ISSN 1471-0498

DEPARTMENT OF ECONOMICS

DISCUSSION PAPER SERIES

LABOUR MARKET EFFECTS OF INTERNATIONAL TRADE WHEN MOBILITY IS COSTLY

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Number 751
July 2015

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LABOUR MARKET EFFECTS OF INTERNATIONAL TRADE WHEN MOBILITY IS COSTLY

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ABSTRACT. I build and estimate a dynamic structural model of sectoral choices with heterogeneous workers accumulating human capital that is imperfectly transferable across sectors. Utility costs of switching sectors provides an additional barrier to mobility. Estimating the utility costs by Simulated Minimum Distance on administrative data covering the population of Danish workers and firms, costs are found to be in the range of 10% to 18% of average annual wages. By conducting counterfactual policy experiments, it is shown that the both the imperfect transferability of human capital and the utility costs are important for explaining the slow adjustment of the labour market following shocks to the economy.

Keywords: Globalisation, adjustment costs, worker heterogeneity
JEL: E24, F13, F16

1. INTRODUCTION

Developed countries have experienced increasing foreign competition, particularly from low wage countries, since the early 1990s. This has been coupled with a shift in production away from the manufacturing sector towards non-traded goods and services. The reallocation process has naturally involved a decline of some industries and the expansion of others. While the public debate on globalisation often focuses on the destruction of jobs rather than the gains, economists and policy makers insist that the gains from trade outweigh the losses, at least in the long run as resources are allocated towards comparative advantage industries. But focusing only on long term gains does not address questions on the sluggishness and costs of the reallocation process. As globalisation continues, this tension between workers concerned by short term outcomes and policy makers focused on aggregate long term outcomes is bound to increase, making

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Date: July 9, 2015.
I would like to thank the editor and three anonymous referees for comments that have significantly improved the paper. I have benefitted from discussions with Martin Browning, Rafael Dix-Carneiro, Mette Ejrnæs, Thomas Jørgensen, Jakob R. Munch, J. Peter Neary, John Rust, and Bertel Schjerning. I would like to thank participants at various seminars and conferences for helpful comments. All errors are my own.

estimation of the adjustment costs following globalisation an ever more present concern.

This paper attempts to do just that for Denmark. Among Continental European countries Denmark is special as the flexibility of the Danish labour market is very high, comparable even to the United States.[1] With weak employment protection and high unemployment insurance (UI) benefits being two of three pillars of the 'flexicurity' system (active labour market policies is the third) firms are relatively free to hire and lay off workers as they desire. Workers, on the other hand, pay the price of this flexibility: They may experience spells of unemployment, they may find that their human capital is imperfectly transferable across sectors, or they may have a distaste for switching sectors for other reasons. The main purpose of this paper is to quantify these reallocation costs following globalisation.

To this end I build and estimate a dynamic structural model of the Danish economy, where heterogeneous workers of overlapping generations accumulate imperfectly transferable human capital. In every period of time, workers receive wage offers from all sectors of the economy after which they choose to work in the sector that maximises expected lifetime utility. The choice takes into account the possibility of becoming unemployed and receiving unemployment benefits. If the worker wishes to switch sectors from one year to the next, he faces different costs. First, he may not be able to offer the same amount of human capital to all sectors as human capital is only partially transferable. Second, the worker faces a utility cost of switching sectors that depends on characteristics such as gender, education and age. The production side of the model is characterised by perfect competition where sector-representative firms demand human and physical capital in order to produce output according to a Cobb-Douglas production function.

The structural parameters of the model are estimated using Simulated Minimum Distance (SMD) on a matched worker-firm dataset covering the population of Danish workers and the universe of firms from 1996 to 2008. Employing SMD on this dataset, I fit a set of Auxiliary Parameters (APs) that provide a detailed description of the data. The SMD estimator finds the set of structural parameters such that the distance between APs estimated on actual data and APs estimated on data simulated from the model is minimised.

[1]See Botero, Djankov, La Porta, Lopez-De-Silanes, and Shleifer (2004) for a cross country comparison of labour market flexibility.

The main estimation results are (i) that the utility cost of switching sectors for the median worker is between 10% and 18% of average annual wages, providing an additional barrier to inter-sectoral mobility other than partially transferable human capital, and (2) between 88% and 98% of a worker's experience is transferable across sectors. The median utility cost covers substantial heterogeneity over the population of workers: Female, less-educated, and in particular older workers face higher costs. A key feature of my model is that workers are allowed to be unemployed. This allows me to study the consequences of unemployment on human capital accumulation, where I find every year of unemployment to depreciate work experience, which enters human capital, by 6%.

Once the model parameters are estimated, I use it to explore the dynamic adjustment processes following a globalisation shock to the economy. While globalisation manifests itself in numerous ways, this paper focuses on two of these. First, by causing some sectors to expand and others to contract, globalisation can increase the probability of becoming unemployed for workers in the contracting sectors, particularly if workers are unable to reallocate immediately. There is some evidence that globalisation increases unemployment probabilities: Working on similar data, Munch (2010) finds that outsourcing increases the unemployment risk of low-skilled Danish workers, albeit with modest quantitative effects. The second way globalisation affects the economy in this paper is through trade liberalisation, which lowers the output price of the liberalising sector. Since trade barriers are already low for Denmark, lower output prices can also be seen as a consequence of increased international competition. For example, it is well-established that, following its integration into the world economy, China exports products at lower unit values than other countries. In fact, Schott (2008) finds that, within product categories, Chinese unit values are 48% lower than unit values from countries at a similar level of development, and that this discount has increased over time. Although this type of shock is likely to be gradual, it remains relevant to treat it as a one-off episode for the purpose of studying labour market dynamics.

Consider increased globalisation of the manufacturing sector. The globalisation shock consists of two separate shocks: i) An unemployment shock increasing the probability of becoming unemployed for workers employed in the manufacturing sector; ii) A trade liberalisation episode lowering the output price of the manufacturing sector. First, the unemployment and trade liberalisation shocks are studied in isolation before turning to the impact of a joint shock. In the simulations, I find that: i) The labour market reallocation process is sluggish, so that only 92.5% is completed after 10 years following the globalisation shock; ii) The utility costs provide an important barrier to mobility, and without these costs the reallocation process would be faster: 40% additional reallocation would occur in the first post-shock year alone.

Recent empirical papers have studied how international trade affects domestic labour markets. In an influential paper, Autor, Dorn, and Hanson (2013) find that increasing import competition from China increases unemployment in local labour markets: For every $1,000 increase in imports per worker, the share of employed manufacturing workers falls by 0.7 percentage points. Examples of other reduced form studies are the papers by Autor, Dorn, Hanson, and Song (2012), and Ebenstein, Harrison, McMillan, and Phillips (2014). Recently, efforts have been made to estimate the transition costs of labour reallocation in structural models, e.g. Artuç, Chaudhuri, and McLaren (2010), Artuç and McLaren (2012), Coşar (2013), Coşar, Guner, and Tybout (2011). The paper closest to mine in the structural literature is Dix-Carneiro (2014), who estimates a similar model on Brazilian worker data. He is focused on the distributional effects of trade liberalisation on high and low skilled workers. In contrast, although my model allows workers to be highly educated, this affects only the *amount* of human capital they can offer, not the *type*. In addition, the key innovation of my model is the formal modelling of the institutional setting facing unemployed workers in Denmark, a feature we know from the theoretical literature on labour markets and international trade to be important.[2] Specifically, allowing workers to be unemployed allows me to analyse the consequences of unemployment for human capital accumulation, and to conduct policy-relevant counter-factual simulations changing the UI scheme.

The remainder of the paper is organised as follows. The next section presents a dynamic structural model of the labour market allowing for observed and unobserved heterogeneity on the worker side. Section 3 describes the matched worker-firm data and the aggregate data used for estimation. Section 4 gives an overview of the estimation procedure and presents the results. Section 5 examines the dynamic adjustments following different shocks to the economy and conducts policy experiments. Finally, Section 6 concludes.

[2] A growing body of theoretical papers studies the effect of international trade on unemployment. In Davidson, Martin, and Matusz (1999), Helpman and Itskhoki (2010), Helpman, Itskhoki, and Redding (2010), and Helpman, Itskhoki, and Redding (2011), the equilibrium unemployment rate may rise following trade liberalisation.

2. EMPIRICAL MODEL

The objective is to design and estimate a general equilibrium model of the labour market that allows for an assessment of the transition costs of labour reallocation across sectors while allowing workers to be unemployed. Building on the framework developed in Keane and Wolpin (1994), Lee (2005), Lee and Wolpin (2006), and Dix-Carneiro (2014), the strategy is to estimate a dynamic Roy (1951) model.[3]

Each year, the economy is populated by overlapping generations of workers aged 30 to 65. Workers supply their human capital to one of five sectors: (1) Agriculture/Mining, (2) Manufacturing, (3) Construction, (4) Trade/Utilities/Transportation/Communication, or (5) Services.[4] A worker has different levels of human capital to offer the five sectors. Thus, a productive manufacturing worker may be a productive or unproductive construction worker. Changing sectors from one period to the next is costly for two reasons: First, not all experience is transferable across sectors, and second, the worker faces a utility cost of switching. In addition to the five productive sectors there is an unproductive unemployment sector (0) where workers sit idle, receiving UI benefits or welfare assistance. Workers cannot choose the unemployment sector as unemployment arrives with individual specific probability. Thus, all unemployment is involuntary. While unemployment is a major concern for the public, the literature has thus far ignored it.

The timing of the model is illustrated in Figure 2.1. Consider a worker who initially

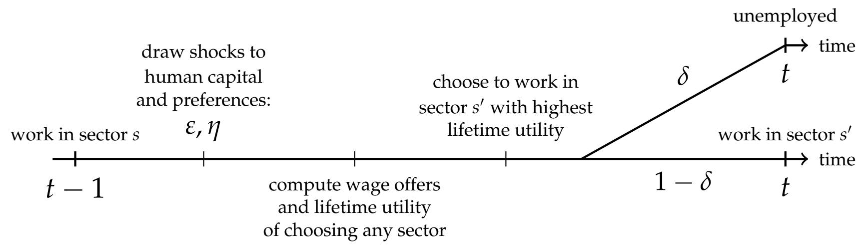


FIGURE 2.1. Model Timing

works in sector s in year $t-1$. In order to decide on a sector for year t he first draws shocks, ε, to the human capital he can supply each sector. For each, he also draws a preference shock, η. Once these shocks are realized, the worker is able to compute the wage he will receive in every single sector as well as the lifetime utility of choosing

[3]See Heckman and Sedlacek (1985, 1990), and Heckman and Honoré (1990).

[4]These sectors are chosen due to the availability of aggregate data for a number of variables from Statistics Denmark (see Section 3).

each. The wages and lifetime utilities take into account all costs of switching sectors. Having computed these, the worker decides on the sector, s', that maximises lifetime utility. This choice, however, is only realised with probability $1-\delta$ since there is a chance that the worker becomes unemployed (with probability δ). Then, in year t, the process is repeated.

In the following I describe the production and worker sides of the model before discussing how the model is solved and estimated.

2.1. **Sectoral Production.** Representative firms in each sector demand the human capital supplied by workers in order to produce output. The production technology is assumed to be of a Cobb-Douglas form so that the value added of sector s becomes

$$Y_t^s = p_t^s A_t^s (H_t^s)^{\alpha_t^s} (K_t^s)^{1-\alpha_t^s}, \tag{1}$$

where p_t^s is the output price, A_t^s is productivity, H_t^s is the human capital employed in the sector, and K_t^s is physical capital. Notice that α_t^s is allowed to vary over time, and that the aggregate human capital, H_t^s, is not observed.

Given the production technology, the unit prices of human capital and physical capital are

$$\begin{aligned} r_t^s &= \alpha_t^s \frac{Y_t^s}{H_t^s}, \\ r_t^{s,K} &= \left(1-\alpha_t^s\right) \frac{Y_t^s}{K_t^s}. \end{aligned} \tag{2}$$

2.2. **Workers.** Each year, workers choose to work in the sector that maximises the present value of lifetime utility, taking into account the costs of switching sectors and the probability of becoming unemployed. The mobility costs are comprised of imperfectly transferable work experience, and of a utility cost of switching. Consider worker i with a set of characteristics, Ω_{it}, in year t. The characteristics are specified below. Let $\mathbf{V}(\Omega_{it})$ denote the value function of this worker. The value function represents the maximum expected present value of lifetime utility over the choice alternatives. The Bellman equations are then

$$\mathbf{V}\left(\Omega_{it}\right) = \max_s \left\{\mathbf{V}^s\left(\Omega_{it}\right)\right\}, \tag{3}$$

with alternative-specific value functions

$$(4)\quad \mathbf{V}^s(\Omega_{it}) = \begin{cases} [1-\delta(\Omega_{it})]\left[w^s(\Omega_{it}) + \rho\mathbb{E}_{\varepsilon,\eta}\mathbf{V}(\Omega_{i,t+1}|\Omega_{it}, d_{it}=s)\right] + \\ \delta(\Omega_{it})\left[w^0(\Omega_{it}) + \rho\mathbb{E}_{\varepsilon,\eta}\mathbf{V}(\Omega_{i,t+1}|\Omega_{it}, d_{it}=0)\right] + & \text{if age} < 65 \\ \eta^s_{it} - \mathbf{C}^{s_{t-1},s}(\Omega_{it}) \\ \\ [1-\delta(\Omega_{it})]w^s(\Omega_{it}) + \delta(\Omega_{it})\,w^0(\Omega_{it}) + \\ \eta^s_{it} - \mathbf{C}^{s_{t-1},s}(\Omega_{it}) & \text{if age} = 65 \end{cases}$$

where $w^s(\Omega_{it})$ is the real wage offer in sector s, $w^0(\Omega_{it})$ is the unemployment benefit, η^s_{it} is a zero mean random sectoral preference shock, $\mathbf{C}^{s_{t-1},s}(\Omega_{it})$ is the utility cost incurred by a worker switching from sector s_{t-1} to sector s, and ρ is the discount factor. The variable d_{it} records the sectoral choice of worker i in year t. The alternative-specific value functions reflect that workers face the possibility of becoming unemployed with probability $\delta(\Omega_{it})$, which not only affects income in year t, but also the present value of future incomes. Note that workers aged 65 retire at the end of year t and therefore have no future expected values.

In the following I describe each of the components of the value function.

2.2.1. *Wages.* As is common in the literature, the wage offer a worker receives in a sector is the product of the unit price of human capital in that sector and the amount of sector-specific human capital that the worker possesses.[5] The wage offer in sector s is given by

$$(5)\qquad w^s(\Omega_{it}) = r^s_t \cdot H^s(\Omega_{it}),$$

where r^s_t is the unit price of human capital, and $H^s(\Omega_{it})$ is the amount of human capital worker i can offer to sector s. The sector-specific human capital production function can be decomposed into a deterministic part and an idiosyncratic shock. The deterministic part depends on worker characteristics such as gender, education, and experience

$$(6)\qquad H^s(\Omega_{it}) = \exp\left[\beta^s_1\text{Female}_i + \beta^s_2\text{Educ}_i + \beta^s_3\text{Exper}_{it} + \beta^s_4\left(\text{Exper}_{it}\right)^2 + \lambda^s_i + \varepsilon^s_{it}\right],$$

where Female_i is a gender indicator, Educ_i indicates if the worker has completed college education, and ε^s_{it} is the mean zero idiosyncratic human capital shock. The λ^s_i parameter

[5] See e.g. Dix-Carneiro (2014), Heckman and Sedlacek (1985), Lee (2005), and Lee and Wolpin (2006).

captures permanent unobserved (by the econometrician) heterogeneity in the human capital supplied to sector s.

