OPTIMAL SEVERANCE PAYMENT:
A QUANTITATIVE EXERCISE ACROSS COUNTRIES

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ABSTRACT

I present a model in which the employment contract includes severance payment as an instrument for achieving optimal separation between the firm and the worker. I show that the privately optimal severance payment from the model can replicate the level and the variation in actual severance payments (and notice periods) across OECD countries. I conduct a policy experiment in which the existing unemployment benefits are financed by a separation tax. Under this policy, the actual severance payments need to change only marginally in order to achieve socially optimal separation.

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1. Introduction

I study severance payment as an instrument for achieving efficient separation between the firm and the worker. I present a model, calibrate it, and compare the actual and the optimal severance payments across countries. There are a number of previous related studies. Some versions of the implicit contract theory, including Grossman and Hart (1983) and Hall and Lazear (1984), featured severance payment as an element of optimal employment contract under asymmetric information on the worker's productivity. However, their focus was on explaining employment fluctuations as a second-best solution of the informational problem. Some recent studies on severance payment, including Pissarides (2000), Alvarez and Veracierto (2001), and Rogerson and Schindler (2002), focused on its role as a means of providing insurance to the worker although severance payment could affect the efficiency of separation as a consequence. Fella (2000) and Jeong (2003) are more focused on the efficiency-enhancing role of severance payment in an efficiency-wage and a search environments, respectively.[1] In comparison, this paper examines the quantitative significance of the efficient-separation role of severance payment.[2]

In Section 2, I cast the efficient-separation role of severance payment in the search and matching model of Mortensen and Pissarides (1994). Employment is a contractual relationship between the firm and the worker instead of a continuous bargaining relationship;

[1] The recent studies in general take on a more favorable view on severance payment than the earlier ones, and are in contrast with the view that severance payment and other restrictions on separation are costs that hinder efficient turnovers, which is implicit in Bentolila and Bertola (1990) and Hopenhayn and Rogerson (1993), for example.

[2] This paper updates Jeong (2005), making some corrections and changes. Fella (2007) also examines the welfare properties of contractually determined severance payments in a model and a dataset similar to this paper. Consequently, the results are substantially similar as well. The main difference is that Fella's paper has an elaboration of the contractual environment while this paper conducts a quantitative exercise including policy experiments across countries. I note that previous versions of this paper were presented under the titles "The Efficiency of Severance Payment," "The Welfare Effects of Firing Restrictions," and "Optimal Severance Payment: Theory and Practice" on various occasions as stated on the title page starting in 2000. I came to be aware of a version of Fella's paper in 2004 after having completed much of the exercise contained in the current version. We apparently share a long period of independent research and revisions.

severance payment makes the firm internalize the utility loss of the worker from separation, thereby achieving efficient separation. The utility loss depends on, among other things, how responsive the contract wage is to the productivity shock: there are many optimal contracts in which severance payment inversely corresponds to wage responsiveness. I select one optimal contract, featuring a fixed wage and a fixed severance payment, under the assumption that the worker's productivity shock is unobservable to the worker or unverifiable in court. Thus, the rationale for severance payment stems purely from the contractual environment, not from the need for income insurance, even though its level depends on the utility loss of the worker from separation. Another result is that an unemployment benefit financed by an employment tax creates a wedge between the private and the social valuation of separation, which can be eliminated by switching from employment tax to a separation tax as a means of financing unemployment benefits.

In Section 3, I bring the model to the data. I present relevant labor market data for a cross section of OECD countries, and compute the effective severance payments that summarize the levels of severance payment and notice period. The calibration exercise shows that the privately optimal severance payment from the model is roughly able to generate the level and the variation of severance payments from the data. Based on the calibrated model, I conduct policy experiments with the objective of achieving socially optimal separation. The main experiment is switching from employment tax to a separation tax. With this tax change, holding unemployment benefits at the existing levels, the actual severance payments need to change only marginally in order to achieve socially optimal separation.

2. The Model

In this section, I present a model economy that builds on the search and matching model of Mortensen and Pissarides (1994). I characterize optimal severance payments in the presence of unemployment benefits financed by an employment tax.

2.1 The Environment

There are many workers whose measure is normalized to 1. At the beginning of each period, a worker is either employed or unemployed. Employment is a match between a firm and a worker. A firm can employ only one worker. Thus there are as many matched firms as employed workers. A matched firm is either new or old, depending on whether the firm has produced in the previous period. A new firm receives a productivity, i.e., the output that will be obtained if it produces, drawn from the distribution function $F(y)$.[3] An old firm receives a new productivity, drawn from $F(y)$, with probability λ; it maintains the previous period's productivity with probability $1 - \lambda$. If a firm produces, it pays employment tax τ to the government, pays wage $w(y)$ to the worker, and keeps the residual $y - \tau - w(y)$. The firm survives into the next period with the current worker. If a firm does not produce, it pays severance payment $s(y)$ to the worker and the firm dies. Since the value of a vacant firm is zero in equilibrium, I could alternatively assume that the firm enters the matching market to recruit a new worker without any change in results.

A newly unemployed worker joins the pool of unemployed workers. An unemployed worker produces a fixed output l, and receives an unemployment benefit b from the government. The output l can be interpreted as leisure, return from home work, or return from working in the informal sector. The unemployed workers also search for new firms in a matching market. There is a free entry of firms, but each firm in the matching market must spend a search cost c in each period. Let u and v denote the number of unemployed workers and the number of vacant firms. The number of new matches is given by the matching function $m(u, v) = Au^{\alpha}v^{1-\alpha}$, where A is the matching productivity parameter and α the matching elasticity parameter. Finally, the government balances its budget by equating

[3] As will become clear in following paragraphs, a new firm may choose not to produce if the productivity draw is low enough. Thus the worker matched with a new firm may receive a severance payment and become unemployed without ever having worked for the firm. This is partially an artifact of discrete-time modeling. More substantively, as modeled here, the severance payment is purely a contractual obligation that is in effect once the contract is signed, and abstracts from the worker heterogeneity in tenure.

the expected tax revenue from the representative firm and the expected unemployment benefits that result from the separation of that firm and its worker.

