Intersectoral Labor Mobility and the Growth of the Service Sector, Econometrica, 2006

Wenzhi Wang *

June 17, 2023

1. Model

1.1. Preliminaries

Our goal is to design and estimate an equilibrium model of the labor market that is capable of reproducing the facts presented above and that, more specifically, enables a quantitative assessment of the relative importance of demand and supply factors in the growth of the service sector. The development of the model is necessarily constrained by a trade-off between complexity and computational tractability. The existence of such a trade-off requires that modelling choices be made at quite fundamental levels.

The most fundamental decision concerns the modelling of markets. We begin with the assumption that the factor and product markets are competitive. Within that paradigm, ideally we would like to model equilibrium in all markets simultaneously, that is, to solve jointly for equilibrium prices and quantities in factor and product markets. However, these markets differ in their openness and we want, for tractability, to avoid having to model international trade flows. Given that and modelling the labor market as closed, there are two alternatives: to assume that all other markets are either closed or that they are open. We adopt the latter because it is more tractable and because it is unclear a priori which assumption is a better approximation. Thus, we assume that the real rental price of capital (and thus the rental interest rate) and real product prices are exogenous, that is, they are set internationally and taken as given.

A second issue, closely connected to the first, is the choice of modelling the behavior of economic agents. On the production side, in terms of equilibrium determination, the main feature we want to capture is that both labor and capital are allocated efficiently between the two sectors. For that purpose, it is sufficient to specify production technologies in the two sectors at the aggregate, rather than the firm, level. Given the questions we pose, the worker-consumer side is modelled at the micro-level as a dynamic optimization problem. However, for tractability, we do not model savings

*This note is written in my MPhil period at the University of Oxford.

behavior and we assume that labor supply decisions are independent of relative product prices. This latter assumption avoids several complications. We do not have to specify a stochastic process for the evolution of the relative price of goods to services and, more importantly, we do not have to estimate the parameters of the consumption branch of the utility function.

To motivate the model specification, it is useful to summarize how demand and supply factors are incorporated into the model. As noted, the setup is that there are six skill types of labor, three within each of the two production sectors. The demand for skill types is determined by their respective marginal revenue products. Factor demand and product supply shift because there is technological change in each sector. The model allows for both sector-specific Hicks-neutral and skill-biased technological change. Because there seems to have been a structural break in 1980, the model allows for the pace of skill-biased technological change to differ after 1980. In addition, exogenous (by assumption) changes in the relative price of goods to services and in the rental price of capital directly affect product supplies and factor demands. Periods of a rising relative price of services to goods would induce faster relative growth in service-sector output and employment. A declining rental price of capital would increase the demand for capital relatively more in the capital intensive sector, as well as increasing the demand for complementary inputs, that is, for higher skill occupations if there is capital-skill complementarity. The model's estimates will determine the extent to which the growth in the service sector resulted from technological change, and factor and product price changes.

On the supply side, individuals choose among eight possible activities at each age, working in any of the six sector-occupations, attending school, or remaining at home. The rate at which individuals accumulate sector-occupation-specific skill depends on their initial endowments of each skill and on the history of their choices. For any given (birth) cohort, there is an age-dependent distribution of potential supplies of the six types of skill. In a stationary environment of constant cohort size, these potential supplies would not vary with calendar time. However, because of variations in cohort size, the environment we consider is not stationary in terms of the age distribution of the population; thus, the potential supply of sector-occupation skills varies with calendar time and may provide a part of the explanation for relative service-sector growth. Changes in skill supply may also have accompanied the increase in the female labor force participation, because females are modelled as having potentially different skill endowments and preferences. Changes over time in female labor supply arise in the model because of changes in fertility (considered exogenous) by cohort and the effect that children have on the value of female home time. Finally, changes over time in school attainment at age 16 (initial schooling) may also have affected the skill distribution in ways that influenced the growth in the service sector. Again, the model's estimates will quantify the relative importance of supply factors in determining the growth in the service sector.

1.2. Model Specification

1.2.1. Technology

We consider a two-sector economy, the goods-producing sector (G) and the service sector (R), each producing output (Y) using three skill categories of workers–white-, pink-, and blue-collar

(W, P, B), and homogeneous capital (K). Each sector is also subject to an aggregate productivity shock (ζ). Skill units (S) of each worker category (occupation) employed in each sector are additive over workers in that occupation and sector. Specifically, production at time t, valued at the sector's period t real price (p), is given by the nested CES function

$$\begin{aligned} & p_t^j Y_t^j \\ & = p_j^t \zeta_t^j F^j\left(S_t^{jW}, S_t^{jP}, S_t^{jB}, K_t^j\right) \\ & = z_t^j\left\{\alpha_{1t}^j\left(S_t^{jP}\right)^{\sigma^j} + \alpha_{2t}^j\left(S_t^{jB}\right)^{\sigma^j} + \left(1-\alpha_{1t}^j-\alpha_{2t}^j\right)\left[\lambda_t^j\left(S_t^{jW}\right)^{\nu^j} + \left(1-\lambda_t^j\right)\left(K_t^j\right)^{\nu^j}\right]^{\frac{\sigma^j}{\nu^j}}\right\}^{\frac{1}{\sigma^j}}, \end{aligned} \tag{1}$$

where $j \in \{G, R\}$ denotes the sector. Production in each sector is subject to constant returns to scale. The elasticity of substitution between capital and white-collar skill is $\frac{1}{1-\nu^j}$ and that between the composite capital-white-collar skill input and the other skill categories is $\frac{1}{1-\sigma^j}$. Hicks-neutral and factor-biased technological change are assumed to be time-varying.