Work experience, Exper_{it}, is gained for each year of employment. However, when a worker switches from one sector to another, part of his human capital is lost. Specifically, I assume that labour market experience depreciates at the sector-specific rate of $1-\gamma^s$ when switching, such that only the fraction γ^s is transferable:

$$\text{Exper}_{it} = \begin{cases} \text{Exper}_{i,t-1} + 1 & \text{if } s = s_{t-1} \\ \gamma^s \text{Exper}_{i,t-1} & \text{else} \end{cases} \tag{7}$$

The wage offers in Equations (5) and (6) differ from those in the literature in one important way.[6] Rather than accumulating sector-specific experience, workers accumulate general work experience that is then transferred across sectors only at sector-specific discounts of γ^s. The benefit of the current modelling strategy is that it avoids the initial-value problem of sector-specific experience terms: Since my dataset runs from 1996 to 2008 (see Section 3) I observe sectoral employment only in those years. The literature attempts to address this issue by assuming that only the, say, 7 latest years of employment matter for human capital. Then it is possible to treat the years from 1996 to 2002 as a pre-sample period that is used only to construct initial values for the sector-specific experience terms. My modelling of human capital avoids this issue entirely and comes with the additional computational benefit of reducing the state-space from five sector-specific experience terms to one general experience term.

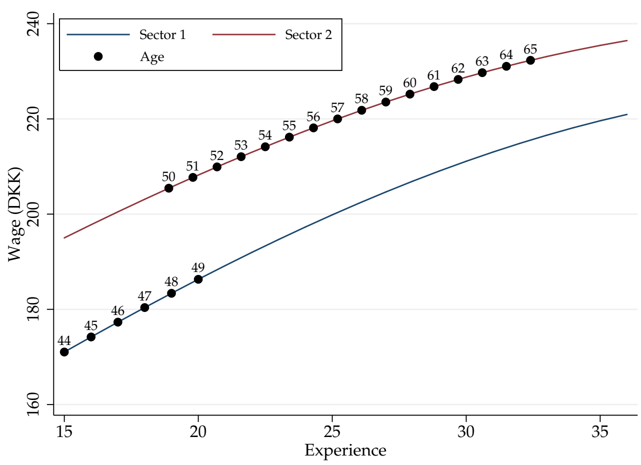


FIGURE 2.2. Wage Dynamics

[6]See Dix-Carneiro (2014) or Neal (1995).

Figure 2.2 shows what these assumptions imply in terms of wage dynamics. The solid lines in the figure show hypothetical wage profiles for different levels of experience, while the markers indicate a possible wage dynamic for a worker aged 44 to 65. Initially the worker is employed in Sector 1. Then at age 50, he decides to switch to Sector 2. This depreciates his work experience so that he enters Sector 1 with less experience than he had the year before. In this particular case, however, his wage increases in spite of the experience depreciation.

2.2.2. *Unemployment.* Workers become unemployed with individual specific probability, $\delta(\Omega_{it})$. These probabilities are allowed to vary with gender, education level, age, and previous sector of employment, meaning that workers for whom these attributes are identical face the same probability of becoming unemployed. This gives 864 unemployment probabilities that are set to the empirical frequencies observed in the data.

Here, I build a model of the institutional setting that unemployed workers face in Denmark. During spells of unemployment, the worker receives unemployment benefits, the size of which depends on whether he is eligible for UI benefits or has to rely on welfare assistance:

$$w^0\left(\Omega_{it}\right) = \begin{cases} \min\left\{k \cdot w_{i,t-\mathcal{T}}, \overline{\mathrm{UI}}\right\} & \text{if } \mathrm{Elig}_{it} = 1, \\ \mathrm{WA} & \text{if } \mathrm{Elig}_{it} = 0, \end{cases} \tag{8}$$

where k is the degree of compensation for the insured, $w_{i,t-\mathcal{T}}$ is the wage received in the most recent employment (so that $\mathcal{T}$ denotes the year of last employment), $\overline{\mathrm{UI}}$ is the maximum UI benefit, Elig_{it} is an indicator of whether the worker is eligible for UI benefits, and WA is the welfare assistance. $\overline{\mathrm{UI}}$, WA, and k are set to values that matches what unemployed Danish workers are facing.[7] Eligibility for UI benefits depends on two criteria. First, the worker must be member of a UI fund. Second, the worker must not have received UI benefits for more than 4 years. This is why it is necessary to keep track of the year of last employment: A worker is only eligible for UI benefits if $t - \mathcal{T}$ is less than or equal to 4 years.

Work experience is discounted with every year of unemployment at a rate of γ^0. Thus, if a worker with experience Exper_i is unemployed for one year before he finds

[7] Online Appendix A describes the institutional setting facing unemployed workers in Denmark in some detail.

work in sector s, he enters with experience $\gamma^s \cdot (\gamma^0 \cdot \text{Exper}_i)$, where the term in parenthesis is the human capital cost of one year of unemployment and γ^s is the human capital cost of switching to sector s.

The inclusion of unemployment is a distinct feature of my model, and allows me to asses the effects of various reforms to the institutional setting facing unemployed workers in the simulation exercises in Section 5. Specifically, I will explore the implications of lowering the period of eligibility for UI benefits from 4 years to 2 years, and of lowering the degree of compensation, k.

2.2.3. *Utility Costs.* The utility cost that a worker incurs when switching sectors is a function of gender, education and age, and is given by

(9)
$$\mathbf{C}^{s_{t-1},s}(\Omega_{it}) = \exp\left[\xi^s + \xi^{s_{t-1}} + \kappa_1 \text{Female}_i + \kappa_2 \text{Educ}_i + \kappa_3(\text{age} - 30) + \kappa_4(\text{age} - 30)^2\right],$$

where ξ^s and $\xi^{s_{t-1}}$ are parameters depending on the chosen and previous sectors, respectively. The costs are only incurred if the worker switches productive sectors from one year to the next, meaning that $\mathbf{C}^{s_{t-1},s}(\Omega_{it}) = 0$ if $s_{t-1} = s$ or $s = 0$. Since all unemployment is involuntary it is not possible to identify utility costs for switching to and from unemployment. The utility costs represent workers' distaste for switching to a new sector. It may arise for a number of reasons, e.g. due to the existence of search costs. This paper remains agnostic as to the exact source of the utility costs, and leaves exploring this important issue to future research.

2.2.4. *Expectations of Future Human Capital Prices.* For a worker to be able to decide in which sector to work in any given year, he must compute what wage offers he expects to receive in the future. These wage offers depend not only on the idiosyncratic sector specific shocks to his human capital $\boldsymbol{\varepsilon}_{i\tau}$, which is unknown to him in year $t < \tau$, but also on the unit price of human capital in all sectors, $\mathbf{r}_\tau$. The bold symbols are vectors over the five productive sectors in the economy such that the first entry of $\boldsymbol{\varepsilon}_{i\tau}$ is $\varepsilon^1_{i\tau}$ and so forth. Following Lee (2005), it is assumed that workers have perfect foresight with respect to the future sequence of human capital prices, a sequence that is computed endogenously when the model is solved.

2.2.5. *Idiosyncratic Shocks and Distribution of Types.* The vectors of idiosyncratic shocks, $\boldsymbol{\varepsilon}_{it}$ and $\boldsymbol{\eta}_{it}$, comprise the components of the state space that are unobserved by the researcher. In order to solve the model, assumptions on their distributions are necessary.

It is assumed that they are independent and drawn from a mean zero normal distribution and a mean zero Extreme Value Type I distribution, respectively:

$$\begin{aligned} \varepsilon_{it}^{s} &\overset{\text{iid}}{\sim} \mathcal{N}\left(0, \sigma^{s}\right), \\ \eta_{it}^{s} &\overset{\text{iid}}{\sim} \mathrm{EV}(-0.5772\nu, \nu). \end{aligned} \tag{10}$$

The i.i.d. extreme value assumption on the preference shocks yields a convenient closed form solution when taking the expectation, contributing to computational tractability.

In order to identify the permanent unobserved heterogeneity in the wage offers it is assumed that there are two types of workers, so that the vector (over sectors) of unobserved heterogeneity, $\boldsymbol{\lambda}_i$, has two points of support.

$$\boldsymbol{\lambda}_i \sim \left\{\left(\boldsymbol{\lambda}_1, \mathcal{P}_1\right), \left(\boldsymbol{\lambda}_2, \mathcal{P}_2\right)\right\}, \tag{11}$$

where $\mathcal{P}_1$ and $\mathcal{P}_2$ are the probabilities of being a type 1 and type 2 worker, respectively. The type probabilities are assumed to depend on gender, level of education and general work experience

$$\begin{aligned} \mathcal{P}_1 &= \frac{1}{1 + \exp\left[\phi_0 + \phi_1 \mathrm{Female}_i + \phi_2 \mathrm{Educ}_i + \phi_3 \mathrm{Exper}_i\right]}, \\ \mathcal{P}_2 &= 1 - \mathcal{P}_1, \end{aligned} \tag{12}$$

and the parameters in these equations are estimated along with the other structural parameters of the model.

2.2.6. *State Space.* Finally, having specified all the variables necessary for workers' decision making, it is possible to define the state space, Ω_{it}. It is given by all variables that are relevant for the determination of the real wage the worker would get in any sector and any other variables relevant for the formation of expectations.

$$\Omega_{it} = \left\{\mathrm{age}_i, \mathrm{Female}_i, \mathrm{Educ}_i, \mathrm{Elig}_{it}, \mathrm{Exper}_{it}, \{\mathbf{r}_{t+\tau}\}_{\tau=0}^{65-\mathrm{age}_i}, s_{t-1}, w_{i,t-\mathcal{T}}, \boldsymbol{\lambda}_i, \boldsymbol{\eta}_{it}, \boldsymbol{\varepsilon}_{it}\right\}. \tag{13}$$

These include age, gender, level of education, eligibility for UI benefits, experience, the sequence of future human capital prices, previous sector including unemployment, wage in last employment, and current idiosyncratic shocks.

Again, the bold symbols for $\mathbf{r}$, $\boldsymbol{\lambda}$, $\boldsymbol{\eta}$ and $\boldsymbol{\varepsilon}$ indicate vectors over the five productive sectors. Note that $\{\mathbf{r}_{t+\tau}\}_{\tau=0}^{65-\mathrm{age}}$ is the sequence of human capital returns that workers of any ages face from the current year until retirement. Thus, for a worker of age 60 in year t, what matters for the current sectoral choice are the current human capital prices, $\mathbf{r}_t$, and those of the following five years until year $t+5$.

2.3. **Model Equilibrium.** In year t, each worker solves his optimisation problem given by Equations (3) and (4) in order to decide what sector to work in. Once all workers have made their choices, the total supply of human capital to sector s is

$$H_t^{s,sup}\left(\{\mathbf{r}_{t+\tau}\}_{\tau=0}^{35}\right) = \sum_{a=30}^{65}\sum_{i=1}^{n_{at}} H^s\left(\Omega_{it}\right)\cdot \mathbf{1}\left\{d_{it}=s\right\}, \tag{14}$$

where $H^s(\Omega_{it})$ is the individual sector specific human capital of worker i, $\mathbf{1}\{d_{it}=s\}$ is an indicator function for sectoral choice s, and n_{at} is the number of workers of age a in year t. The current aggregate supply of human capital in sector s, $H_t^{s,sup}$, is a function of the entire sequence of human capital prices in all sectors, $\{\mathbf{r}_{t+\tau}\}_{\tau=0}^{35}$.

In equilibrium, sectoral supply of human capital, from Equation (14), equals sectoral demand, which is found from Equation (2) to be

$$H_t^{s,dem} = \alpha_t^s \frac{Y_t^s}{r_t^s}.$$

Combining the aggregate supply and demand for human capital yields the equilibrium condition for sector s

$$H_t^{s,sup}\left(\{\mathbf{r}^*_{t+\tau}\}_{\tau=0}^{35}\right) = \alpha_t^s \frac{Y_t^s}{r_t^{s,*}}, \tag{15}$$

whose solution determines the equilibrium human capital prices. As my sample period is finite, I am able to impose perfect foresight only between the initial and final sample years. Therefore it is assumed that workers have static expectations from the the final year onwards. Thus, when deciding where to work in, say, the final sample year, a worker of age 30, who forms expectations on the future sequence of human capital prices from now until he retires at age 65, assumes that future human capital prices remain at their contemporaneous levels.

As the aggregate sectoral value added series, Y_t^s, and wage bill series, $\alpha_t^s Y_t^s$, are observed in the data, I impose these during estimation. This entirely removes the need to make assumptions on the evolution of physical capital.

2.4. **Solving the Model.** The set of structural model parameters consists of the discount factor, ρ, the full set of 25 wage offer function parameters for all sectors, $\boldsymbol{\beta}$ and $\boldsymbol{\sigma}$, the 14 unobserved permanent heterogeneity and type probability parameters, $\boldsymbol{\lambda}$ and $\boldsymbol{\phi}$, the 14 mobility cost parameters, $\boldsymbol{\xi}$ and $\boldsymbol{\kappa}$, the 6 experience depreciation parameters γ, the 3 unemployment benefit parameters, k, $\overline{\text{UI}}$, and WA, the scale parameter of the preference shock, $\boldsymbol{\nu}$, and finally the 864 unemployment probability parameters, δ.

Solving the model for a given set of structural parameters involves computing the expected values in the Bellman equations (3) and (4), which presents several computational challenges. First, taking the expectation involves integrating over the distributions of η_{it}^s and ε_{it}^s. The distributional assumptions on these in (10), means that the integral over η_{it}^s has a convenient closed form solution (Rust, 1994). The integral over ε_{it}^s does not have a closed form, and therefore has to be numerically approximated. Here the integration is done by Monte Carlo methods.[8] The second difficulty concerns the "curse of dimensionality". The state space in (13) is large and contains continuous variables ($\{\mathbf{r}_{t+\tau}\}_{\tau=0}^{65-a}$ and $w_{i,t-\mathcal{T}}$). To address this issue, I employ the Keane and Wolpin (1994) method of computing the expectations only at a subset of the state space and then inter- and extrapolating over this subset by regression. Here, that is done by second order polynomial regression, including all cross-terms. To obtain the equilibrium sequence of of human capital prices, I use the perfect foresight algorithm developed by Lee (2005).

Dropping the individual subscript i for convenience, define

$$\begin{aligned}&\text{Emax}_t\left(\text{age}, \text{Female}, \text{Educ}, \text{Elig}_t, \text{Type}, s_{t-1}, \text{Exper}_t, \mathbf{r}_t, \{\mathbf{r}^*_{t+\tau}\}_{\tau=1}^{65-\text{age}}, w_{t-\mathcal{T}}\right) = \\ &\mathbb{E}_{\varepsilon,\eta}\mathbf{V}\left(\text{age}, \text{Female}, \text{Educ}, \text{Elig}_t, \text{Exper}_t, \mathbf{r}_t, \{\mathbf{r}^*_{t+\tau}\}_{\tau=1}^{65-\text{age}}, w_{t-\mathcal{T}}, \boldsymbol{\lambda}, \boldsymbol{\varepsilon}, \boldsymbol{\eta} \mid d_{t-1} = s_{t-1}\right)\end{aligned}$$

to be the expected value, prior to drawing contemporaneous shocks of $\boldsymbol{\varepsilon}$ and $\boldsymbol{\eta}$, of a worker in year t, who in the previous year was employed in sector s_{t-1}, where s_{t-1} can also be 0, in which case the worker was unemployed. Here, $\mathbf{r}_t$ is the current human capital prices, and $\{\mathbf{r}^*_{t+\tau}\}_{\tau=1}^{65-\text{age}}$ are the future human capital prices. Given the assumptions of the model, $\boldsymbol{\lambda}$ depends only on whether the worker is of type 1 or 2. Now, let

$$\Delta = \left\{(\text{Exper}_t, \mathbf{r}_t, w_{t-\mathcal{T}}) \mid \text{Exper}_t \leq 35;\ \underline{r} \leq r^s \leq \overline{r};\ \underline{w} \leq w_{t-\mathcal{T}} \leq \overline{w}\right\},$$

where $\underline{r}$, $\overline{r}$, $\underline{w}$, and $\overline{w}$ are lower and upper bounds for human capital prices and wage in previous employment, respectively.[9] $\text{Emax}_t(\cdot)$ is approximated for all Female $\in \{0, 1\}$,

[8] Other integration methods can be used such as Gauss-Hermite quadrature (Judd, 1998), but these methods are computationally expensive for high-dimensional problems. Although the dimensionality problem can be somewhat alleviated by sparse grid or monomial methods, this comes at the cost of precision.