Let V_0 denote the value of a vacant firm, and $V(y)$ the value of a matched firm after the productivity shock is realized. Let π denote the job-finding rate: $\pi \equiv m(1, v/u)$. I have

$$V_0 = -c + \beta\pi \cdot \frac{u}{v} \cdot \int_y V(y)dF(y) = 0 \tag{1}$$

and

$$V(y) = g(y)\Big\{y - \tau - w(y) + \beta\lambda \int_{y'} V(y')dF(y') + \beta(1-\lambda)V(y)\Big\} + (1-g(y))\Big\{-s(y)\Big\} \tag{2}$$

where β is a discount rate between 0 and 1, and $g(y)$ denotes the production decision: it is equal to 1 if the firm produces and 0 if it does not. Similarly, let W_0 denote the expected utility of an unemployed worker, and $W(y)$ the expected utility of a worker after the productivity shock. I have

$$W_0 = l + b + \beta\pi \int_y W(y)dF(y) + \beta(1-\pi) \cdot W_0 \tag{3}$$

and

$$W(y) = g(y)\Big\{w(y) + \beta\lambda \int_{y'} W(y')dF(y') + \beta(1-\lambda)W(y)\Big\} + (1-g(y))\Big\{s(y) + W_0\Big\}. \tag{4}$$

Let ϕ denote the separation rate conditional on the output shock: $\phi \equiv \int_y (1 - g(y))dF(y)$. The number of unemployed workers equates the outflow and the inflow:

$$\pi u = \phi(\pi u + \lambda(1-u)). \tag{5}$$

From (1) to (4), I can derive the government budget constraint:

$$\frac{b\phi}{1-\beta(1-\pi)} = \frac{\tau(1-\phi)}{1-\beta(1-\lambda)}. \tag{6}$$

See Appendix for derivation. The left-hand side is the expected discounted sum of unemployment benefits for an employed worker and the right-hand side is the expected discounted tax revenue generated from his employment (after a common multiplicative term has been canceled on both sides).[4]

2.2 Privately Optimal Separation

So far, I assumed the production decision $\{g(y)\}$, the wages $\{w(y)\}$, and the severance payments $\{s(y)\}$. Now consider employment as a contractual relationship between a worker and a firm, whereby the production decision is made by the firm and the worker receives a pre-specified wage or a severance payment depending on the firm's production decision. From (2), the firm's production decision is

$$\begin{aligned} g(y) = 1 \quad &\text{if } y - \tau - w(y) + \beta\lambda \int_{y'} V(y')dF(y') + \beta(1-\lambda)V(y) \geq -s(y); \\ g(y) = 0 \quad &\text{if } y - \tau - w(y) + \beta\lambda \int_{y'} V(y')dF(y') + \beta(1-\lambda)V(y) < -s(y). \end{aligned} \tag{7}$$

The firm and the worker bargain over the contract after having been matched but before drawing the productivity shock. Assume the Nash bargaining solution:

$$\{(w(y), s(y))\} = \arg\max \left\{ \left(\int_y W(y)dF(y) - W_0 \right)^{\rho} \left(\int_y V(y)dF(y) \right)^{1-\rho} \right\} \tag{8}$$

where the maximization is subject to (2), (4), (7), and takes W_0 as given; and $\rho \in (0,1)$ is the bargaining power parameter. Given the unemployment benefit b, an *endogenous-severance-payment equilibrium* is the wage schedule $\{w(y)\}$, the severance payment schedule $\{s(y)\}$, the firm values V_0 and $\{V(y)\}$, the worker's utilities W_0 and $\{W(y)\}$, the

[4] Thus each worker's unemployment benefits are actuarially fully funded by his own employment at the moment of matching (or, equivalently, at the moment of each productivity draw) so that the government balances its budget dynamically, equating the expected discounted sum of tax revenue and that of unemployment benefits. This may involve the government running a primary deficit (i.e., $bu > \tau(1-u)$) in each period that is funded by interest income, or a primary surplus (i.e., $bu < \tau(1-u)$) that covers interest costs. Its realism aside, the assumption of a dynamically balanced budget simplifies the analysis greatly in comparison with a period-by-period balanced budget.

production rule $\{g(y)\}$, the number of unemployed workers u, the number of vacant firms v, and the employment tax τ, which together satisfy (1) to (8).

Let $\bar{y}$ denote the cut-off output in (7): $\bar{y} \equiv \tau + w(y) - s(y) - \beta\lambda \int_{y'} V(y')dF(y') - \beta(1-\lambda)V(y)$. Observe that by appropriately adjusting $w(y)$ and $s(y)$, the cut-off output $\bar{y}$ and the division of surplus $\int_y V(y)dF(y)/(\int_y W(y)dF(y) - W_0)$ can be chosen independently of each other. It follows from (8) that any equilibrium contracts maximize the joint-surplus and divide the surplus by the shares ρ and $1-\rho$ between the worker and the firm. From (2) and (4), observe that the joint-surplus maximizing production rule is

$$\begin{aligned} g(y) = 1 \quad &\text{if } y - \tau + \beta\lambda \textstyle\int (V(y') + W(y'))dF(y') + \beta(1-\lambda)(V(y) + W(y)) \geq W_0; \\ g(y) = 0 \quad &\text{if } y - \tau + \beta\lambda \textstyle\int (V(y') + W(y'))dF(y') + \beta(1-\lambda)(V(y) + W(y)) < W_0. \end{aligned} \tag{9}$$

Assume that $w(y)$ and $s(y)$ are continuous everywhere. For the firm to choose the joint-surplus maximizing production rule, from (7) and (9) I have

$$w(\bar{y}) + \beta\lambda \int_y W(y)dF(y) + \beta(1-\lambda)W(\bar{y}) = s(\bar{y}) + W_0 \tag{10}$$

and

$$\begin{aligned} w(y) - w(\bar{y}) &\leq s(y) - s(\bar{y}) + y - \bar{y} \quad \text{if } y \geq \bar{y}; \\ w(y) - w(\bar{y}) &> s(y) - s(\bar{y}) + y - \bar{y} \quad \text{if } y < \bar{y}. \end{aligned} \tag{11}$$

Conditions (10) and (11) are necessary and sufficient for the contract to maximize the joint surplus.

Observe that there are an infinite variety of equilibrium contracts. One such contract, which I will call the *flexible-wage contract*, is to provide no severance payment and to divide any incremental output by the shares ρ and $1-\rho$ between the worker and the firm: $s(y) = 0$ for all y; $w(y) - w(\bar{y}) = \rho(y - \bar{y})$ for all y; and $w(\bar{y}) + \beta\lambda \int W(y)dF(y) + \beta(1-\lambda)W(\bar{y}) = W_0$. Under this contract, the outcome is the same as if there was bargaining between the worker and the firm in each period, as in Mortensen and Pissarides (1994). An alternative contract, which I will call the *fixed-wage contract*, is to provide a fixed wage and a fixed severance payment: $s(y) = \bar{s}$ for all y; $w(y) = \bar{w}$ for all y; and $\bar{w} + \beta\lambda \int W(y)dF(y) + \beta(1-\lambda)W(\bar{y}) = \bar{s} + W_0$. From (3) and (4), I can derive

$$\bar{s} = \frac{\bar{w} - l - b}{1 - \beta(1-\pi)}. \tag{12}$$

See Appendix for derivation. Note that the severance payment exactly compensates for the utility loss from becoming unemployed. Thus the worker's utility is the same under all y and the output shock is entirely absorbed by the firm. These two contracts are two extremes, and there are a variety of contracts where the wage is neither fully flexible nor fully fixed.

