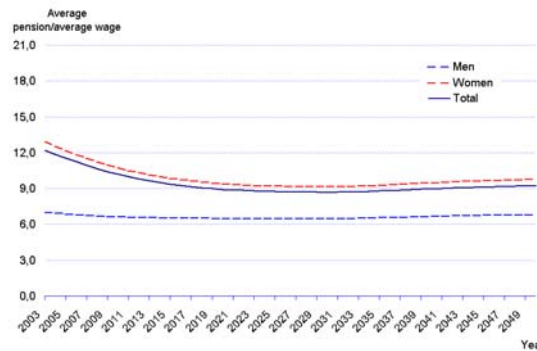
**Figure 18: Ratio of average pension to average wage – partial disability pensions**



**Figure 19: Ratio of average pension to average wage – widow's/widower's pensions solo**



**Figure 20: Ratio of average pension to average wage – widow's pensions in concurrence**



Figures 16 to 20 show the evolution of average pension to average wage ratio. The fall in the ratio is caused by the assumed indexation rate. Indexation was set equal to the minimum legal requirement (CPI inflation plus 1/3 of the real wage growth). It corresponds to the obligation adopted by the government but is significantly lower than the indexation applied in the past. The discrepancy between the current and the past indexation practice leads to the fall in the ratio. Moreover, there are other factors at play in case of the old-age pensions. The fall in the ratio of average old-age pension to average wage is more apparent because of a gradual increase in the number of early retirement permanently reduced pensions (this scheme was introduced in the half of 1990's and it will amend the structure of benefits in the next two or

three decades) and because of the gradual increase in the retirement age<sup>20</sup> that slows down the inflow of higher (compared to average pension) newly granted pensions.

## Reference

- [1] **Burniaux, J.M., Duval R., Jaumotte, F.:** Coping with ageing: a dynamic approach to quantify the impact of alternative policy options on future labour supply in OECD countries. Paříž, OECD Economic Department, 2003.
- [2] **European Commission:** The 2005 EPC projections of age-related expenditure (2004-2050): Underlying assumptions and projection methodologies to be used for EU25 Member States. Economic Policy Committee, 2005.
- [3] **Eurostat:** EUROPOP2004, Population projection of the Czech Republic.
- [4] **Zákon č. 155/1995 Sb. O důchodovém pojištění.**

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<sup>20</sup> However, in the long run it will contribute to rise in the ratio since the period, in which the pension is disbursed, will be shorter. Thus the relative gap between the average pension and the average wage will become narrower.