[9] The choice of upper and lower bounds for $\boldsymbol{r}$ and $w_{t-\mathcal{T}}$ is somewhat arbitrary. They should be chosen to give sufficient variation for the interpolation regression. Here, they are chosen such that all observed values lie within the bounds.

Educ $\in \{0,1\}$, Elig $\in \{0,1\}$, Type $\in \{1,2\}$, and $s_{t-1} \in \{0,1,2,3,4,5\}$ by the backward recursion algorithm:

(1) Start at the final period $t = T$ and the final age $= 65$. Draw $N = 1500$ random values of $\{\mathbf{z}^n = (\text{Exper}^n, \mathbf{r}^n, w^n_{T-\mathcal{T}})\}_{n=1}^N \in \Delta$.

(2) For each n draw $\boldsymbol{\varepsilon}$ and integrate over $\boldsymbol{\eta}$. Then integrate over the $\boldsymbol{\varepsilon}$ draws to get an approximation of $\text{Emax}_T(65, \text{Female}, \text{Educ}, \text{Elig}_T, \text{Type}, s_{T-1}, \mathbf{z}^n)$.

(3) Approximate $\text{Emax}_T(65, \text{Female}, \text{Educ}, \text{Elig}_T, \text{Type}, s_{T-1}, \cdot)$ by a second order polynomial regression, including cross-products, of $\text{Emax}_T(65, \text{Female}, \text{Educ}, \text{Elig}_T, s_{T-1}, \text{Type}, , \mathbf{z}^n)_{n=1}^N$ on $\{1, \text{Exper}^n, \mathbf{r}^n, w^n_{T-\mathcal{T}}\}_{n=1}^N$. This polynomial regression gives a very good fit: For all regressions I have $R^2 \geq 0.90$.

(4) Repeat steps 1 to 3 recursively for age $= 64$ through age $= 31$ to get an approximation for $\text{Emax}_T(\text{age}, \text{Female}, \text{Educ}, \text{Elig}_T, \text{Type}, s_{T-1}, \cdot)$. Since this is the final year workers have static expectations over the future human capital prices.

(5) Repeat steps 1 to 4 for periods $t = T-1$ to $t = 1$ using equilibrium skill prices such that $\mathbf{r}_t = \mathbf{r}^*_t$.

Once the model is solved, it can be estimated. The paper proceeds with a section describing the dataset used for estimation before turning to estimation strategy and results.

3. DATA

Estimating the empirical model puts certain requirements on the data. It necessitates the use of panel data on the worker side, including observations of outcomes for the unemployed. It also requires panel data on sectoral real value added and income shares for the factors of production. Both such datasets are available from Statistics Denmark for the period 1996 to 2008. This section documents each of the sources of these data, and gives some descriptive statistics.

3.1. **Worker Data.** For each year in the sample period, the worker data is taken from the administrative register "Integrated Database for Labour Market Research" (IDA), which covers the entire Danish population aged 15-74. At birth, or when becoming a permanent resident, every individual is given a unique personal identification number, used by the local and central government to record a variety of individual level information. Likewise, the universe of Danish firms, each with a unique identifier, are recorded in the "Firm Statistics Register" (FirmStat), whose information allows me to assign each firm to the five productive sectors that are defined in accordance with the NACE Rev. 2 statistical classification of economic activities in the European Union. Workers and firms can then be matched using the "Firm-Integrated Database for Labour Market Research" (FIDA) database.

From this matched worker-firm dataset I extract data on age, gender, labour market status (employed or unemployed), UI fund membership, work experience, and hourly wages for workers aged 30 to 65. The entry age of 30 is chosen since almost all workers have completed their education at this age. For workers who are employed I observe hourly wage rates, while for the unemployed I observe unemployment benefits, which can be decomposed into UI benefits for those eligible and welfare assistance for others. It is possible to match workers with firms only from 1995 onwards, so I use the 1995 data to construct initial conditions for estimating the model.

The dataset allows me to track individual workers over the sample period, which makes it possible to construct sectoral transition rates as well as transitions to and from unemployment. Table 3.1 shows average yearly transition rates between the five productive sectors as well as the unemployment sector. Several features are worth noting.

TABLE 3.1. Average Yearly Transition Rates

From ↓ , To →	(0)	(1)	(2)	(3)	(4)	(5)
(0)	0.4794	0.0141	0.1053	0.0436	0.1046	0.2531
(1)	0.0409	0.8447	0.0281	0.0228	0.0265	0.0370
(2)	0.0294	0.0017	0.9090	0.0080	0.0249	0.0271
(3)	0.0290	0.0042	0.0208	0.9009	0.0191	0.0261
(4)	0.0227	0.0016	0.0226	0.0063	0.9144	0.0324
(5)	0.0182	0.0009	0.0075	0.0026	0.0111	0.9596

Sectors: (0) Unemployment, (1) Agriculture/Mining, (2) Manufacturing, (3) Construction, (4) Trade/Utilities/Transportation/Communication, (5) Services.

First, a key feature of the data that the model must be able to replicate is the high degree of persistence in sectoral choices: The diagonal elements of the transition matrix are all much larger than the off-diagonals, which may be the result of workers being unable to arbitrage wage differentials. Second, although there is persistence in unemployment, the persistence is smaller than that of the productive sectors. Third, workers initially unemployed are less likely to find a job in the Agriculture/Mining sector and the Construction sector than they are of finding a job in the other sectors, with the service sector being the most likely employer. Moreover, workers initially employed in

Agriculture/Mining are those most likely to become unemployed, while those from the Service sector are least likely.

A final observation is timely here. The transition rates to unemployment from any sector can be further decomposed into rates as a function of worker characteristics such as age, gender, and education level. This decomposition gives exactly the unemployment probabilities, $\delta(\Omega_{it})$, from Section 2, which is then fixed throughout the estimation procedure.

3.2. **Aggregate Series.** The aggregate series used for estimation and simulation are taken from the online databases of Statistics Denmark.[10] From the PRIS8 database I extract the Consumer Price Index (CPI) and set the base year to 2000. Gross value added series on the sectoral level are obtained from NATE101, while income shares for human capital and physical capital, also on the sectoral level, are constructed from data from NATE102 as

$$\alpha_t^s = \frac{(\text{Wage bill})_t^s}{(\text{Gross value added})_t^s - (\text{Production taxes})_t^s},$$

with the physical capital share being $1 - \alpha_t^s$. Figure 3.1 shows the evolution of human capital income shares.

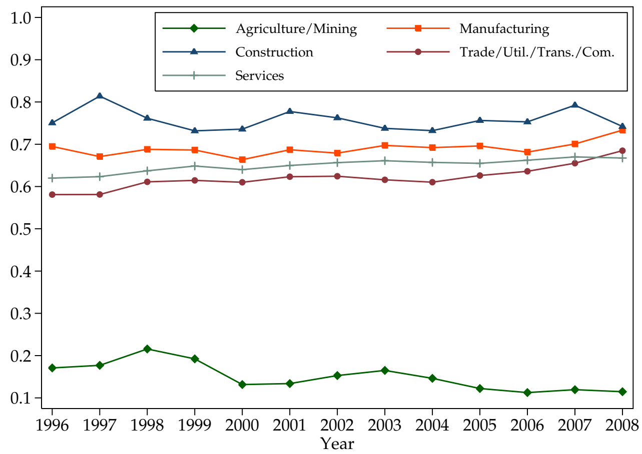


FIGURE 3.1. Evolution of Labour Income Shares

From NAT09N I extract data on sectoral capital stocks, which together with income shares of capital allows me to compute the return to capital in sector s as

$$r_t^{s,K} = (1 - \alpha_t^s)\,\frac{Y_t^s}{K_t^s} = \frac{(\text{Gross surplus from production})_t^s}{(\text{Capital stock})_t^s}.$$

[10] Statistikbanken (http://statistikbanken.dk)

Finally, using Input-Output tables for the Danish economy in 2008, I construct economy-wide expenditure shares as

$$\mu^s = \frac{(\text{Total uses})^s}{\sum_{k=1}^{5} (\text{Total uses})^k},$$

where $(\text{Total uses})^s$ is the share of income that is spent on the output of sector s for any use, including purchases from other sectors. The expenditure shares are shown in Table 3.2.

TABLE 3.2. Expenditure Shares

	μ^s
Agriculture/Mining	0.0114
Manufacturing	0.1757
Construction	0.0610
Trade/Util./Trans./Com.	0.2748
Services	0.4770

In order to reduce the choice set, the sectors have been aggregated to the five productive sectors of (1) Agriculture/Mining, (2) Manufacturing, (3) Construction, (4) Trade/Utilities/Transportation/Communication, (5) Services. The exact composition of each sector is specified in Online Appendix B. Aggregate data series for these sectors are readily available from the sources indicated above.

4. ESTIMATION STRATEGY AND RESULTS

The model has 928 structural parameters. Of these, 864 are unemployment probabilities that are set to the values observed in the data. The three unemployment benefit parameters are chosen to replicate the institutional setting in Denmark. The discount factor is set to 0.95. This leaves 60 parameters. These are further reduced by assuming that the unobserved permanent heterogeneity parameters of Type 1 workers is zero. This assumption aids in the identification of the remaining unobserved heterogeneity parameters and is common in the literature.[11] Finally, the fixed utility cost parameter for choosing the Agriculture/Mining sector, $\xi^{s=1}$, is set to zero so that the remaining ξ parameters are interpreted in terms relative to switching to this sector. That leaves 54 structural parameters, denoted by θ, to be estimated.

These are estimated using Simulated Minimum Distance (SMD), also known as Indirect Inference (see Hall and Rust (2002) and Gourieroux and Monfort (1996) for details).

[11] See e.g. Dix-Carneiro (2014).

As the name suggests, this is a simulation based estimation technique that minimises the distance between a set of simulated and sample moments, known as Auxiliary Parameters (APs). The sample APs are calculated once and for all, and stored in a vector, $\mathbf{a}^D$. Then, for a trial value of θ, the APs are calculated on data from one or more simulations of the model, and stored in $\mathbf{a}^S(\theta)$. The SMD estimator of θ is the vector that minimises a quadratic form of distance between the two sets of APs:

$$\widehat{\theta}_{SMD} = \arg\min_{\theta} \left[\mathbf{a}^S(\theta) - \mathbf{a}^D\right]' \mathbf{A} \left[\mathbf{a}^S(\theta) - \mathbf{a}^D\right],$$

where $\mathbf{A}$ is a positive definite matrix. So long as the APs are well enough specified, $\widehat{\theta}_{SMD}$ is a consistent estimator (asymptotically) of the true structural parameters, even when computing $\mathbf{a}^S(\theta)$ using a single simulation. As shown in Online Appendix C, using a single simulation effectively doubles the asymptotic variance of the SMD estimator compared to a situation where the number of simulations approaches infinity. In the present context, this is a fairly small price to pay when compared to the significant computational gain of simulating data from the model only once.

4.1. **Auxiliary Parameters.** The purpose of the APs is to capture statistical relationships that allows for identification of the structural parameters of the model. Therefore, although the researcher's choice of APs may seem rather *ad hoc*, the choice should be motivated by identification reasons. As the parameters to be estimated here relate to the wage offer functions and the utility costs of switching, the APs are simply chosen to be the coefficients of OLS regressions of the form

$$Y_{it} = X_{it}'\zeta + \lambda_t + \eta_{it},$$

where Y_{it} is the outcome, X_{it} is a vector of regressors excluding a constant, ζ is a parameter vector, and λ_t are year fixed effects for each of the years from 1996 to 2008.

In order to identify the parameters of the wage offer functions in Equations (5) and (6), the first set of regressions are chosen to be log wage regressions for each of the five productive sectors. In addition to recording the coefficients, I also record the standard error of the regressions to help in the identification of the standard error of the shock to human capital. For these regressions, the regressors X_{it} are a female dummy, a college education dummy, age, age squared, and experience. The AP-coefficients on gender and education are directly relevant for the identification of their corresponding structural parameters (β_1^s and β_2^s), while the age and experience coefficients help identify both the experience coefficients (β_3^s and β_4^s) and the fraction of experience that is transferable (γ^s) in Equation (7). The time dimension aids in the identification of the unobserved permanent heterogeneity parameters and the corresponding type probability parameters (λ_i^s and ϕ_0–ϕ_3) in Equation (12). However, identification of the latter is also aided by the AP-coefficients on the female dummy, the education dummy, and the age and experience terms.

The next set of regressions are linear probability models (LPMs) for sectoral choices (five regressions) where the left-hand side variable for each regression is an indicator for working in a particular sector. Finally I have LPMs for transitions between any pair of productive sectors (25 regressions). For all LPMs, I also include log wages as an additional regressor to get sectoral choices and transitions conditional on wages. These regressions are crucial for identifying the utility cost parameters in Equation (9). The idea is that, for a given wage, the LPMs are informative on the characteristics of those who are likely to switch sectors and the characteristics of those who are not. The transition regressions are also important for identifying the scale parameter on the preference shock (ν). Finally, it should be noted that these APs also aid in the identification of the fraction of experience that is transferable across sectors and the unobserved permanent heterogeneity parameters.

The APs are comprised of the ζ's and λ's from the regressions, as well as the root mean squared error of the log wage regressions, making a total of 665 APs. Online Appendix D shows the results of their estimation on the sample data. The efficient choice of the weighting matrix, $\mathbf{A}$, is the inverse covariance matrix of the APs, which I bootstrap also using the matched worker-firm data.

4.2. **Estimation Procedure.** The estimation procedure involves searching for a minimum over the 54 structural parameters. As already mentioned, the remaining parameters (unemployment probabilities, unemployment benefit parameters, and the discount factor) are calibrated. The parameters concerning unemployment benefits are set to mimic the institutional setting faced by Danish workers (see Online Appendix A).

The estimation procedure follows the steps:

(1) From the data, obtain series for real value added, Y_t^s, and human capital income shares, α_t^s. These are imposed throughout the estimation procedure.
(2) Obtain the 665 sample auxiliary parameters, $\mathbf{a}^D$, and get their covariance matrix by a bootstrap procedure.

TABLE 4.1. Calibrated Parameters

Parameter		Equation	Value	USD
Discount factor,	ρ	(4)	0.95	
Compensation rate,	k	(8)	0.90	
Maximum benefit,	$\overline{\text{UI}}$	(8)	101	\$22.47
Welfare assistance,	WA	(8)	75	\$16.69

The values for $\overline{\text{UI}}$ and WA are hourly real benefits in 2000 DKK, calculated by dividing deflated annual figures by 1,702 work hours per year. The last column shows the benefits in current US dollars using Danish CPI of 1.288 to convert to 2012 DKK and then the exchange rate of 5.79 DKK/\$.

(3) Solve the structural model and simulate sectoral choice paths that resembles those observed in the data with respect to e.g. age, gender and education profiles. Obtain simulated auxiliary parameters, $\mathbf{a}^S(\theta)$, using the simulated data.
(4) Search for the structural parameter vector, $\widehat{\theta}_{SMD}$, that minimises the quadratic distance between the simulated and sample auxiliary parameters using the bootstrapped covariance matrix as the weighting matrix.[12]

Once the structural model parameters are estimated, the covariance matrix is computed at their optimised values. As shown in Online Appendix C, the covariance matrix for the estimated parameters is computed using the bootstrapped covariance matrix of the sample auxiliary parameters. Thus, the precision of the structural estimates are a function of the precision of the auxiliary estimates.