The selection among contracts would depend on the contractual environment, about which little has been said so far. Now suppose that the productivity shock is unobservable to the worker, following Grossman and Hart (1983), among others. The incentive-compatibility requires: $g(y_1)\{y_1 - \tau - w(y_1) + \beta\lambda \int_{y'} V(y')dF(y') + \beta(1-\lambda)V(y_1)\} + (1 - g(y_1))\{-s(y_1)\} \geq g(y_2)\{y_1 - \tau - w(y_2) + \beta\lambda \int_{y'} V(y')dF(y') + \beta(1-\lambda)V(y_1)\} + (1 - g(y_2))\{-s(y_2)\}$ for any y_1 and y_2. It follows that, for any y, $w(y) = \arg\min_{\check{y}}\{w(\check{y}) : g(\check{y}) = 1\}$ if $g(y) = 1$; $s(y) = \arg\min_{\check{y}}\{s(\check{y}) : g(\check{y}) = 0\}$ if $g(y) = 0$. Intuitively, the contract wage and severance payment would have to be independent of the shock since otherwise the firm would always claim a low productivity shock. Thus the fixed-wage contract would emerge as the unique optimal contract.[5] The same result follows if the productivity shock is not verifiable in court. Based on these considerations, I assume the fixed-wage contract for the rest of the paper. I underline this assumption since the flexible-wage contract could

[5] Wages and severance payments are not the only instruments through which privately optimal separation can be achieved. For example, an up-front sign-up bonus and appropriately specified wages could deliver privately optimal separation too. Therefore, the uniqueness result is conditional on limiting the contract space to wage and severance payment schedules. It would seem that severance payment is factually more relevant than a sign-up bonus in actual firm-worker separation decisions.

outperform the fixed-wage contract in an alternative contractual environment, e.g., one with high enforcement costs.[6]

2.3 Socially Optimal Separation

There are potentially two sources of inefficiency in the current model: the unemployment-vacancy rate and the cut-off output for separation. Absent unemployment benefits, the unemployment-vacancy rate is too high if the worker's surplus share ρ is greater than the matching elasticity α, and vice-versa (Hosios 1990). Unemployment benefits strengthen the bargaining position of the worker, lower the value of a matched firm, and raise the unemployment-vacancy rate, thereby worsening matching efficiency if $\rho \geq \alpha$ while improving it up to an amount if $\rho < \alpha$. The cut-off output affects the (expected) surplus of a firm-worker match. Since a fixed share of the surplus is the value of a matched firm, a single cut-off output maximizes the surplus of a firm-worker match and minimizes the unemployment-vacancy rate at the same time. If $\rho \geq \alpha$, therefore, this cut-off output achieves efficiency in both matching and separation, taking unemployment benefits as given. Assume this condition to simplify the analysis. With unemployment benefits financed by employment taxes, the equilibrium cut-off output is set above the efficient level since the firm-worker takes benefits as costless while taking employment taxes as costly, thereby overvaluing unemployment and undervaluing employment in making the separation decision.

Formally, I consider the socially optimal separation as given by the cut-off output that leads to the maximum present value of aggregate outputs net of vacancy costs, taking unemployment benefits as given and ignoring any transitional and distributional issues.[7]

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[6] To elaborate on the conjecture, if enforcement costs are high and the productivity shock is partially revealed to the worker, the contract wage and severance payment may be renegotiated in favor of the worker (firm) upon the realization of a positive (negative) shock, in effect leading to a flexible wage contract.

[7] An equilibrium as defined above is implicitly a steady-state, which leaves open transitional issues. A transition would feature a redistribution of outputs among the firms, the employed workers, and the unemployed workers.

Let Y_0 denote the discounted expected output net of vacancy costs associated with an unemployed worker, and $Y(y)$ that associated with an employed worker with current output y:

$$Y_0 = l - c \cdot \frac{v}{u} + \beta\pi \int_y Y(y)dF(y) + \beta(1-\pi) \cdot Y_0 \tag{13}$$

and

$$Y(y) = g(y)\Big\{y + \beta\lambda \int_{y'} Y(y')dF(y') + \beta(1-\lambda)Y(y)\Big\} + (1-g(y)) \cdot Y_0. \tag{14}$$

Comparing (13) and (14) with (1) to (4), I can show that, holding $\{g(y)\}$, $\int_y Y(y)dF(y) = \int_y V(y)dF(y) + \int_y W(y)dF(y)$; $Y_0 = W_0 - b/(1-\beta(1-\pi))$; and $Y(y) = V(y) + W(y) + \tau/(1-\beta(1-\lambda))$ if $g(y) = 1$. Substituting these expressions in (14) and comparing with (9), observe that the social value of production is higher than the private value of production by the discounted expected amount of employment taxes $\tau/(1-\beta(1-\lambda))$ while the social value of separation is lower than the private value of separation by the discounted expected amount of unemployment benefits $b/(1-\beta(1-\pi))$, holding V, W, and W_0.

Now, consider an alternative tax/benefit policy of eliminating the employment tax (i.e, $\tau = 0$) and funding the unemployment benefits by a severance tax instead.[8] Thus I can rewrite (2):

$$V(y) = g(y)\Big\{y - w(y) + \beta\lambda \int_{y'} V(y')dF(y') + \beta(1-\lambda)V(y)\Big\} + (1-g(y))\Big\{-s(y) - \check{\tau}\Big\} \tag{2$'$}$$

where $\check{\tau}$ is the severance tax. As before, the government balances the budget by equating the expected tax revenue from the representative firm and the expected unemployment benefits that result from that firm's separation decision. From (1), (2)$'$, (3), and (4), I have

$$\check{\tau} = \frac{b}{1-\beta(1-\pi)}. \tag{6$'$}$$

[8] This is equivalent to a fully experience-rated unemployment benefit scheme, whose merit has been debated in a variety of contexts. See Cahuc and Malherbet (2004) and Mongrain and Roberts (2005) for recent examples.

Thus each tax payment pays for the (expected) unemployment benefits for the worker who has become unemployed on the occasion. From (2)′, the firm's production decision is

$$\begin{aligned} g(y) = 1 \quad &\text{if } y - w(y) + \beta\lambda \textstyle\int_{y'} V(y')dF(y') + \beta(1-\lambda)V(y) \geq -s(y) - \check{\tau}; \\ g(y) = 0 \quad &\text{if } y - w(y) + \beta\lambda \textstyle\int_{y'} V(y')dF(y') + \beta(1-\lambda)V(y) < -s(y) - \check{\tau}. \end{aligned} \tag{7$'$}$$

The definition of equilibrium is the same as in Section 2.2, except for replacing τ, (2), (6), and (7) with $\check{\tau}$, (2)′, (6)′, and (7)′.

Repeating the comparison of (13) and (14) with (1), (2)′, (3), and (4), I can show that, holding $\{g(y)\}$, $Y_0 = W_0 - \check{\tau}$; and $Y(y) = V(y) + W(y)$ for all y. From (2)′ and (4), the joint-surplus maximizing production rule is

$$\begin{aligned} g(y) = 1 \quad &\text{if } y + \beta\lambda \textstyle\int (V(y') + W(y'))dF(y') + \beta(1-\lambda)(V(y) + W(y)) \geq W_0 - \check{\tau}; \\ g(y) = 0 \quad &\text{if } y + \beta\lambda \textstyle\int (V(y') + W(y'))dF(y') + \beta(1-\lambda)(V(y) + W(y)) < W_0 - \check{\tau}. \end{aligned} \tag{9$'$}$$

Comparing (9)′ with (14), observe that the social and the private values of production/separation are equalized. To be precise, using that the firm's share of surplus is $1-\rho$, I can rewrite the free entry condition in (1) as

$$c = \beta\pi \cdot \frac{u}{v} \cdot (1-\rho)\Big\{\int_y Y(y)dF(y) - Y_0 - \frac{b}{1-\beta(1-\pi)}\Big\}. \tag{15}$$

Given a production rule $\{g(y)\}$, I can find Y_0 and $\{Y(y)\}$ as well as the ratio u/v from (13), (14), and (15). The present value of aggregate outputs is the sum of Y's weighted by the shares of workers across employment status and current productivity. However, the shares of workers are not relevant in finding the socially optimal production rule: I can show that, under the assumption that $\rho \geq \alpha$, each and every Y (i.e., Y_0 and $Y(y)$ for all y) is maximized by the production rule, $g(y) = 1$ if $y + \beta\lambda \int Y(y')dF(y') + \beta(1-\lambda)Y(y) \geq Y_0$ and $g(y) = 0$ otherwise. This rule is equivalent to (9)′.

3. Quantitative Exercise

In this section, I conduct a calibration exercise, and examine the relevance of the optimal severance payments from the model in a cross section of OECD data. I conduct policy experiments, and assess the welfare effects.

3.1 Labor Market Data

Table 1 presents the levels of severance payments and advance notice periods for 24 OECD countries. The data are from the OECD Employment Outlook (1999) and cover the late 1990's. They are mainly based on the legal regulation, and are average values across worker types. The motivation for looking at the notice period is that it works as a significant restriction on separation like severance payment does. Imagine that the firm effectively fires the worker when the notice period begins and pays wages during the period as a severance payment; being effectively unemployed, the worker searches for a new job during the notice period.

Table 1 also presents unemployment rates, unemployment duration, and replacement rates for the same countries. Unemployment rates and duration were constructed based on the OECD Labour Force Statistics (2002) and cover the years from 1992 to 2001. The unemployment rates are the averages over the period. The Labor Force Statistics provide the percentage of the unemployed who have been unemployed for one month or less for all countries except for Korea, Poland, and Turkey, for which the three-month figures are provided. I averaged the percentages over the ten year period (less than that for some depending on the availability of data). The unemployment duration in months for a country is the reciprocal of the average percentage for each country (multiplied by three for the three countries mentioned above). The replacement rates are from the OECD Benefits and Wages (2002), and are for the year 1999. I report the summary measure: it measures the ratio of the after-tax benefit and the after-tax previous wage of the unemployed worker, averaged over five years of unemployment and over different types of workers. The data were not available for Turkey and Mexico.

3.2 Adjusting the Data

In the data, there are three different levels of severance payment and lengths of notice period depending on employment duration. For each country, I fix the levels as follows. I estimate the expected employment duration as $e_d = (1-u_d)/(\pi_d \cdot u_d)$, where u_d denotes the unemployment rate in the data and π_d the job-finding rate, computed as the reciprocal of unemployment duration in the data. The estimate ranges from 45 months for the United States to 333 months for the Netherlands. Let s_4 denote the severance payment for 4 years (48 months) of employment in the data and s_{20} that for 20 years (240 months) of employment. The fixed severance payment is a weighted average: $s_f = s_4 \cdot (240-e_d)/192 + s_{20} \cdot (e_d - 48)/192$. Similarly, the fixed notice period is $n_f = n_4 \cdot (240 - e_d)/192 + n_{20} \cdot (e_d - 48)/192$.

As discussed above, the notice period effectively adds to unemployment and severance payment. I adjust the data in order to account for this. The first column of Table 2, the effective unemployment rate, presents the official rates from Table 1 plus the estimated fractions of the work force under the notice period:

$$u_e = \frac{u_d}{(1-\pi_d)^{n_f}}. \tag{16}$$

Since unemployed workers in reality do not receive unemployment benefits during the notice period, I adjust downward the benefits in the data so that if the adjusted level were applied to an unemployed worker throughout his effective unemployment duration, the expected discounted sum of his unemployment benefits would be equal to that under the actual sequence of benefits. Let b_d denote the replacement rate in the data. The effective replacement rate or, equivalently, the effective monthly unemployment benefit in units of monthly wage is

$$b_e = b_d \beta^{n_f} (1-\pi_d)^{n_f}. \tag{17}$$

I set the discount rate $\beta = .9966$, which implies an annual interest rate of about 4%. The second column of Table 2 presents the results. The third column of Table 2 presents the expected discounted sum of unemployment benefits, i.e., $b_e/(1-\beta(1-\pi_d))$, for an unemployed worker.

I make a similar adjustment to severance payment. Let s_d denote the severance payment in units of monthly wage in the data. The effective severance payment in units of monthly wage is

$$s_e = s_f \beta^{n_f}(1-\pi_d)^{n_f} + \frac{1-\beta^{n_f}(1-\pi_d)^{n_f}}{1-\beta(1-\pi_d)}. \tag{18}$$

The first term is the expected severance payment discounted to the period when the notice period starts. The second term is the expected wages during the notice period.[9] The fourth column of Table 2 presents the effective severance payments computed this way. The fifth and sixth columns of Table 2 present the expected severance payments and the expected wages during the notice period that make up the effective severance payments.