4.3. **Estimation Results.** Panels A to F of Table 4.2 present estimates for the 54 structural parameters of the model. The human capital production functions for the five productive sectors are shown in Panel A. They show that, on average, women earn less than men, higher educated workers have higher wages, and wages increase at a decreasing rate in work experience. Panel B reports estimates for the standard deviation of the human capital shocks and the scale parameter for the preference shocks. The smallest and largest values of σ are found for sectors 1 and 4, respectively. The estimates suggest that a one standard deviation idiosyncratic shock to human capital raises wages by 20% to 22%.

The unobserved permanent heterogeneity parameters in Panel C are all positive. Having restricted these to be zero for type 1 workers, these results can be interpreted as indicating that type 2 workers are more productive. Panel D shows the estimates of the

[12] I use the Nelder-Mead simplex search algorithm. Only the diagonal elements of the bootstrapped covariance matrix is used.

TABLE 4.2. Parameter Estimates

Panel A: Human Capital Production Functions, Equation (6)						
		(1)	(2)	(3)	(4)	(5)
β_1, Female		-0.253086	-0.176116	-0.297340	-0.204478	-0.143008
		(0.000192)	(0.000055)	(0.000336)	(0.000089)	(0.000085)
β_2, Educ		0.139063	0.319737	0.244914	0.218590	0.240135
		(0.000085)	(0.000295)	(0.000141)	(0.000113)	(0.000182)
β_3, Exper		0.042649	0.027848	0.032080	0.030190	0.021670
		(0.000003)	(0.000001)	(0.000002)	(0.000002)	(0.000001)
β_4, Exper^2		-0.000562	-0.000307	-0.000404	-0.000339	-0.000245
		(0.000000)	(0.000000)	(0.000000)	(0.000000)	(0.000000)
Panel B: Standard Errors and Scale Parameter of Shocks, Equation (10)						
		(1)	(2)	(3)	(4)	(5)
σ		0.179779	0.198677	0.180949	0.199401	0.183374
		(0.000102)	(0.000097)	(0.000073)	(0.000096)	(0.000100)
ν	2.277571					
	(0.013895)					
Panel C: Unobserved Permanent Heterogeneity, Equation (6)						
		(1)	(2)	(3)	(4)	(5)
λ		1.335654	0.901221	1.164783	1.065557	0.867373
		(0.003038)	(0.000953)	(0.003486)	(0.002171)	(0.001421)
Panel D: Type Probabilities, Equation (12)						
	Constant	Female	Educ	Exper		
ϕ	0.737795	-0.206102	0.283763	0.091694		
	(0.001046)	(0.000236)	(0.000875)	(0.000018)		
Panel E: Transferability of Experience, Equation (7)						
	(0)	(1)	(2)	(3)	(4)	(5)
γ	0.936391	0.929973	0.965635	0.936070	0.882965	0.979561
	(0.000887)	(0.000242)	(0.000138)	(0.000187)	(0.000194)	(0.000059)
Panel F: Utility Costs of Switching, Equation (9)						
		(1)	(2)	(3)	(4)	(5)
ξ^{s}		2.125859	2.010794	1.789689	2.117272	2.961471
		(0.008920)	(0.011656)	(0.011867)	(0.017784)	(0.021863)
$\xi^{s_{t-1}}$			0.616659	0.759066	1.175710	1.922661
			(0.001529)	(0.001757)	(0.005167)	(0.010026)
	Female	Educ	Age	Age^2		
κ	0.244669	-0.413461	0.035420	-0.000382		
	(0.000468)	(0.000706)	(0.000002)	(0.000000)		

Standard errors in parenthesis. Sectors: (0) Unemployment, (1) Agriculture/Mining, (2) Manufacturing, (3) Construction, (4) Trade/Utilities/Transportation/Communication, (5) Services.

parameters determining type probabilities. These are interpreted in Table 4.3, which presents the distribution of type probabilities for type 1 workers (the corresponding type 2 probabilities are 1 minus the type 1 probabilities). The probability of being a type 1 worker decreases in education and experience, with women being more likely to be type 1 than men.

TABLE 4.3. Distribution of Type 1 Probabilities

	Experience						
	1	5	10	15	20	25	30
Panel A: Male							
Educ = 0	0.3038	0.2321	0.1605	0.1078	0.0710	0.0461	0.0296
Educ = 1	0.2473	0.1854	0.1258	0.0834	0.0544	0.0351	0.0225
Panel B: Female							
Educ = 0	0.3490	0.2709	0.1902	0.1293	0.0858	0.0560	0.0362
Educ = 1	0.2876	0.2186	0.1503	0.1006	0.0660	0.0428	0.0275

The table shows the distribution of Type 1 probabilities, $\mathcal{P}_1$ from Equation (12), for workers with 1 to 30 years of work experience, conditional on college education and gender. Type 2 probabilities are $\mathcal{P}_2 = 1 - \mathcal{P}_1$.

Panel E shows estimates of the fraction of work experience that is transferable when switching sectors. Work experience is most transferable to the Service sector and least transferable to the Trade/Utilities/Transportation/Communication sector. The panel also shows that each year of unemployment depreciates 6.4% of previous experience. Consider an unemployed worker who has to decide which sector to re-enter. Table 4.4 shows the fraction of previous experience that he is able to retain as a function of the number of years he has been unemployed and the return sector. One year of unemployment depreciates experience between 8% and 17%. These numbers increase in the number of years he has been unemployed. As illustrated in Figure 2.2, depreciation of work experience does not necessarily equal lower wages as wages depend both on the parameters of the human capital functions and on the prices of human capital.

Finally, Panel F shows parameter estimates for the utility costs of switching. These are higher for women, lower for higher educated workers, and increasing at a decreasing rate in age. They differ across sectors due to the sector specific fixed parameters, ξ^s and $\xi^{s_{t-1}}$. To interpret these, Table 4.5 shows the median costs of entering the indicated sector in terms of average annual wages and in terms of expected future earnings. The median cost of entering the Service sector is 18% of average annual wages while the corresponding number for the Construction sector is 10%. However, in terms of future

TABLE 4.4. Retainment of Experience Following Unemployment

	Years Unemployed				
	1	2	3	4	5
Return Sector					
(1)	0.8708	0.8154	0.7636	0.7150	0.6695
(2)	0.9042	0.8467	0.7928	0.7424	0.6952
(3)	0.8765	0.8208	0.7686	0.7197	0.6739
(4)	0.8268	0.7742	0.7250	0.6788	0.6357
(5)	0.9173	0.8589	0.8043	0.7531	0.7052

The table shows the fraction of initial work experience that is retained following an unemployment spell of 1 to 5 years. Return sectors: (1) Agriculture/Mining, (2) Manufacturing, (3) Construction, (4) Trade/Utilities/Transportation/Communication, (5) Services.

earnings, these drop to 0.9% and 0.5%, respectively. Note that when computing the costs in terms of future earnings that the future earnings vary greatly over workers of different ages: The future earnings of a 64 year old worker is lower than for a 35 year old as the older worker only has one year left on the labor market prior to retirement.

The utility costs of switching sectors are significantly lower than those found for Brazil by Dix-Carneiro (2014), who found median costs of 1.4 to 2.7 times average annual wages. The costs are also much lower than the intersectoral switching costs reported by Artuç, Chaudhuri, and McLaren (2010) for the U.S. of about 6 times average annual wages.[13] That the utility costs are lower for Denmark suggests that the Danish economy is better able to adjust to shocks that change the equilibrium sectoral distribution of workers. However, it is important to stress that the total adjustment costs include both the utility costs and the imperfect transerability of human capital. Thus, low utility costs do not suggest that the adjustment costs are insignificant. I turn to the question of quantifying the adjustment costs in Section 5 after discussing the goodness of fit of the model.

4.4. **Goodness of Fit.** To asses the goodness of fit of my model, I plot the auxiliary parameters from the data against auxiliary parameters simulated from the model. A perfect fit would result in all point lying on the plotted 45 degree line. Though all points are not on the 45 degree line, the estimated model does a sensible job of matching the moments from the observed data. The parameters that are most off the diagonal are related

[13]Note that the estimates in Artuç, Chaudhuri, and McLaren (2010) are not directly comparable to those found here as they employ a very different model where workers are homogeneous apart from an i.i.d. random shock.

TABLE 4.5. Median Utility Costs of Switching

	Entry costs in terms of	
	Annual Wages	Future Earnings
Agriculture/Mining	0.1371	0.0071
Manufacturing	0.1404	0.0075
Construction	0.1031	0.0053
Trade/Util./Tran./Com.	0.1542	0.0078
Services	0.1796	0.0086

Median costs of entry to the indicated sector is computed as $\mathbf{C}^{ss'}(X_i)/\hat{w}(X_i)$ in the first column, where $\hat{w}(X_i)$ is an estimate of the average annual wage of a worker with characteristics X_i. In the second column the utility cost is computed as $\mathbf{C}^{ss'}(X_i)/\mathbb{E}\mathbf{V}(X_i)$, where $\mathbb{E}\mathbf{V}(X_i)$ is the present value of expected future earnings.

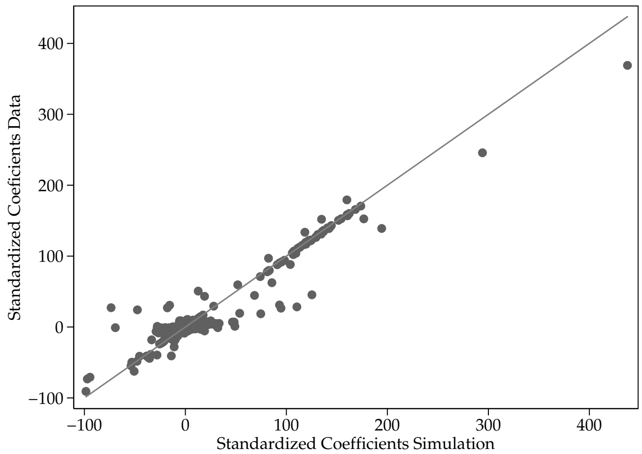


FIGURE 4.1. Goodness of Fit – Scatter over 45 degree line

to the LPMs for sectoral transitions out of the Trade/Utilities/Transportation/Communication sector. This is corroborated in Table 4.6. Panel A replicates the sectoral transition matrix from Table 3.1 while Panel B shows the transition matrix in the data simulated by the model. Though the model generally does a reasonable job of replication the transitions present in the data, it does less well in replicating the transitions away from the Trade/Utilities/Transportation/Communication sector as shown in row (4) of Panel B.

Table 4.7 shows average sectoral choices in actual and simulated data. The model somewhat underestimates the fraction of workers choosing the Service sector while it overestimates the fraction of Trade/Utilities/Transportation/Communication workers.

TABLE 4.6. Sectoral Transition Matrix

PANEL A: ACTUAL DATA						
From ↓ , To →	(0)	(1)	(2)	(3)	(4)	(5)
(0)	0.4794	0.0141	0.1053	0.0436	0.1046	0.2531
(1)	0.0409	0.8447	0.0281	0.0228	0.0265	0.0370
(2)	0.0294	0.0017	0.9090	0.0080	0.0249	0.0271
(3)	0.0290	0.0042	0.0208	0.9009	0.0191	0.0261
(4)	0.0227	0.0016	0.0226	0.0063	0.9144	0.0324
(5)	0.0182	0.0009	0.0075	0.0026	0.0111	0.9596
PANEL B: SIMULATED DATA						
(0)	0.4968	0.0155	0.0891	0.0470	0.1117	0.2399
(1)	0.0405	0.8217	0.0333	0.0145	0.0325	0.0574
(2)	0.0291	0.0023	0.9146	0.0082	0.0143	0.0315
(3)	0.0293	0.0031	0.0179	0.9103	0.0195	0.0199
(4)	0.0230	0.0009	0.0049	0.0034	0.9648	0.0031
(5)	0.0190	0.0005	0.0065	0.0029	0.0066	0.9645

Sectors: (0) Unemployment, (1) Agriculture/Mining, (2) Manufacturing, (3) Construction, (4) Trade/Utilities/Transportation/Communication, (5) Services.

TABLE 4.7. Average Sectoral Choices

	Actual Data	Simulated Data
Unemployment	0.0397	0.0438
Agriculture/Mining	0.0132	0.0117
Manufacturing	0.1861	0.1736
Construction	0.0591	0.0609
Trade/Util./Tran./Com.	0.1948	0.2230
Services	0.5071	0.4871

5. SIMULATIONS

Now that the parameters of the model are estimated, it can be used to evaluate the effects of counter-factual structural changes in the model economy. The focus here is to study the dynamics following a shock to the manufacturing sector that both increases the probability of becoming unemployed for workers there and, at the same time, reduces the output price of the sector. Before doing that, however, it will be useful to consider the shocks in isolation in order to compare the differential way in which they affect the economy. This section therefore considers the dynamics following three shocks: (i) an unemployment shock only, (ii) a price shock only, and (iii) a joint unemployment and price shock). All shocks occur to the manufacturing sector. A maintained assumption through all simulations is that only the outputs of the agriculture/mining sector and the manufacturing sector are traded globally at exogenous world market prices. The output prices of the remaining non-traded sectors are endogenously determined by the model.

The unemployment shock is modelled as a permanent unanticipated doubling of the unemployment probability for workers employed in manufacturing, such that a worker previously facing a one percent probability of becoming unemployed now faces a two percent unemployment probability. The price shock is modelled as a permanent 10% decline in the output price of the manufacturing sector.

5.1. **Additional Assumptions.** In estimating the model in Section 4, no assumptions were made on the accumulation of physical capital. All that was needed was the sectoral real value added series and income shares, both of which were observed.[14] When simulating the model this no longer suffices: Further assumptions are necessary in order to endogenize output prices for the non-traded sectors. I assume that the sectoral returns to physical capital, which are observed in the sample period (see Section 3), remain fixed at their 2008 level. This has two consequences: (i) Physical capital cannot flow across sectors, so physical capital is sector specific, and (ii) Sectoral physical capital levels adjust freely in order for physical capital returns to remain constant. This has the consequence that, for the traded-goods sectors, the marginal product of human capital will only be affected by changes to the exogenous prices or to productivity.

The instantaneous utility from consumption is given by the Cobb-Douglas function

$$u(\mathbf{C}) = \prod_{s=1}^{5} C_s^{\mu^s},$$

where the expenditure shares, $\boldsymbol{\mu}$, are those from Table 3.2. The indirect utility of a worker with nominal wage w_t is then $w_t / \prod_{s=1}^{5} (p_t^s)^{\mu^s}$. The real income of capital owners is $\sum_{s=1}^{5} r_t^{s,K} K_t^s$.

[14] This is an implicit assumption that capital is allocated efficiently during the estimation procedure.