3.3 Calibration

I calibrate the model in Section 2 for each country. At the outset, I leave open whether the effective severance payment from the data should resemble the privately optimal severance payment in the model. Instead, I let the calibration exercise guide me on the relevance

[9] As mentioned, it is implicit that the worker produces no output (net of non-labor inputs) for the firm and foregoes no leisure during the notice period. In general, some leisure may be sacrificed in producing non-zero (possibly negative) output. We can gain a rough sense of the significance of this production by subtracting the value of leisure during the notice period in calculating the effective severance payment in (18). Holding the unconditional output mean as calibrated in Section 3.3, the effective severance payment falls from 4.2 to 3.8 months of wage on average across countries (Table 2, fourth column) when the value of leisure is 20% of the unconditional output mean. When the value of leisure is 40% of the unconditional output mean, the effective severance payment falls to 3.4 months of wage on average across countries. The range of effective severance payment remains comparable to the range of utility loss (Table 2, seventh column), which suggests that variations in the treatment of the notice period would not have a large impact on the results of the policy experiments in Section 3.4. All this is a bit of stretch in reconciling the model with the data since the model does not provide any rationale for production after the separation decision.

of privately optimal severance payments. Formally, I assume that the firm-worker takes as given a government-mandated severance payment instead of imposing the privately optimal severance payment in (12).[10] Let $\tilde{s}$ denote a government-mandated severance payment. For this payment to be binding, the firm-worker must not have a means of undoing its intended effect (Lazear 1990). In the current model, it is sufficient that the employment contract specifies a fixed wage, call it $\tilde{w}$, taking $\tilde{s}$ as given: for all y, $s(y) = \tilde{s}$; $w(y) = \tilde{w}$; and

$$\tilde{w} = \arg\max \left\{ \left(\int_y W(y)dF(y) - W_0 \right)^{\rho} \left(\int_y V(y)dF(y) \right)^{1-\rho} \right\} \tag{8$'$}$$

where the maximization is subject to (2), (4), (7), and takes $\tilde{s}$ and W_0 as given. Note that $\tilde{w}$ will not in general maximize the joint surplus unlike in (8).[11] Given the unemployment benefit b and the severance payment $\tilde{s}$, an *exogenous-severance-payment equilibrium* is the wage $\tilde{w}$, the firm values V_0 and $\{V(y)\}$, the worker's utilities W_0 and $\{W(y)\}$, the production rule $\{g(y)\}$, the number of unemployed workers u, the number of vacant firms v, and the employment tax τ, which together satisfy (1) to (7), and (8)$'$.

I calibrate the model so that, given the effective unemployment benefit b_e and the effective severance payment s_e, the exogenous-severance-payment equilibrium defined above replicates the effective unemployment rate u_e and the job-finding rate π_d. As mentioned, I set $\beta = .9966$. I assume that the output distribution function is normal: $F(y) \sim N(\mu, \sigma)$. I set the output shock frequency $\lambda = .083$, which implies that a new shock arrives about once a year. This is not based on any data, but the main results are not sensitive to λ. I make the common assumption that the matching elasticity $\alpha = .5$ and the bargaining parameter $\rho = .5$. I assume that the firm's search cost $c = .2\mu$, which is (a version of) a

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[10] It is easy to imagine that the actual severance payment is (in part) determined by factors absent in the current model, e.g., unions, voters. As mentioned, this is an implicit assumption in some of the earlier studies such as Bentolila and Bertola (1990) and Hopenhayn and Rogerson (1993). It is an explicit assumption in Saint-Paul (2000).

[11] It turns out that actual severance payments are close to what the firm-worker would have chosen (see Section 3.4). Thus the implementability of the government-mandated severance payments, as regards the calibration exercise, does not seem to be a (quantitatively) significant issue.

common specification.[12] Similarly, I assume that the home output is a constant fraction of the mean output at work: $l = \theta\mu$. Given a value of θ, I choose the values of the output mean μ, the output standard deviation σ, and the matching productivity parameter A so that in equilibrium the unemployment rate is u_e, the job-finding rate is π_d, and the wage $\tilde{w}$ is (normalized to) 1.

It remains to calibrate θ, which has a large impact on the quantitative results. Without an obvious way of fixing its value, I work with a range of values.[13] The seventh column of Table 2 presents the utility loss from unemployment, that is, the value of the right-hand side of (12) in equilibrium, when $\theta = .2$. Observe that the utility loss and the effective severance payment are fairly correlated across countries, and the two are comparable on average. Thus, if $\theta = .2$, the effective severance payments from the data roughly resemble the privately optimal severance payments from the model. The seventh column also reports a range of utility loss in brackets. The first number in the range corresponds to $\theta = .4$, the second number to $\theta = .0$. If $\theta > .4$, the utility loss from unemployment turns negative (i.e., the sum of home output and unemployment benefit exceeds the wage) and, consequently, the equilibrium does not exist for many countries. For the Netherlands, this is the case even if $\theta = .4$. In summary, the privately optimal severance payments in the model, under reasonable parameter values, come close to the effective severance payments from the data.[14]

[12] This is a normalization in that the search cost c affects only the equilibrium unemployment-vacancy ratio u/v with the matching productivity A scaled appropriately and does not affect any other parameters or equilibrium values (see equation 1).

[13] For the United States, .4 is commonly used for the flow value of unemployment as a share of labor productivity (i.e., $(l + b)/\mu$). See Shimer (2005) for example. Recent calibration exercises came up with higher values: .955 in Hagedorn and Manovskii (2006) and .73 in Hall (2006). Subtracting the unemployment benefits from these values, the range of remaining values come close to 0 to .4 explored below.

[14] Recall that the data on severance payments and notice periods are mainly based on legal regulation. A possible interpretation is that the legal codes are set to save on the 'transaction costs' of signing and enforcing what would be a privately optimal contract.

3.4 Policy Experiments

Having calibrated the model, I calculate optimal severance payments under various assumptions. First, consider a policy that allows severance payment to be privately set, while maintaining the existing level of unemployment benefit b_e.[15] The economy would then adjust to the endogenous-severance-payment equilibrium in Section 2.2 under which (12) holds. The first column of Table 3 presents the privately optimal severance payments, after calculating the new equilibrium. The payments are in units of *initial* monthly wage (see Footnote 15). Throughout the table, the main number corresponds to $\theta = .2$, the first number in the bracket to $\theta = .4$, and the second number in the bracket to $\theta = .0$, repeating the convention in Table 2. Many equilibria do not exist.[16] If the equilibrium exists, the new severance payment is not so different from the initial payment (Table 2, fourth column), and is nearly the same as the initial utility loss from unemployment (Table 2, seventh column). Since the initial payments were not far from the initial utility loss, the required adjustments are modest.

Next, consider a policy that allows severance payment to be privately set with employment taxes replaced by severance taxes, while maintaining the existing level of unemployment benefit b_e. The economy would then adjust to the endogenous-severance-payment equilibrium in Section 2.3 under which (12) holds. The second column of Table 3 presents (privately and socially) optimal severance payments under the separation tax policy. They nearly replicate the privately optimal severance payments under the employment tax policy (Table 3, first column), which were not far from the initial severance payments (Table 2, fourth column) and were nearly the same as the initial utility loss from unemployment

[15] That is, the absolute level of unemployment benefit, equivalently the benefit in units of *initial* monthly wage, is maintained. In all policy experiments, the wages change in the order of a few percent at most, so the benefit in units of new equilibrium wage is approximately constant as well.

[16] They are mainly for high values of θ, which imply that the severance payment has to fall from the initial level. Intuitively, a fall in severance payment raises the separation rate, which requires a hike in the employment tax rate, leading to a further rise in the separation rate and so on. In other words, the given unemployment benefit b_e is unsustainable under some parameter values.

(Table 2, seventh column). This somewhat hides two offsetting general equilibrium effects. The efficiency improvement in separation allows for a higher wage. At the same time, it raises the incentive for firm entry, increasing the job-finding rate. The third column of Table 3 presents the severance taxes in $(6)'$ under the severance tax policy. They are comparable on average to severance payments in the second column of the same table while the ranges of the severance taxes are somewhat narrower than those of severance payments. Roughly speaking, a firm would make about one-half of the total separation payment to the worker as a severance payment and the other half to the government as a severance tax under this policy. The first and the second columns of Table 4 present the welfare effects of the severance tax policy, that is, the changes in $\int Y(y)dF(y)$ and Y_0 (Equations 13 and 14) from the calibrated equilibrium values (Section 3.3). Again, throughout the table, the main number corresponds to $\theta = .2$, the first number in the bracket to $\theta = .4$, and the second number in the bracket to $\theta = .0$. The welfare gains are in the order of a few percentage points across countries.

Up to now, I have fixed the unemployment benefit at the effective level b_e from the data, and studied its impact on the optimal severance payment. The model in this paper does not provide a rationale for unemployment benefits. Nonetheless, within the model the optimal level of unemployment benefits depends on the matching elasticity α and the surplus share ρ. In calibrating the model, I made the common assumption that $\alpha = \rho$, in which case zero unemployment benefit is optimal.[17] With this motivation, consider the policy of eliminating taxes and benefits all together. The economy would then adjust to the endogenous-severance-payment equilibrium in Section 2.2 (Section 2.3) with $\tau(\check{\tau})$ and b set to 0, under which (12) holds. The fourth column of Table 3 presents the optimal severance payments under the no-tax-benefit policy. They are larger than the privately optimal severance payments under the employment tax policy (Table 3, first column), but are

[17] To be precise, in the problem of output maximization in Section 2.3, each and every Y (i.e., Y_0 and $Y(y)$ for all y) is maximized when the unemployment benefit b is zero.

moderated by the general equilibrium effects on wages and the job-finding rate. Eliminating unemployment benefits directly raises the utility loss from unemployment. The efficiency improvement in matching and separation raises wages somewhat but, more significantly, raises the job-finding rate, lowering the utility loss. The third and the fourth columns of Table 4 present the welfare effects of the no-tax-benefit policy, again measured by the changes in $\int Y(y)dF(y)$ and Y_0 (Equations 13 and 14) from the calibrated equilibrium values (Section 3.3). The welfare gains are only slightly larger than those under the severance tax policy (Table 4, first and second columns). Therefore, switching from the employment tax to the severance tax in financing unemployment benefits eliminates most of the welfare loss associated with unemployment benefits.

4. Conclusion

I presented a model in which the employment contract features severance payment as a means of achieving (privately) optimal separation under asymmetric information between the firm and the worker. The main result is that the privately optimal severance payment, under reasonable parameter values, closely mimics the average of and the variation in actual severance payments (and notice periods) across the OECD countries. Further, under the presence of unemployment benefits, the privately optimal severance payment achieves socially optimal separation if the funding source switches from the employment tax to a separation tax. Switching the tax regime while maintaining the existing unemployment benefits makes little change in the privately optimal severance payment, so socially optimal separation requires only marginal changes in actual severance payments.

I note some shortcomings and limitations. First, I assumed asymmetric information between the firm and the worker in order to select among the optimal contracts, but this is not necessarily the dominant aspect of the actual contractual environment. For example, I am not sure what would be the optimal contract if there is a degree of asymmetric information combined with an enforcement cost. Second, I included the notice period in calculating the summary measure of severance payment. Doing so, I effectively assumed that the notice period is a perfect substitute for severance payment. The rationale for the notice period and its impact on the labor market could be different from that for severance payment. Third, social optimum was defined in terms of maximizing the discounted sum of outputs net of vacancy costs in the steady state of the economy. This could be refined by incorporating distributional and transitional constraints. I leave these issues for future research.

Appendix: Derivation of Equations 6 and 12

Equation 6

Let B denote the budget balance (expected revenue minus spending) associated with a firm-worker pair at the moment of a productivity draw. We have

$$\begin{aligned} B = {} & \tau(1-\phi)\left(1+\beta(1-\lambda)+\beta^2(1-\lambda)^2+\ldots\right) \\ & - b\phi\left(1+\beta(1-\pi)+\beta^2(1-\pi)^2+\ldots\right) \\ & + B(1-\phi)\cdot\beta\lambda\left(1+\beta(1-\lambda\phi)+\beta^2(1-\lambda\phi)^2+\ldots\right). \end{aligned}$$

Setting $B=0$, we obtain (6).

Equation 12

Given that $s(y)=\bar{s}$ for all y; $w(y)=\bar{w}$ for all y; and $\bar{w}+\beta\lambda\int W(y)dF(y)+\beta(1-\lambda)W(\bar{y})=\bar{s}+W_0$, we have

$$W(y)=\frac{\bar{w}}{1-\beta}=\bar{s}+W_0 \tag{A1}$$

for all y from (4). From (3) and (A1), we have

$$W_0=\frac{1}{1-\beta(1-\pi)}\left(l+b+\frac{\beta\pi\bar{w}}{1-\beta}\right). \tag{A2}$$

We obtain (12) from (A1) and (A2).