All output from the non-traded sectors must be consumed domestically, which identifies the output prices of these sectors:

$$\mu^s \sum_{k=1}^{5} Y_t^k = Y_t^s \iff$$
$$p_t^s = \frac{\mu^s}{1-\mu^s} \left[\frac{\left(\sum_{k=1}^{5} Y_t^k \right) - Y_t^s}{A_t^s \left(H_t^s\right)^{\alpha_t^s} \left(K_t^s\right)^{1-\alpha_t^s}} \right] \quad \text{for } s = 3, 4, 5.$$

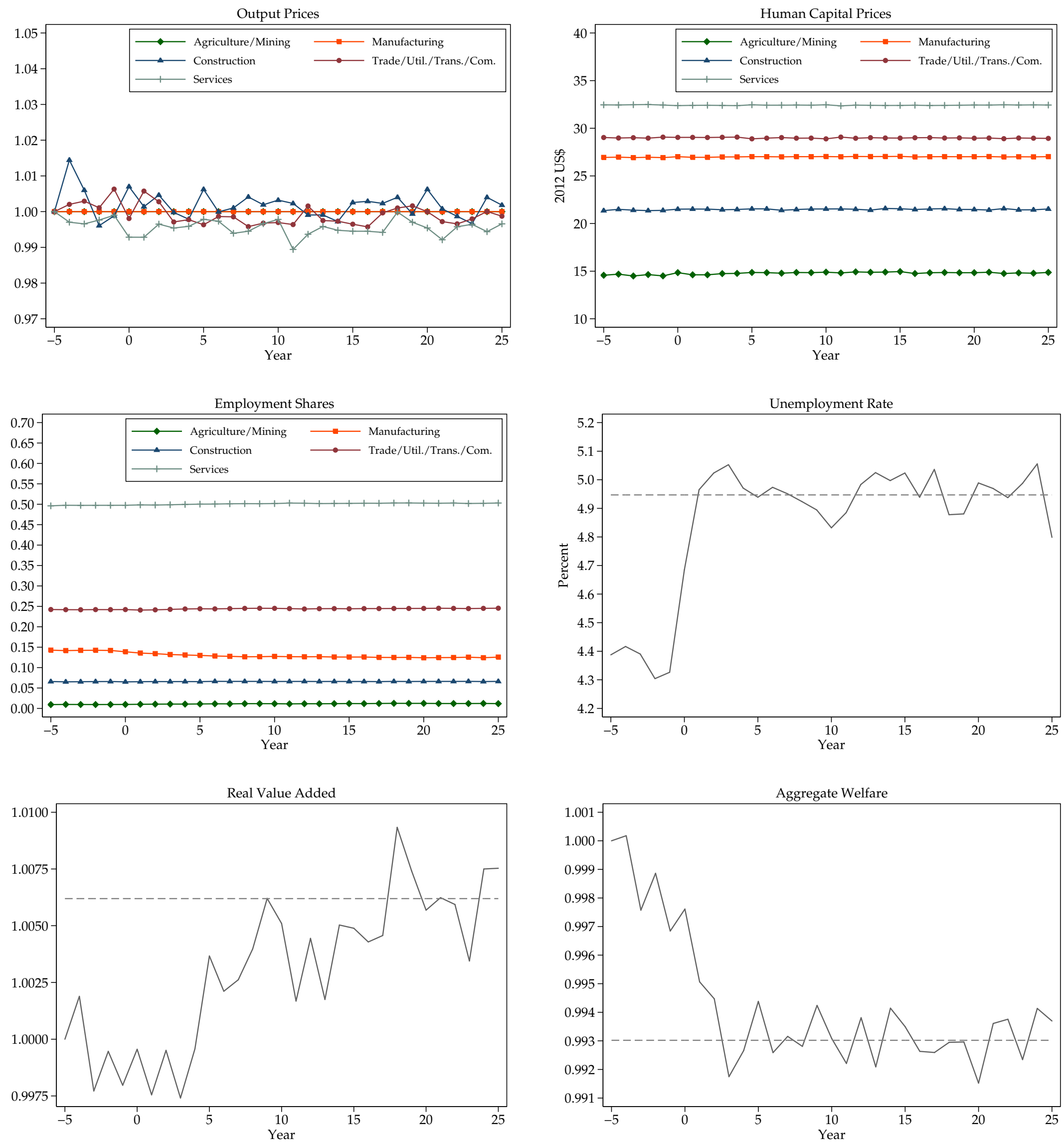
Finally, the unemployed are compensated by lump-sum transfers from employed workers and capital owners. With these assumptions, the dynamics following counterfactual shocks to unemployment and to the output price of the manufacturing sector can now be examined.

5.2. **Unemployment Shock.** Consider the effect of a permanent shock to the probability of becoming unemployed for workers in the manufacturing sector. The share of manufacturing workers who become unemployed increases, leading to a higher unemployment rate. The manufacturing sector is now less attractive, which leads workers to seek out opportunities in other sectors, lowering the share of the workforce employed in manufacturing from 14.2% to 12.5%. Due to the reallocation costs, the adjustment process is sluggish: 52% of the reallocation is completed after 4 years. The employment share of manufacturing drops by 12% compared to the initial steady state. However, this adjustment in the labour market leaves both output prices and human capital prices virtually unaffected. As manufacturing workers are reallocated elsewhere, production drops, putting downward pressure on wages. But, as the price of physical capital is assumed to be fixed, the physical capital level drops proportionally to human capital in order to hold constant the rental price of physical capital. As the ratio of physical to human capital remains unchanged, so do the human capital prices. That human capital prices remain unaffected therefore follows from the assumptions regarding the accumulation of physical capital.

In the new steady state, the real value added of the economy has increased by 0.62%. This increase is a consequence of the assumption of perfect capital mobility. As workers shift away from the adversely affected manufacturing sector, the marginal product of capital in the absorbing sectors increases. But as the return to capital is assumed to be fixed, capital flows into these sectors, which in turn increases their production. The total output of the economy rises as the increased production of the unaffected sectors is greater than the fall in manufacturing production.

Despite the increase in real value added, aggregate welfare is 0.7% lower in the new steady state. The reason for this drop in welfare is that the new equilibrium unemployment rate is higher, meaning greater transfers from the employed to the unemployed workers.

FIGURE 5.1. Simulation – Unemployment Shock



Top left: output prices relative to year $t = -5$. Top right: real human capital prices. Middle left: shares of total employment. Middle right: unemployment rate as a percent of the workforce. Bottom left: total real value added relative to year $t = -5$. Bottom right: total welfare relative to year $t = -5$. All real variables have been divided with the price index.

5.3. **Price Shock.** Now consider the effects of a 10% decrease in the output price of the manufacturing sector due to e.g. trade liberalisation. The output price of the Agriculture/Mining sector remains constant as it is assumed that its output is traded internationally. The output prices of the remaining non-traded sectors adjust endogenously.

Human capital prices in the manufacturing sector drop with the output price shock for two reasons. First, lowering output prices reduces the marginal product of human capital, putting downward pressure on human capital prices. Second, in order to keep the physical capital return fixed, the ratio of physical to human capital drops, further lowering human capital prices. Whereas human capital prices drop in the manufacturing sector, they rise in the remaining sectors as the price index falls.

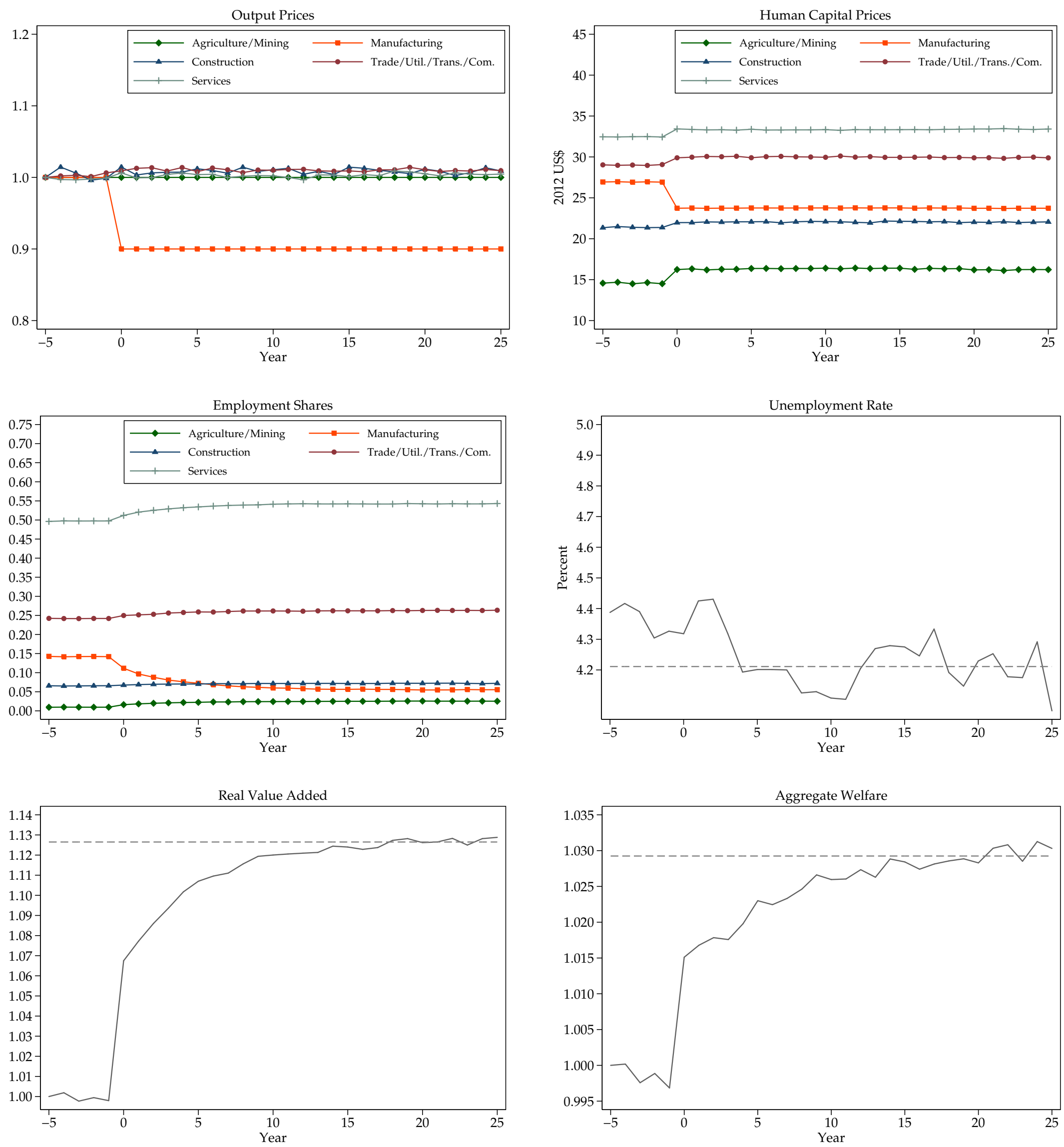
The manufacturing sector employment falls from 14.2% to 5.5% as workers reallocate towards the other sectors. The adjustment process is sluggish: 25% of the reallocation is complete after 1 year, while 92% is completed in 10 years. On average, manufacturing workers are more likely to become unemployed than workers in the other sectors, so as workers reallocate away from manufacturing, the unemployment rate drops from 4.4% to 4.2%.

As human capital reallocates to the sectors that are unaffected by the shock, physical capital flows freely into these to keep physical capital returns constant. This in turn increases the real output of the economy after the initial jump at year zero due to the falling price index. When the economy reaches the new steady state, real value added has increased by 12.7%.

Aggregate welfare is comprised not only of workers' wages and the return to capital owners. It also includes the preference shocks, η_{it}^{s}, and the utility costs of reallocating workers, $\mathbf{C}^{s_{t-1},s}$. It also takes into account the transfers from the employed to the unemployed workers in terms of unemployment benefits. The long run welfare gains are 3%.

5.4. **Unemployment and Price Shocks.** Focus now on the dynamics following a joint shock; that is, both a doubling of the unemployment probabilities facing manufacturing workers, and a 10% decrease in the manufacturing output price. Again, the output price of the Agriculture/Mining sector remains constant while the prices of the remaining non-traded sectors adjust endogenously. Human capital prices in the manufacturing sector drop with the output price shock and workers reallocate towards other industries.

FIGURE 5.2. Simulation – Price Shock



Top left: output prices relative to year $t = -5$. Top right: real human capital prices. Middle left: shares of total employment. Middle right: unemployment rate as a percent of the workforce. Bottom left: total real value added relative to year $t = -5$. Bottom right: total welfare relative to year $t = -5$. All real variables have been divided with the price index.

The unemployment rate initially jumps as it is now more likely for manufacturing workers to become unemployed. However, as the labour market adjusts, the unemployment rate gradually drops towards its new steady-state level. This drop happens even though the rise in unemployment probability for manufacturing workers is assumed to be permanent. But as the manufacturing employment share declines from

14.2% of the workforce to 4.8%, the number of workers affected by the increase in unemployment probabilities is dramatically reduced.

The labour market adjustment process is sluggish. 70% of the adjustment is completed 5 years after the shock, and 92% completion is reached 10 years after the simultaneous drop in manufacturing output prices and rise of the unemployment rate.

Production increases due to the inflow of physical capital into the sectors that are not directly affected by the shocks. The inflow happens in order to keep physical capital returns constant as human capital reallocates towards these sectors. At the new steady-state, output has increased by 12.9%.

The new steady-state yearly welfare gain of 2.8% is net of both the reallocation costs and the unemployment benefits. However, focusing only on the steady-state welfare gains is problematic since, as is evident from Figure 5.3, the steady-state gains take more than 15 years to materialize. This suggests that the present value of the yearly stream is a more appropriate measure of aggregate welfare gains. The present value of the percentage gain in aggregate welfare is computed as

$$\text{pvWelfareGain} = \frac{\sum_{t=0}^{\infty} \rho^t \left(\text{Welfare}_t - \text{Welfare}_{-1}\right)}{\text{Welfare}_{-1}},$$

where Welfare_{-1} is the initial equilibrium welfare level. Computed this way, the present value of the aggregate welfare gains is found to be 46.6% of initial welfare. In terms of the lower right diagram, this is the area below the line showing the evolution of aggregate welfare, but above a horizontal line (that is not shown) representing the equilibrium level of welfare prior to the shock.

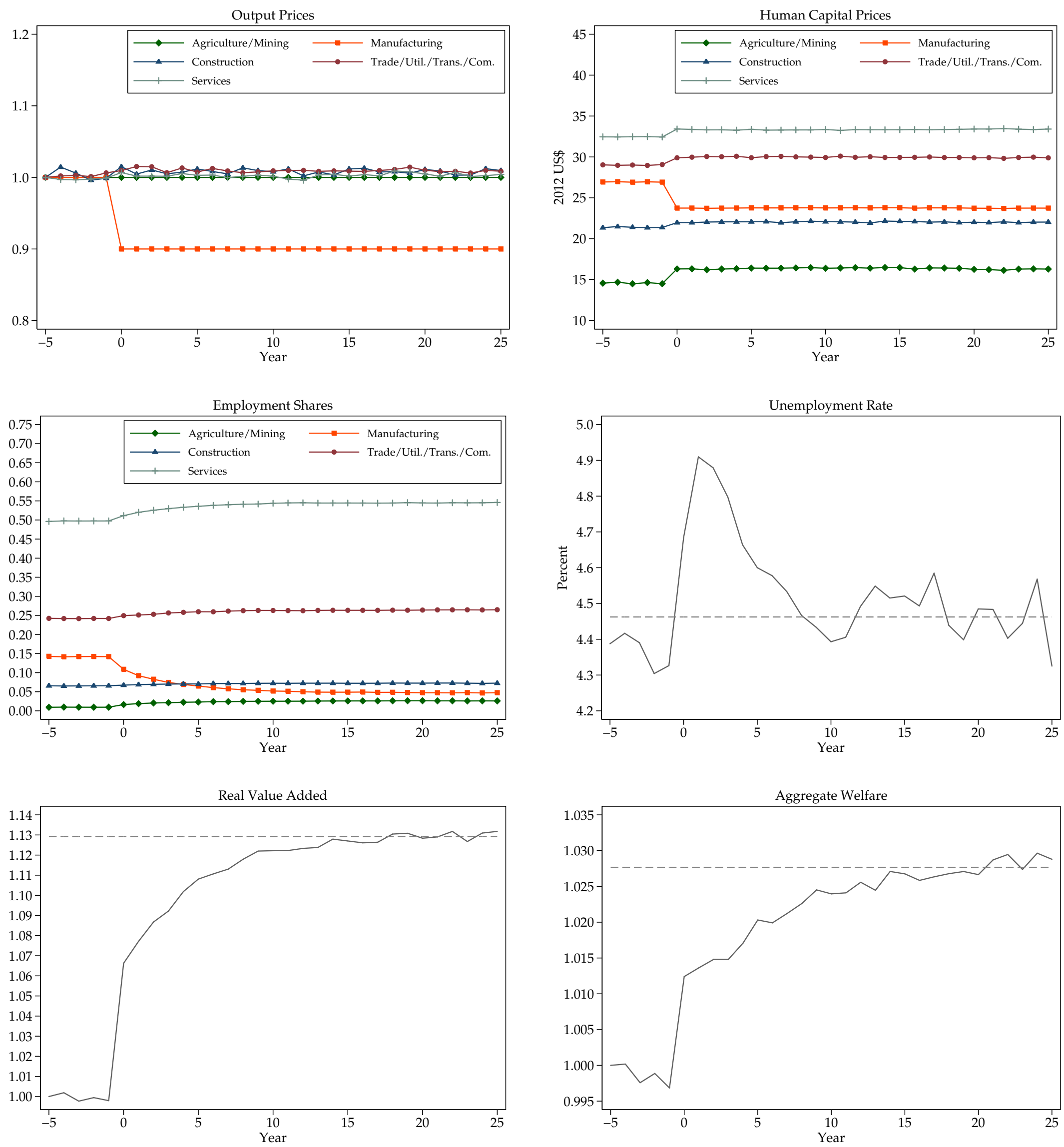
The gradual realisation of the aggregate welfare gains is due to the adjustment costs. If the transition had been immediate, welfare would have reached its new steady-state level in the year of the shock. This implies that the difference between the welfare levels of a hypothetical immediate adjustment process and the actual adjustment process is a measure of the total adjustment costs. In present value terms, the potential welfare gain with an immediate transition is

$$\text{Gain} = \frac{1}{1-\rho}\left(\text{Welfare}_\infty - \text{Welfare}_{-1}\right),$$

where Welfare_∞ and Welfare_{-1} are the post and pre shock steady-state welfare levels, respectively. The welfare costs of adjustment is then the difference between potential and actual welfare

$$\text{AC} = \frac{1}{1-\rho}\text{Welfare}_\infty - \sum_{t=0}^{\infty} \rho^t \text{Welfare}_t.$$

FIGURE 5.3. Simulation – Unemployment and Price Shocks



Top left: output prices relative to year $t = -5$. Top right: real human capital prices. Middle left: shares of total employment. Middle right: unemployment rate as a percent of the workforce. Bottom left: total real value added relative to year $t = -5$. Bottom right: total welfare relative to year $t = -5$. All real variables have been divided with the price index.

I find the ratio of the adjustment costs (AC) to potential welfare gains (Gain) to be 23.2%, implying that the adjustment costs dissipate 23.2% of the increase in welfare.

It is worth noting that the preceding analysis of aggregate welfare masks a great deal of heterogeneity over the population of workers, some of whom are affected adversely by the shocks to unemployment and prices. In particular, older workers are less capable of responding to the shocks by switching to a new sector; indeed, workers who are 65 in the year of the shock cannot respond at all, as they retire the following year.

TABLE 5.1. Welfare Effects (%) Across Sectors and Ages

Initial age	30–39	40–49	50–59	60–65
(1)	4.45	5.18	4.65	5.31
(2)	−1.82	−2.95	−3.50	−4.74
(3)	2.98	2.66	2.80	2.31
(4)	3.66	3.60	3.60	2.99
(5)	2.69	2.60	2.59	2.28
Average welfare change (%): 2.15				

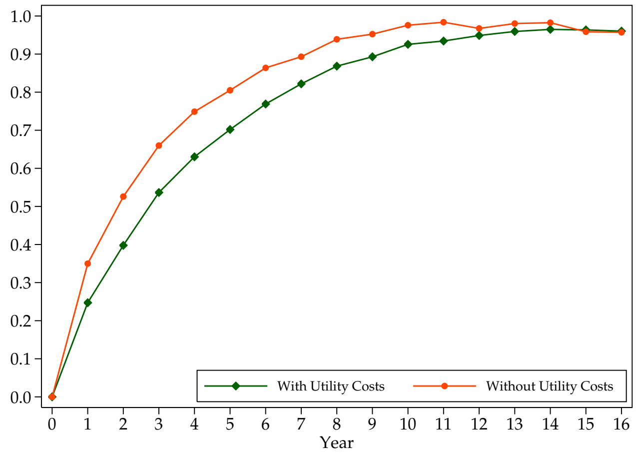
The table shows present value welfare effects in percent for workers initially employed in the indicated sector. Workers are divided into groups based on ages at the year of the shock. The bottom row shows the welfare effect averaged over workers of all ages. Sectors: (1) Agriculture/Mining, (2) Manufacturing, (3) Construction, (4) Trade/Utilities/Transportation/Communication, (5) Services.

Table 5.1 shows average welfare effects for workers employed in each sector in the year of the shock. The sample is split into age groups to capture heterogeneous welfare effects. On average, the present value of welfare for manufacturing workers initially aged 30 to 39 is 1.82% less than it would have been had the shocks not occurred. As expected, this figure increases to a welfare loss of 4.74% for workers aged 60 to 65. Workers in the other sectors experience welfare gains. Generally, these gains are lower for older workers who remain on the labour market for fewer years after the shock. The average welfare effect is a gain of 2.15% as reported in the bottom row. This table makes it very clear that the older manufacturing workers are the losers from the shock.

5.5. **The Role of the Utility Costs.** In order to examine how the reallocation costs affect the dynamic adjustment process, it is useful to consider a situation in which the utility cost of switching sectors is zero. Figure 5.4 plots the cumulated labour market reallocation as a percent of the final year for the globalisation shock. This is done for two scenarios: One where the utility cost is set to zero for all workers, and one where the utility cost is the one estimated above.

The green line in the figure shows the reallocation process described in the simulation above where utility costs are estimated. The reallocation process is sluggish and takes several years to complete: One year after the shock 24.7% of the reallocation process is completed and 92.5% completion is reached only after 10 years. In absence of the utility costs, the reallocation is much faster: 35.0% of the reallocation is completed by the end

FIGURE 5.4. Speed of Labour Reallocation Following an Unemployment and Price Shock



of the first year and 97.6% after ten years. The reallocation is not immediate when the utility costs are zero for two reasons: (i) depreciation of sector specific human capital makes it costly to switch sectors even when utility costs are zero, and (ii) a worker's draw of sector-specific idiosyncratic shocks, ε_{it}^{s} and η_{it}^{s} may be such that that the worker is better off remaining in the adversely affected sector, even as human capital prices fall.

This would suggest that, policy makers wishing to minimise the length of the reallocation period could focus on policies that minimise the utility costs and increases the cross-sectoral transferability of human capital. One such policy may be educating workers through job training programs. Modelling and assessing the impact of such policies is important and left for future research.

5.6. **UI Reforms.** The institutional setting facing unemployed workers in this paper has been designed to replicate that faced by Danish workers in the sample period (see Online Appendix A). Unemployed workers are eligible for UI benefits of up to 90% of their previous wage, but only for 4 years.

From 1 July 2010 the maximum UI benefit period was lowered from 4 to 2 years. In my model, this means that workers are only eligible for UI benefits if $t - \mathcal{T}$ in Equation (8) is less than or equal to 2 years. Since unemployment is exogenous, the unemployment rate is left unaffected by this reform, which therefore only affects the benefits. When replicating the unemployment and price shock exercise from above, I find that the total UI benefits of all unemployed workers is 2.37% lower when the UI eligibility period is halved from 4 to 2 years.

Instead of lowering the UI eligibility period, policy makers can lower the maximum compensation rate, k in Equation (8). Rerunning the exercise with an eligibility period of 4 years, but a maximum compensation rate of 50% instead of 90% yields a saving on benefits of 1.57%. The modest saving from a large decrease in the compensation rate implies that the UI benefits for many unemployed workers are independent of the degree of compensation, which is the case if the benefit payments are at the cap of $\overline{\text{UI}}$.

In a final exercise, I therefore reset the compensation rate to 90% and instead lower the cap on UI benefits, $\overline{\text{UI}}$, by 10%. If all unemployed workers received UI benefits at the cap level, this should decrease benefit payments by 10%. What I find is that the saving is 7.84%, which confirms that most, but not all, unemployed workers receive $\overline{\text{UI}}$ in UI benefits.

In so far as these policies are alternatives, the trade-off facing policy makers is whether to aim the reform at the long-term unemployed, unemployed workers with benefits below the cap of $\overline{\text{UI}}$, or unemployed workers with benefits at the cap-level. It is worth noting that the policy experiments do not alter the work incentives of workers in my model due to the exogenous nature of unemployment. Any policy changing the UI benefit system is likely to aim to change these probabilities. However that is not allowed for in my model.

6. Conclusion

This paper built and estimated a dynamic structural model of the Danish labour market in order to quantify the reallocation costs involved when the economy transitions from one steady-state equilibrium to another. The reallocation costs consist of imperfectly transferable experience and a utility cost of switching sectors. The degree of transferability ranges from 88% to 98% over the sectors. Unemployment is found to depreciate experience by 6% per year. Median utility costs are found to be between 10% and 18% of average annual wages, though this number is higher for workers that are females, have less education, and older workers.

The costs I find are much lower than those found in the literature. Artuç, Chaudhuri, and McLaren (2010) used a model where workers are homogeneous up to a random shock, and estimated average reallocation costs to be around 6 times average wages in the US. Dix-Carneiro (2014) estimated a model similar to the present one on Brazilian data and found median mobility costs in the range of 1.4 to 2.7 times average annual wages.

The estimated model is used to trace out the dynamic adjustment of the economy when the manufacturing sector is hit by a shock to unemployment, a shock to output prices, and a shock to both. The unemployment shock leads workers to reallocate away from manufacturing towards more productive sectors, but only modestly as the share of manufacturing workers falls by 1.7 percentage-points. The new steady-state level of aggregate welfare dropped as the unemployment rate increased. The price shock (a 10% decrease in manufacturing output prices) also lead to labour reallocation away from manufacturing. Unlike the unemployment shock, aggregate welfare increased by 3% in the new equilibrium.

Finally, the shocks are combined in a dual unemployment and price shock. In this exercise, manufacturing employment fell from 14.2% of total employment to 4.8%. The labour market adjustment process is sluggish: After 5 years, only 70% of the reallocation is completed. In the new post-shock steady state, the yearly welfare gain is 2.8%. The present value of the welfare gain is 46.6% higher than it would have been in the absence of the shocks. However, this welfare gain would have been higher had it not been for the adjustment costs: These are shown to dissipate 23.2% of the potential welfare gains. Although aggregate welfare has increased, some workers lose welfare. Specifically, workers who are employed in the manufacturing sector in the year of the shock lose on average 2.95% of their remaining lifetime utility. This number increases in the initial age of the worker such that those who are initially between 30 and 39 face a welfare loss of 1.82% while those initially aged 60 to 65 lose 4.74%.

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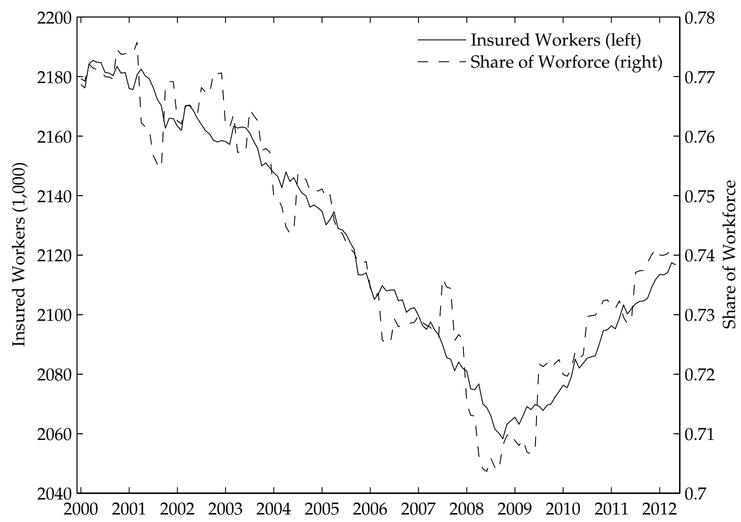
APPENDICES NOT FOR PUBLICATION

APPENDIX A. UNEMPLOYMENT BENEFITS IN DENMARK

This section describes the institutional setting for the unemployed in Denmark as applicable to the period from 1996 to 2008. The structural model in Section 2 includes a model of the institutional setting presented here.

All unemployed workers who wish to receive benefits must be registered as "seeking employment" at local job-centers run by the government. Then there are two separate systems: One for members of unemployment insurance (UI) fund, and one for those who are not.

FIGURE A.1. Insured Workers



The figure shows that the vast majority of the workforce are members of a UI fund; the membership rate is about 70-77 percent in the period shown.

A.1. **Benefits for the Insured.** The UI system is administered by government approved UI funds ("A-kasser"). In order to be eligible for UI benefits, a worker must satisfy certain criteria. The worker must

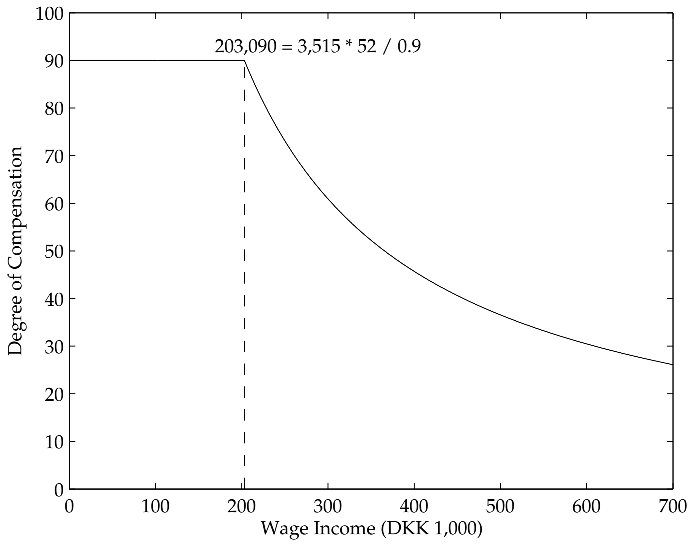
1. have been member of an UI fund for at least one year,
2. satisfy the employment criterion,
3. satisfy the availability criteria,
4. not be unemployed by self-infliction.

The employment criterion states that full-time insured must have been employed for at least 52 weeks out of the last 3 years while the part-time insured must have been employed for at least 34 weeks out of the last 3 years in order to be eligible for UI benefits. Some of the availability criteria are that the worker must actively seek any employment opportunities and reside in Denmark.

If the worker is eligible for UI benefits, then the weekly benefit is calculated as 90 percent of the worker's labor income for the past 3 months or 12 weeks, depending on whether the wage was paid on a monthly basis, or weekly of biweekly basis. However, the maximum benefit is DKK 3,515 per week from January 1, 2008. This number is regulated once a year by a factor that takes into account the general development of wages for the employed. The UI benefits are paid out for a maximum of four years after which the benefits expire.

Since the maximum UI benefit is capped at DKK 203,090 a year in 2008, the degree of compensation drops in incomes above this level. The resulting compensation degree is 61 and 46 percent for yearly incomes of DKK 300,000 and DKK 400,000, respectively.

FIGURE A.2. Compensation Rate



A.2. **Benefits for the Uninsured.** The unemployed workers who are either uninsured or ineligible for UI benefits may apply for welfare assistance ("kontanthjælp"). The size of the assistance depends on a number of factors. For workers of age 25 and above that are caretakers of children, the monthly maximum assistance is DKK 13,732 in 2012, while that figure is DKK 10.335 for those without children. For workers under the age of 25 the maximum assistance is DKK 6,660 for caretakers and DKK 5,662 for others.