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Table 1: Labor Market Data

Country	Severance Pay. in mon. wage after working for: 9 months	4 years	20 years	Notice Period in months after working for: 9 months	4 years	20 years	Unemp. Rate in percent	Unemp. Duration in months	Replace. Rate in percent
Belgium	.0	.0	.0	2.0	2.8	9.0	11.7	11.6	70
France	.0	.4	2.7	1.0	2.0	2.0	11.2	22.8	52
Germany	.0	.0	.0	1.0	1.0	7.0	8.4	12.2	63
Ireland	.0	.2	2.2	.3	.5	2.0	10.2	18.2	55
Netherland	.0	.0	.0	1.0	1.0	3.0	5.3	18.6	76
Switzerland	.0	.0	2.0	1.0	2.0	3.0	3.4	8.1	83
United Kingdom	.0	.5	2.4	.2	.9	2.8	7.6	7.9	69
Greece	.3	1.0	5.8	.5	1.5	8.0	10.3	18.6	17
Italy	.7	3.5	18.0	.3	1.1	2.2	11.2	21.7	13
Portugal	3.0	4.0	20.0	2.0	2.0	2.0	5.5	10.6	62
Spain	.5	2.6	12.0	1.0	1.0	1.0	19.1	24.9	50
Turkey	.0	4.0	20.0	1.0	2.0	2.0	7.8	14.8	–
Denmark	.0	.0	1.5	1.8	3.0	4.3	6.9	4.2	81
Finland	.0	.0	.0	1.0	2.0	6.0	12.8	7.2	69
Sweden	.0	.0	.0	1.0	3.0	6.0	8.1	5.6	79
Czech Republic	1.0	1.0	1.0	2.0	2.5	2.5	5.7	9.8	72
Hungary	.0	1.0	5.0	1.0	1.2	3.0	9.0	13.5	42
Poland	.0	.0	.0	1.0	3.0	3.0	13.7	14.7	60
Canada	.0	.2	1.3	.5	.5	.5	9.1	4.7	54
Mexico	3.0	3.0	3.0	.0	.0	.0	3.2	3.1	–
United States	.0	.0	.0	.0	.0	.0	5.3	2.6	32
Australia	.0	1.0	1.0	.2	.7	1.2	8.3	6.3	49
Japan	.0	1.5	4.0	1.0	1.0	1.0	3.6	6.1	64
Korea	.0	2.0	6.0	1.0	1.0	1.0	3.5	5.3	20
Average	.4	1.1	4.5	.9	1.5	3.0	8.4	11.4	56

Table 2: Quantitative Exercise - Calibration

Country	Effective Unemp. R. in percent	Effective Replace. R. in percent	Expected Unemp. B. in mon. wage	Effective Sever. Pay. in mon. wage	Of Which: Expected Sever. Pay.	Of Which: Wages in Notice P.	Worker's Utility Loss in mon. wage
Belgium	16.9	48	5.4	3.6	0.0	3.6	3.5 (1.1-5.9)
France	12.3	47	10.0	3.8	1.8	2.0	6.7 (2.2-11.2)
Germany	11.5	46	5.4	3.3	0.0	3.3	4.0 (1.5-6.4)
Ireland	11.0	51	8.7	2.6	1.3	1.4	4.8 (1.2-8.5)
Netherland	6.6	60	10.6	3.6	0.0	3.6	3.3 (NA-7.0)
Switzerland	5.0	56	4.4	3.9	1.3	2.6	1.9 (0.3-3.5)
United Kingdom	9.2	57	4.4	2.2	0.8	1.3	1.7 (0.1-3.3)
Greece	13.9	12	2.2	7.5	2.8	4.7	11.8 (8.3-15.4)
Italy	12.2	12	2.4	13.5	11.7	1.8	13.8 (9.7-17.9)
Portugal	6.7	51	5.2	14.3	12.4	1.9	3.0 (0.9-5.1)
Spain	19.9	48	11.0	6.2	5.2	1.0	7.0 (2.0-12.0)
Turkey	8.9	–	–	14.5	12.6	1.9	—
Denmark	15.7	35	1.5	2.4	0.0	2.4	1.9 (1.1-2.7)
Finland	17.3	51	3.5	1.9	0.0	1.9	2.0 (0.5-3.5)
Sweden	15.3	41	2.3	2.6	0.0	2.6	2.1 (1.0-2.1)
Czech Republic	7.5	55	5.2	3.1	0.8	2.3	2.4 (0.4-4.3)
Hungary	10.5	36	4.6	4.4	2.4	1.9	5.7 (3.0-8.3)
Poland	16.9	48	6.7	2.8	0.0	2.8	4.3 (1.2-7.3)
Canada	10.3	48	2.2	0.7	0.2	0.5	1.5 (0.5-2.4)
Mexico	3.2	–	–	3.0	3.0	0.0	—
United States	5.4	32	0.8	0.0	0.0	0.0	1.2 (0.7-1.7)
Australia	9.5	43	2.6	1.6	0.9	0.8	2.3 (1.0-3.5)
Japan	4.3	53	3.2	3.5	2.5	1.0	1.6 (0.4-2.8)
Korea	4.3	16	0.9	4.3	3.3	1.0	3.4 (2.3-4.4)
Average	10.6	43	4.7	4.2	2.2	2.0	4.1 (1.9-6.4)