However, workers are only eligible for assistance if their assets do not exceed a total value of DKK 10,000. Furthermore, spousal income is deducted from the assistance.

Appendix B. Sectors

Table B.1. Mapping from NACE Rev. 2 to Sectors

Agriculture/Mining	Agriculture and Horticulture (01); Forestry (02); Fishing (03); Extraction of Oil and Gas (06); Extraction of Gravel and Stone (08); Mining Support Service Activities (09)
Manufacturing	Food Products (10); Beverages (11); Tobacco Products (12); Textiles (13); Wearing Apparel (14); Leather and Related Products (15); Wood and Wood Products (16); Paper and Paper Products (17); Printing and Reproduction of Recorded Media (18); Coke and Refined Petroleum Products (19); Chemicals and Chemical Products (20); Pharmaceuticals (21); Rubber and Plastic Products (22); Other Non-Metallic Mineral Products (23); Basic Metals (24); Fabricated Metal Products (25); Computer, Electronic and Optical Products (26); Electrical Equipment (27); Machinery and Equipment (28); Motor Vehicles (29); Other Transport Equipment (30); Furniture (31); Other Manufacturing (32); Repair and Installation of Machinery and Equipment (33)
Construction	New Buildings (41); Civil Engineering (42); Specialised Construction Activities (43)
Trade/Utilities/ Transportation/Communication	Electricity, Gas, Steam and Air Conditioning Supply (35); Water Collection, Treatment and Supply (36); Sewerage (37); Waste and Recycling (38); Wholesale and Retail Trade and Repair of Motor Vehicles and Motorcycles (45); Wholesale Trade (46); Retail Trade (47); Land Transport and Transport via Pipelines (49); Water Transport (50); Air Transport (51); Support Activities for Transportation (52); Postal and Courier (53); Publishing (58); Motion Picture and TV Program Production (59); Programming and Broadcasting (60); Telecommunications (61); Computer Programming and Consultancy (62); Information Services (63)
Services	Accommodation (55); Food and Beverage Services (56); Financial Services (64); Insurance and Pension Funding (65); Other Financial Activities (66); Real Estate (68); Legal and Accounting (69); Business Consultancy (70); Architecture and Engineering (71); Scientific Research and Development (72); Advertising and Market Research (73); Other Professional, Scientific and Technical Activities (74); Veterinary Activities (75); Renting and Leasing (77); Employment (78); Travel Agency (79); Security and Investigation (80); Services to Buildings and Landscapes (81); Other Business Services (82); Public Administration (84); Education (85); Human Health (86); Residential Care (87); Social Work (88); Creative, Arts and Entertainment (90); Libraries and Museums (91); Gambling and Betting (92); Sports (93); Activities of Membership Organisations (94); Repair of Personal Goods (95); Other Personal Services (96); Activities of Households as Employers of Domestic Personnel (97)

APPENDIX C. ASYMPTOTIC DISTRIBUTION OF THE SMD ESTIMATOR

Define the SMD estimator[15] as

$$\widehat{\theta}_{SMD} = \arg\min_{\theta} \left[\mathbf{a}^S(\theta) - \mathbf{a}^D\right]' \mathbf{A} \left[\mathbf{a}^S(\theta) - \mathbf{a}^D\right], \tag{16}$$

where $\mathbf{a}^S(\theta)$ and $\mathbf{a}^D$ are vectors of auxiliary parameters obtained form simulated and actual data, respectively. The positive definite weighting matrix $\mathbf{A}$ is assumed to converge to a non-stochastic matrix.

Let $\widehat{\theta}$ be a particular vector of structural parameters. If the model is well specified $\mathbf{a}^S(\widehat{\theta})$ converges to $\mathbf{a}^D$. Then, by using $\operatorname{plim} \mathbf{a}^S(\widehat{\theta}) = \mathbf{a}^\infty(\widehat{\theta})$ and $\operatorname{plim} \mathbf{a}^D = \mathbf{a}^0(\theta_0)$, we have

$$\operatorname{plim} \widehat{\theta}_{SMD} = \theta_0,$$

where $\mathbf{a}^\infty(\widehat{\theta})$ is the vector of auxiliary parameters that results for a given $\widehat{\theta}$ when using $J = \infty$ number of simulations to construct $\mathbf{a}^S(\widehat{\theta})$, and $\mathbf{a}^0(\theta_0)$ is the true vector of auxiliary parameters.

Let

$$\begin{aligned}
\mathbf{a}^S(\widehat{\theta}) - \mathbf{a}^D &= \mathbf{a}^S(\widehat{\theta}) - \mathbf{a}^D + \mathbf{a}^\infty(\theta_0) - \mathbf{a}^\infty(\theta_0) + \mathbf{a}^0(\theta_0) - \mathbf{a}^0(\theta_0) \\
&= \left[\mathbf{a}^S(\widehat{\theta}) - \mathbf{a}^\infty(\theta_0)\right] + \left[\mathbf{a}^0(\theta_0) - \mathbf{a}^D\right] + \left[\mathbf{a}^\infty(\theta_0) - \mathbf{a}^0(\theta_0)\right],
\end{aligned}$$

where the last term cancels out when the model is well specified. Now, apply the Central Limit Theorem and evaluate at $\widehat{\theta} = \theta_0$ to get

$$\sqrt{n}\left[\mathbf{a}^S(\theta_0) - \mathbf{a}^D\right] = \sqrt{n}\left[\mathbf{a}^S(\theta_0) - \mathbf{a}^\infty(\theta_0)\right] + \sqrt{n}\left[\mathbf{a}^0(\theta_0) - \mathbf{a}^D\right],$$

and

$$\sqrt{n}\left[\mathbf{a}^S(\theta_0) - \mathbf{a}^D\right] \longrightarrow^d \mathcal{N}\left(0, \frac{J+1}{J}\mathbf{M}_0\right), \tag{17}$$

where J is the number of simulations used to construct $\mathbf{a}^S(\theta_0)$ and $\mathbf{M}_0$ is the true variance-covariance matrix.

The first order condition of the optimisation problem in (16) is

$$\left[\mathbf{a}^S(\widehat{\theta}_{SMD}) - \mathbf{a}^D\right]' \mathbf{A} \nabla \mathbf{a}^S(\widehat{\theta}_{SMD}) = 0,$$

and a Taylor series expansion around θ_0 gives

$$\mathbf{a}^S(\widehat{\theta}_{SMD}) = \mathbf{a}^S(\theta_0) + \nabla \mathbf{a}^S(\theta_0)\left[\widehat{\theta}_{SMD} - \theta_0\right].$$

Substitute back into the first order condition and solve for $[\widehat{\theta}_{SMD} - \theta_0]$ to get

$$\left[\widehat{\theta}_{SMD} - \theta_0\right] = -\left[\nabla \mathbf{a}^S(\widehat{\theta}_{SMD})' \mathbf{A} \nabla \mathbf{a}^S(\widehat{\theta}_{SMD})\right]^{-1} \nabla \mathbf{a}^S(\widehat{\theta}_{SMD})' \mathbf{A} \left[\mathbf{a}^S(\theta_0) - \mathbf{a}^D\right].$$

Using this and (17) we get

$$\sqrt{n}\left[\widehat{\theta}_{SMD} - \theta_0\right] \longrightarrow^d \mathcal{N}\left(0, \frac{J+1}{J}\mathbf{G}_1^{-1}\mathbf{G}_2\mathbf{G}_1^{-1}\right),$$

where

$$\begin{aligned}
\mathbf{G}_1 &= \left[\operatorname{plim} \nabla \mathbf{a}^S(\theta_0)\right]' \mathbf{A}_\infty \left[\operatorname{plim} \nabla \mathbf{a}^S(\theta_0)\right], \\
\mathbf{G}_2 &= \left[\operatorname{plim} \nabla \mathbf{a}^S(\theta_0)\right]' \mathbf{A}_\infty \mathbf{M}_0 \mathbf{A}_\infty \left[\operatorname{plim} \nabla \mathbf{a}^S(\theta_0)\right].
\end{aligned}$$

With the optimal weighting matrix $\mathbf{A} = \mathbf{M}_0^{-1}$, the asymptotic distribution of the Simulated Minimum Distance Estimator is

$$\sqrt{n}\left[\widehat{\theta}_{SMD} - \theta_0\right] \longrightarrow^d \mathcal{N}\left(0, \frac{J+1}{J}\mathbf{G}^{-1}\right),$$

[15] See Hall and Rust (2002), Browning, Ejrnæs, and Alvarez (2010), and Alan (2006).

where

$$\mathbf{G} = \left[\operatorname{plim} \nabla \mathbf{a}^S(\theta_0)\right]' \mathbf{M}_0^{-1} \left[\operatorname{plim} \nabla \mathbf{a}^S(\theta_0)\right].$$

Appendix D. Auxiliary Parameters

Table D.1. Log-Wage Regressions

	Agr/Mining	Manufacturing	Construction	Tr./Ut./Tran./Com.	Services
Female	-0.226241	-0.169728	-0.168647	-0.198453	-0.207124
	(0.0018)	(0.0003)	(0.0009)	(0.0004)	(0.0002)
Educ	0.161606	0.316589	0.215107	0.289084	0.229263
	(0.0019)	(0.0004)	(0.0008)	(0.0005)	(0.0002)
Age	0.038069	0.012849	0.017199	0.017997	0.012515
	(0.0008)	(0.0002)	(0.0003)	(0.0002)	(0.0001)
Age^2	-0.000440	-0.000179	-0.000216	-0.000257	-0.000167
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
Exper	0.004497	0.006815	0.006419	0.008285	0.006859
	(0.0001)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
1996	4.231317	4.836345	4.724536	4.757651	4.846028
	(0.0180)	(0.0037)	(0.0067)	(0.0043)	(0.0025)
1997	4.224913	4.823436	4.708768	4.750908	4.832797
	(0.0180)	(0.0037)	(0.0067)	(0.0043)	(0.0025)
1998	4.247642	4.866347	4.731991	4.774774	4.860608
	(0.0180)	(0.0037)	(0.0067)	(0.0043)	(0.0025)
1999	4.240998	4.854302	4.738804	4.775157	4.861966
	(0.0180)	(0.0037)	(0.0067)	(0.0043)	(0.0025)
2000	4.251494	4.860062	4.743351	4.778431	4.867408
	(0.0180)	(0.0037)	(0.0067)	(0.0043)	(0.0025)
2001	4.267058	4.873846	4.763543	4.793411	4.886463
	(0.0180)	(0.0037)	(0.0067)	(0.0043)	(0.0025)
2002	4.279963	4.877963	4.763591	4.793470	4.884342
	(0.0180)	(0.0037)	(0.0067)	(0.0043)	(0.0025)
2003	4.245921	4.862613	4.746932	4.771257	4.866902
	(0.0180)	(0.0037)	(0.0067)	(0.0043)	(0.0025)
2004	4.245542	4.860584	4.746077	4.762179	4.876557
	(0.0180)	(0.0037)	(0.0066)	(0.0043)	(0.0025)
2005	4.291993	4.903308	4.787530	4.803551	4.913089
	(0.0180)	(0.0037)	(0.0066)	(0.0043)	(0.0025)
2006	4.319431	4.925783	4.814797	4.824168	4.935360
	(0.0180)	(0.0037)	(0.0066)	(0.0043)	(0.0025)
2007	4.343912	4.947456	4.839264	4.852874	4.956261
	(0.0180)	(0.0037)	(0.0066)	(0.0043)	(0.0025)
2008	4.346454	4.941269	4.829658	4.855021	4.969325
	(0.0180)	(0.0037)	(0.0066)	(0.0043)	(0.0025)
Root MSE	0.373505	0.276870	0.285019	0.336883	0.306287
R^2	0.995	0.997	0.997	0.996	0.997
Observations	268224	3791930	1204452	3968220	10331959

Standard errors in parentheses. Sectors: (1) Agriculture/Mining, (2) Manufacturing, (3) Construction, (4) Trade/Utilities/Transportation/Communication, (5) Services.

TABLE D.2. LPMs for Sectoral Choices

	Agr/Mining	Manufacturing	Construction	Tr./Ut./Tran./Com.	Services
log wage	-0.006493	0.068109	0.008673	0.060639	0.107193
	(0.0001)	(0.0002)	(0.0001)	(0.0002)	(0.0003)
Female	-0.013967	-0.092590	-0.081053	-0.074661	0.311104
	(0.0001)	(0.0002)	(0.0001)	(0.0002)	(0.0002)
Educ	-0.006450	-0.116259	-0.049941	-0.149601	0.293530
	(0.0001)	(0.0002)	(0.0001)	(0.0002)	(0.0002)
Age	-0.000237	-0.001239	-0.000808	-0.013334	0.013138
	(0.0000)	(0.0001)	(0.0001)	(0.0001)	(0.0001)
Age^2	0.000003	-0.000019	0.000004	0.000106	-0.000096
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
Exper	-0.000317	0.001281	-0.000130	0.002234	-0.000190
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
1996	0.065556	-0.008355	0.091100	0.291291	-0.674585
	(0.0007)	(0.0025)	(0.0015)	(0.0025)	(0.0029)
1997	0.065570	-0.005980	0.091821	0.292671	-0.671527
	(0.0007)	(0.0025)	(0.0015)	(0.0025)	(0.0029)
1998	0.065808	-0.004807	0.093531	0.294144	-0.671177
	(0.0007)	(0.0025)	(0.0015)	(0.0025)	(0.0029)
1999	0.065834	-0.007522	0.095088	0.296119	-0.668789
	(0.0007)	(0.0025)	(0.0015)	(0.0025)	(0.0029)
2000	0.066050	-0.007548	0.097477	0.294483	-0.670549
	(0.0007)	(0.0025)	(0.0015)	(0.0025)	(0.0029)
2001	0.066511	-0.010212	0.097917	0.292393	-0.669223
	(0.0007)	(0.0025)	(0.0015)	(0.0025)	(0.0029)
2002	0.066865	-0.012993	0.097793	0.292380	-0.668791
	(0.0007)	(0.0025)	(0.0015)	(0.0025)	(0.0029)
2003	0.066502	-0.017643	0.098302	0.294711	-0.669795
	(0.0007)	(0.0025)	(0.0015)	(0.0025)	(0.0029)
2004	0.066672	-0.022866	0.099391	0.296509	-0.666531
	(0.0007)	(0.0025)	(0.0015)	(0.0025)	(0.0029)
2005	0.066942	-0.028635	0.102148	0.297839	-0.667101
	(0.0007)	(0.0025)	(0.0015)	(0.0025)	(0.0029)
2006	0.067052	-0.029675	0.105195	0.297968	-0.665731
	(0.0007)	(0.0025)	(0.0015)	(0.0025)	(0.0029)
2007	0.067834	-0.030648	0.105614	0.299445	-0.666566
	(0.0007)	(0.0025)	(0.0015)	(0.0025)	(0.0029)
2008	0.067550	-0.040619	0.103123	0.301438	-0.656155
	(0.0007)	(0.0025)	(0.0015)	(0.0025)	(0.0029)
R^2	0.018	0.222	0.099	0.235	0.604
Observations	20373918	20373918	20373918	20373918	20373918

Standard errors in parentheses. Sectors: (1) Agriculture/Mining, (2) Manufacturing, (3) Construction, (4) Trade/Utilities/Transportation/Communication, (5) Services.

TABLE D.3. LPMs for Transitions from Agriculture/Mining

	Agr/Mining	Manufacturing	Construction	Tr./Ut./Tran./Com.	Services
log wage	-0.005189	-0.000242	-0.000262	-0.000250	-0.000540
	(0.0001)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
Female	-0.012181	-0.000441	-0.000556	-0.000353	-0.000312
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
Educ	-0.005158	-0.000238	-0.000206	-0.000218	-0.000096
	(0.0001)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
Age	-0.000267	-0.000027	-0.000028	-0.000041	0.000040
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
Age^2	0.000003	0.000000	0.000000	0.000000	-0.000000
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
Exper	-0.000213	-0.000010	-0.000003	-0.000009	-0.000026
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
1996	0.055045	0.002933	0.002797	0.003069	0.002777
	(0.0007)	(0.0001)	(0.0001)	(0.0001)	(0.0001)
1997	0.055154	0.002891	0.002846	0.003121	0.002842
	(0.0007)	(0.0001)	(0.0001)	(0.0001)	(0.0001)
1998	0.055361	0.003137	0.002852	0.003117	0.002859
	(0.0007)	(0.0001)	(0.0001)	(0.0001)	(0.0001)
1999	0.055342	0.002936	0.002879	0.003152	0.002876
	(0.0007)	(0.0001)	(0.0001)	(0.0001)	(0.0001)
2000	0.055423	0.002932	0.002895	0.003141	0.002895
	(0.0007)	(0.0001)	(0.0001)	(0.0001)	(0.0001)
2001	0.055791	0.002925	0.002890	0.003138	0.002972
	(0.0007)	(0.0001)	(0.0001)	(0.0001)	(0.0001)
2002	0.055802	0.002965	0.002882	0.003158	0.002900
	(0.0007)	(0.0001)	(0.0001)	(0.0001)	(0.0001)
2003	0.056009	0.002889	0.003018	0.003118	0.003055
	(0.0007)	(0.0001)	(0.0001)	(0.0001)	(0.0001)
2004	0.056066	0.002855	0.002957	0.003155	0.002907
	(0.0007)	(0.0001)	(0.0001)	(0.0001)	(0.0001)
2005	0.056268	0.002965	0.002959	0.003212	0.003037
	(0.0007)	(0.0001)	(0.0001)	(0.0001)	(0.0001)
2006	0.056239	0.003019	0.003072	0.003294	0.003017
	(0.0007)	(0.0001)	(0.0001)	(0.0001)	(0.0001)
2007	0.056391	0.003041	0.003004	0.003330	0.003074
	(0.0007)	(0.0001)	(0.0001)	(0.0001)	(0.0001)
2008	0.056510	0.003114	0.002935	0.003255	0.003519
	(0.0007)	(0.0001)	(0.0001)	(0.0001)	(0.0001)
R^2	0.015	0.001	0.001	0.001	0.001
Observations	20373918	20373918	20373918	20373918	20373918

Standard errors in parentheses. Sectors: (1) Agriculture/Mining, (2) Manufacturing, (3) Construction, (4) Trade/Utilities/Transportation/Communication, (5) Services.

TABLE D.4. LPMs for Transitions from Manufacturing

	Agr/Mining	Manufacturing	Construction	Tr./Ut./Tran./Com.	Services
log wage	-0.000221	0.068188	-0.000510	-0.000190	0.000148
	(0.0000)	(0.0002)	(0.0000)	(0.0000)	(0.0000)
Female	-0.000372	-0.085101	-0.002345	-0.003054	-0.001020
	(0.0000)	(0.0002)	(0.0000)	(0.0000)	(0.0000)
Educ	-0.000217	-0.109003	-0.001121	-0.002439	0.000092
	(0.0000)	(0.0002)	(0.0000)	(0.0000)	(0.0000)
Age	-0.000018	-0.000722	-0.000103	-0.000340	-0.000192
	(0.0000)	(0.0001)	(0.0000)	(0.0000)	(0.0000)
Age^2	0.000000	-0.000022	0.000000	0.000001	0.000001
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
Exper	-0.000004	0.001808	0.000003	0.000026	-0.000068
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
1996	0.002411	-0.053486	0.009124	0.019287	0.011805
	(0.0001)	(0.0024)	(0.0003)	(0.0004)	(0.0005)
1997	0.002434	-0.052374	0.009054	0.019073	0.011842
	(0.0001)	(0.0024)	(0.0003)	(0.0004)	(0.0005)
1998	0.002410	-0.052292	0.009254	0.019146	0.012237
	(0.0001)	(0.0024)	(0.0003)	(0.0004)	(0.0005)
1999	0.002428	-0.052370	0.009375	0.019308	0.013011
	(0.0001)	(0.0024)	(0.0003)	(0.0004)	(0.0005)
2000	0.002440	-0.055551	0.009476	0.019103	0.012895
	(0.0001)	(0.0024)	(0.0003)	(0.0004)	(0.0005)
2001	0.002476	-0.057390	0.009227	0.019699	0.013296
	(0.0001)	(0.0024)	(0.0003)	(0.0004)	(0.0005)
2002	0.002513	-0.058669	0.009181	0.020033	0.012641
	(0.0001)	(0.0024)	(0.0003)	(0.0004)	(0.0005)
2003	0.002430	-0.061136	0.009419	0.019498	0.012167
	(0.0001)	(0.0024)	(0.0003)	(0.0004)	(0.0005)
2004	0.002429	-0.067439	0.009048	0.019183	0.012333
	(0.0001)	(0.0024)	(0.0003)	(0.0004)	(0.0005)
2005	0.002418	-0.074453	0.009431	0.020252	0.012798
	(0.0001)	(0.0024)	(0.0003)	(0.0004)	(0.0005)
2006	0.002499	-0.077492	0.009743	0.020084	0.012923
	(0.0001)	(0.0024)	(0.0003)	(0.0004)	(0.0005)
2007	0.002519	-0.080174	0.009526	0.020648	0.015651
	(0.0001)	(0.0024)	(0.0003)	(0.0004)	(0.0005)
2008	0.002475	-0.088542	0.009438	0.021070	0.022373
	(0.0001)	(0.0024)	(0.0003)	(0.0004)	(0.0005)
R^2	0.001	0.208	0.003	0.006	0.007
Observations	20373918	20373918	20373918	20373918	20373918

Standard errors in parentheses. Sectors: (1) Agriculture/Mining, (2) Manufacturing, (3) Construction, (4) Trade/Utilities/Transportation/Communication, (5) Services.

TABLE D.5. LPMs for Transitions from Construction

	Agr/Mining	Manufacturing	Construction	Tr./Ut./Tran./Com.	Services
log wage	-0.000071	-0.000097	0.010526	-0.000282	-0.000454
	(0.0000)	(0.0000)	(0.0001)	(0.0000)	(0.0000)
Female	-0.000426	-0.001869	-0.072420	-0.001459	-0.001805
	(0.0000)	(0.0000)	(0.0001)	(0.0000)	(0.0000)
Educ	-0.000204	-0.000922	-0.045311	-0.000852	-0.000429
	(0.0000)	(0.0000)	(0.0001)	(0.0000)	(0.0000)
Age	-0.000004	-0.000054	-0.000714	-0.000102	0.000022
	(0.0000)	(0.0000)	(0.0001)	(0.0000)	(0.0000)
Age^2	-0.000000	0.000000	0.000003	0.000001	-0.000001
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
Exper	-0.000007	-0.000017	0.000061	-0.000002	-0.000025
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
1996	0.001097	0.005069	0.063093	0.006737	0.005821
	(0.0001)	(0.0002)	(0.0014)	(0.0002)	(0.0003)
1997	0.001118	0.005194	0.064378	0.006668	0.005015
	(0.0001)	(0.0002)	(0.0014)	(0.0002)	(0.0003)
1998	0.001109	0.005276	0.065607	0.006673	0.005037
	(0.0001)	(0.0002)	(0.0014)	(0.0002)	(0.0003)
1999	0.001147	0.005189	0.067217	0.006736	0.004969
	(0.0001)	(0.0002)	(0.0014)	(0.0002)	(0.0003)
2000	0.001142	0.005276	0.068725	0.006734	0.005086
	(0.0001)	(0.0002)	(0.0014)	(0.0002)	(0.0003)
2001	0.001220	0.005505	0.069782	0.006865	0.005454
	(0.0001)	(0.0002)	(0.0014)	(0.0002)	(0.0003)
2002	0.001542	0.005462	0.069856	0.006928	0.005431
	(0.0001)	(0.0002)	(0.0014)	(0.0002)	(0.0003)
2003	0.001177	0.005169	0.070189	0.006895	0.005386
	(0.0001)	(0.0002)	(0.0014)	(0.0002)	(0.0003)
2004	0.001171	0.005150	0.071047	0.006734	0.005584
	(0.0001)	(0.0002)	(0.0014)	(0.0002)	(0.0003)
2005	0.001170	0.005108	0.072836	0.007054	0.005382
	(0.0001)	(0.0002)	(0.0014)	(0.0002)	(0.0003)
2006	0.001236	0.005391	0.075271	0.007115	0.005539
	(0.0001)	(0.0002)	(0.0014)	(0.0002)	(0.0003)
2007	0.001247	0.005680	0.076364	0.007490	0.006183
	(0.0001)	(0.0002)	(0.0014)	(0.0002)	(0.0003)
2008	0.001244	0.005606	0.075061	0.007279	0.006376
	(0.0001)	(0.0002)	(0.0014)	(0.0002)	(0.0003)
R^2	0.001	0.002	0.089	0.002	0.002
Observations	20373918	20373918	20373918	20373918	20373918

Standard errors in parentheses. Sectors: (1) Agriculture/Mining, (2) Manufacturing, (3) Construction, (4) Trade/Utilities/Transportation/Communication, (5) Services.

TABLE D.6. LPMs for Transitions from Trade/Util./Tran./Com.

	Agr/Mining	Manufacturing	Construction	Tr./Ut./Tran./Com.	Services
log wage	-0.000184	0.000634	-0.000375	0.063507	0.000844
	(0.0000)	(0.0000)	(0.0000)	(0.0002)	(0.0001)
Female	-0.000326	-0.002861	-0.001572	-0.067344	-0.000483
	(0.0000)	(0.0000)	(0.0000)	(0.0002)	(0.0000)
Educ	-0.000210	-0.002559	-0.000951	-0.141734	-0.001605
	(0.0000)	(0.0000)	(0.0000)	(0.0002)	(0.0000)
Age	-0.000023	-0.000428	-0.000114	-0.012223	-0.000767
	(0.0000)	(0.0000)	(0.0000)	(0.0001)	(0.0000)
Age^2	0.000000	0.000002	0.000001	0.000096	0.000006
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
Exper	-0.000006	0.000000	0.000007	0.002761	-0.000104
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
1996	0.002253	0.016431	0.007371	0.216253	0.023695
	(0.0001)	(0.0004)	(0.0002)	(0.0024)	(0.0005)
1997	0.002167	0.016563	0.007473	0.218095	0.024085
	(0.0001)	(0.0004)	(0.0002)	(0.0024)	(0.0005)
1998	0.002182	0.017010	0.007763	0.218279	0.024444
	(0.0001)	(0.0004)	(0.0002)	(0.0024)	(0.0005)
1999	0.002227	0.016710	0.007701	0.220733	0.025032
	(0.0001)	(0.0004)	(0.0002)	(0.0024)	(0.0005)
2000	0.002307	0.018071	0.007919	0.219343	0.026236
	(0.0001)	(0.0004)	(0.0002)	(0.0024)	(0.0005)
2001	0.002251	0.017521	0.007984	0.216655	0.026301
	(0.0001)	(0.0004)	(0.0002)	(0.0024)	(0.0005)
2002	0.002242	0.017136	0.007820	0.216250	0.025882
	(0.0001)	(0.0004)	(0.0002)	(0.0024)	(0.0005)
2003	0.002234	0.016383	0.007599	0.219104	0.025107
	(0.0001)	(0.0004)	(0.0002)	(0.0024)	(0.0005)
2004	0.002247	0.016455	0.007689	0.220295	0.025805
	(0.0001)	(0.0004)	(0.0002)	(0.0024)	(0.0005)
2005	0.002287	0.017015	0.008001	0.219245	0.025834
	(0.0001)	(0.0004)	(0.0002)	(0.0024)	(0.0005)
2006	0.002332	0.018177	0.008463	0.218487	0.028327
	(0.0001)	(0.0004)	(0.0002)	(0.0025)	(0.0005)
2007	0.002379	0.018963	0.008249	0.218198	0.029273
	(0.0001)	(0.0004)	(0.0002)	(0.0025)	(0.0005)
2008	0.002323	0.018179	0.007977	0.220788	0.029695
	(0.0001)	(0.0004)	(0.0002)	(0.0025)	(0.0005)
R^2	0.000	0.006	0.002	0.219	0.008
Observations	20373918	20373918	20373918	20373918	20373918

Standard errors in parentheses. Sectors: (1) Agriculture/Mining, (2) Manufacturing, (3) Construction, (4) Trade/Utilities/Transportation/Communication, (5) Services.

TABLE D.7. LPMs for Transitions from Services

	Agr/Mining	Manufacturing	Construction	Tr./Ut./Tran./Com.	Services
log wage	-0.000495	0.001175	-0.000427	0.001082	0.115213
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0003)
Female	-0.000290	-0.000460	-0.001407	-0.000435	0.311815
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0002)
Educ	-0.000079	0.000068	-0.000487	-0.001275	0.297115
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0002)
Age	0.000032	-0.000299	-0.000033	-0.000663	0.013238
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0001)
Age^2	-0.000000	0.000002	0.000000	0.000006	-0.000100
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
Exper	-0.000016	-0.000122	-0.000022	-0.000132	0.001245
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
1996	0.002493	0.008159	0.005890	0.019991	-0.762166
	(0.0001)	(0.0004)	(0.0002)	(0.0005)	(0.0029)
1997	0.002509	0.008397	0.005651	0.019542	-0.757077
	(0.0001)	(0.0004)	(0.0002)	(0.0005)	(0.0029)
1998	0.002570	0.008802	0.005848	0.020184	-0.758776
	(0.0001)	(0.0004)	(0.0002)	(0.0005)	(0.0029)
1999	0.002542	0.008537	0.005815	0.020672	-0.755482
	(0.0001)	(0.0004)	(0.0002)	(0.0005)	(0.0029)
2000	0.002620	0.009355	0.006153	0.020795	-0.757827
	(0.0001)	(0.0004)	(0.0002)	(0.0005)	(0.0029)
2001	0.002606	0.009438	0.005987	0.020710	-0.758742
	(0.0001)	(0.0004)	(0.0002)	(0.0005)	(0.0029)
2002	0.002675	0.008862	0.006075	0.020793	-0.755557
	(0.0001)	(0.0004)	(0.0002)	(0.0005)	(0.0029)
2003	0.002566	0.008300	0.005827	0.021003	-0.755543
	(0.0001)	(0.0004)	(0.0002)	(0.0005)	(0.0029)
2004	0.002570	0.008082	0.005990	0.020442	-0.756521
	(0.0001)	(0.0004)	(0.0002)	(0.0005)	(0.0029)
2005	0.002607	0.008610	0.006332	0.021444	-0.757557
	(0.0001)	(0.0004)	(0.0002)	(0.0005)	(0.0029)
2006	0.002678	0.009466	0.006560	0.022496	-0.757989
	(0.0001)	(0.0004)	(0.0002)	(0.0005)	(0.0029)
2007	0.003301	0.011265	0.007037	0.024201	-0.761959
	(0.0001)	(0.0004)	(0.0002)	(0.0005)	(0.0029)
2008	0.003141	0.011394	0.006458	0.024305	-0.758265
	(0.0001)	(0.0004)	(0.0002)	(0.0005)	(0.0029)
R^2	0.001	0.005	0.002	0.007	0.586
Observations	20373918	20373918	20373918	20373918	20373918

Standard errors in parentheses. Sectors: (1) Agriculture/Mining, (2) Manufacturing, (3) Construction, (4) Trade/Utilities/Transportation/Communication, (5) Services.