Table 3: Quantitative Exercise - Optimal Severance Payment

Country	Privately Optimal under Emp. Tax in mon. wage	Optimal under Sever. Tax in mon. wage	Associated Sever. Tax in mon. wage	Optimal under No Tax/Ben. in mon. wage
Belgium	3.5 (NA-6.8)	3.8 (1.2-7.0)	5.0 (3.4-6.1)	5.8 (2.4-9.6)
France	8.4 (NA-15.8)	8.7 (2.2-16.2)	11.5 (6.8-13.4)	13.4 (4.5-21.9)
Germany	4.3 (NA-8.2)	4.5 (1.4-8.4)	5.6 (3.7-6.8)	6.8 (2.7-11.3)
Ireland	6.4 (NA-12.5)	6.7 (1.3-12.9)	10.4 (5.3-12.2)	10.7 (2.9-18.0)
Netherland	3.1 (NA-9.3)	3.4 (NA-9.5)	9.3 (NA-13.2)	6.7 (NA-14.8)
Switzerland	NA (NA-3.3)	1.5 (0.3-3.4)	3.3 (2.2-4.1)	2.7 (0.9-5.1)
United Kingdom	1.5 (NA-4.0)	1.7 (0.2-4.1)	3.7 (2.0-5.1)	3.1 (0.7-6.1)
Greece	13.7 (8.6-19.4)	13.8 (8.7-19.4)	2.6 (2.3-2.8)	15.0 (9.7-20.7)
Italy	13.7 (8.8-20.1)	13.8 (8.9-20.1)	2.4 (2.1-2.7)	14.9 (9.9-21.5)
Portugal	2.5 (NA-3.9)	2.7 (1.5-4.1)	3.1 (2.2-3.5)	4.0 (2.5-5.6)
Spain	7.4 (NA-14.6)	8.0 (2.4-15.1)	10.4 (6.7-12.7)	12.2 (4.7-20.5)
Turkey	—	—	—	—
Denmark	1.9 (1.1-2.8)	1.9 (1.1-2.8)	1.4 (1.2-1.5)	2.5 (1.6-3.5)
Finland	2.0 (NA-4.0)	2.2 (0.6-4.1)	3.2 (2.2-4.0)	3.4 (1.4-5.8)
Sweden	2.1 (NA-3.5)	2.2 (1.0-3.5)	2.1 (1.7-2.5)	3.1 (1.7-4.6)
Czech Republic	2.0 (NA-5.2)	2.2 (0.4-5.3)	4.3 (2.8-6.0)	3.8 (1.2-7.8)
Hungary	6.4 (2.6-10.7)	6.5 (2.8-10.8)	5.2 (3.9-5.9)	8.8 (4.4-13.5)
Poland	5.1 (NA-9.5)	5.4 (1.5-9.8)	7.3 (4.3-8.6)	8.4 (2.9-13.5)
Canada	1.8 (NA-3.2)	1.9 (0.5-3.3)	2.6 (1.7-3.0)	2.9 (1.1-4.5)
Mexico	—	—	—	—
United States	2.0 (1.2-2.8)	2.0 (1.2-2.8)	1.3 (1.3-1.3)	2.6 (1.7-3.4)
Australia	2.6 (NA-4.5)	2.6 (0.9-4.6)	2.9 (2.1-3.4)	3.8 (1.7-6.0)
Japan	1.1 (NA-2.6)	1.2 (0.3-2.6)	2.3 (1.7-2.9)	2.1 (0.8-3.8)
Korea	3.1 (1.8-4.4)	3.1 (1.8-4.4)	0.8 (0.6-0.9)	3.5 (2.1-4.8)
Average	4.5 (NA-7.8)	4.5 (1.9-7.9)	4.6 (2.9-5.6)	6.4 (2.9-10.3)

Table 4: Quantitative Exercise - Welfare Changes

Country	Matched Worker under Sev. Tax in percent	Unmatch. Worker under Sev. Tax in percent	Matched Worker under No Tax/Ben. in percent	Unmatch. Worker under No Tax/Ben. in percent
Belgium	4.9 (3.9-5.7)	5.0 (4.6-5.6)	5.2 (5.0-6.0)	5.7 (6.1-6.3)
France	5.5 (4.5-6.1)	5.1 (5.7-5.8)	5.5 (4.6-6.1)	6.0 (6.5-6.6)
Germany	3.7 (2.8-4.3)	3.7 (3.4-4.1)	3.9 (3.2-4.4)	4.2 (4.2-4.6)
Ireland	5.3 (4.5-5.6)	4.9 (5.7-5.3)	5.3 (4.6-5.7)	5.7 (6.5-6.1)
Netherland	3.4 (NA-3.9)	3.9 (NA-3.3)	3.4 (NA-3.9)	4.9 (NA-4.3)
Switzerland	1.1 (1.9-1.5)	1.5 (2.6-1.7)	1.4 (4.6-1.6)	2.2 (5.8-2.0)
United Kingdom	3.6 (3.0-4.1)	3.8 (3.8-3.9)	3.7 (4.9-4.2)	4.3 (6.1-4.4)
Greece	1.4 (0.5-2.6)	1.5 (0.4-3.1)	1.4 (0.5-2.6)	1.6 (0.5-3.1)
Italy	0.2 (0.4-0.9)	0.2 (0.5-1.0)	0.3 (0.4-0.9)	0.3 (0.6-1.0)
Portugal	7.5 (16.5-3.9)	8.4 (17.6-4.8)	9.0 (18.8-4.8)	10.2 (20.2-5.9)
Spain	7.4 (5.5-8.6)	7.7 (7.1-8.6)	7.6 (6.2-8.8)	8.6 (8.5-9.5)
Turkey	—	—	—	—
Denmark	1.0 (1.2-1.4)	1.0 (1.3-1.4)	1.5 (2.0-1.8)	1.6 (2.2-1.8)
Finland	5.6 (4.7-6.1)	5.7 (5.1-6.0)	6.1 (5.8-6.5)	6.5 (6.5-6.7)
Sweden	1.8 (1.8-2.3)	1.9 (2.0-2.3)	2.4 (2.9-2.8)	2.6 (3.2-2.9)
	0.0			
Czech Republic	2.6 (2.0-3.1)	3.0 (2.8-2.9)	2.7 (3.5-3.2)	3.5 (4.8-3.4)
Hungary	2.3 (1.6-3.1)	2.2 (1.9-3.0)	2.5 (1.8-3.2)	2.6 (2.4-3.4)
Poland	6.9 (5.8-7.4)	6.7 (6.6-7.3)	7.0 (6.1-7.6)	7.4 (7.4-8.0)
Canada	3.9 (3.8-4.2)	3.8 (3.9-4.1)	4.1 (3.9-4.4)	4.2 (4.3-4.5)
Mexico	—	—	—	—
United States	1.9 (1.6-2.3)	1.9 (1.5-2.4)	2.0 (1.7-2.4)	2.1 (1.7-2.6)
Australia	2.6 (2.1-3.1)	2.6 (2.3-3.0)	2.8 (2.4-3.3)	2.9 (2.8-3.3)
Japan	0.8 (1.9-0.9)	1.2 (2.5-1.1)	1.2 (4.1-1.1)	1.8 (4.9-1.4)
Korea	0.1 (0.8-0.1)	0.1 (1.0-0.1)	0.1 (0.9-0.1)	0.2 (1.0-0.2)
Average	3.3 (3.4-3.7)	3.5 (3.9-3.7)	3.6 (4.2-3.9)	4.0 (5.1-4.2)