Sector-specific real productivity is subject to shocks, $z_t = p_t^j \zeta_t^j$, that, evaluated at constant dollars (p_t^j is the real price of sector j output), are assumed to follow a joint first-order vector autoregressive (VAR) process in growth rates. Specifically,

$$\log z_{t+1}^j - \log z_t^j = \phi_0^j + \sum_{k=G,R} \phi_k^j\left(\log z_t^k - \log z_{t-1}^k\right) + \epsilon_{t+1}^j \quad (j = G, R), \tag{2}$$

where the innovations are joint normal with the elements of the variance-covariance matrix σ_{jk}^z, $j, k = G, R$. The time-varying factor shares, reflecting biased technological change, are assumed to be constant up to 1960, then to follow separate linear trends until 1980, and then different linear trends thereafter. Specifically,

$$\alpha_{kt}^j = \begin{cases} \alpha_{k0}^j & \text{if } t < 1960, \\ \alpha_{k0}^j + \alpha_{k1}^j(t-1960) & \text{if } 1980 \geq t \geq 1960 \\ \left[\alpha_{k0}^j + 20\alpha_{k1}^j\right] + \alpha_{k2}^j(t-1980) & \text{if } 2000 \geq t \geq 1980, \end{cases} \tag{3}$$

where $j = G, R$; $k = 1, 2, 3$.

1.2.2. Choice Set

At each age, from $a = 16-65$, an individual of type h who is alive at time t chooses among eight mutually exclusive alternatives, each denoted by a dichotomous variable (d_{hat}^j) equal to 1 if alternative j is chosen and 0 otherwise. Adopting the convention, which we continue throughout, that sector-occupation categories are ordered as $\{GW = 1, GP = 2, GB = 3, RW = 4, RP = 5, RB = 6\}$. In additional to these working choices, people can also choose to attend school, d_{hat}^7; or to take leisure (neither work nor attend school), d_{hat}^8.

The population consists of H discrete types of individuals who permanently differ in preferences and skill endowments as described below. The probability that an individual is of any given type (π_h) depends on the individual's initial conditions, namely the level of schooling attained at age 16 and gender. In what follows, we drop the h and t subscripts when the meaning is clear.

1.2.3. Preferences

As previously noted, for tractability, we assume that the discrete time allocation decision is independent of the relative price of goods to services, that is, we assume a utility specification that enables us to ignore the consumption allocation decision. The flow utility at each age a for an individual of type h is given by

$$\begin{aligned} U_a^h = \sum_{k=1}^{6} \gamma_k d_a^k + \gamma_{7h} d_a^7 + \left(\gamma_{80h} + \gamma_{81} n_{05,a}\right) d_a^8 + \gamma_9 d_a^8 d_{a-1}^8 \\ + \gamma_{10} d_a^7 \left(1 - d_{a-1}^7\right) I\left(E_a < 12\right) \\ + \gamma_{11} d_a^7 \left(1 - d_{a-1}^7\right) I\left(E_a \geq 12\right) + u\left(c_a^G, c_a^R\right), \end{aligned} \tag{4}$$

where $u\left(c_a^R, c_a^G\right)$ is the separable consumption branch of the utility function.

To fit the choice data requires additional structure on utility. For example, the utility specification allows for differential nonpecuniary benefits associated with working in each sector-occupation, given by γ_k for $k = 1, \ldots, 6$, because wage differentials alone do not provide a good fit to the choice distribution. To capture the strong degree of persistence in the choice of the schooling and home alternatives, those choice-specific utilities are assumed to vary by an individual's time-invariant type, in addition to being subject to age-varying independent and identically distributed (i.i.d.) stochastic shocks, namely,

$$\gamma_{kha} = \gamma_{kh} + \epsilon_{ka}, k = 7, 8.$$

To fit the fact that returning to school after a period of nonattendance is rare, the utility specification also includes a psychic cost of reentering high school, E_a (completed years of schooling up to age a) less than 12, γ_{10}, and a separate cost for reentering college, E_a at least 12, γ_{11}. Particularly because females are less likely to work when there are young children in the household, the utility associated with being at home is allowed to depend on the number of children under the age of six ($n_{05,a}$) and, to better fit persistence in the home alternative, on whether the individual was at home in the previous period, γ_9. All parameters vary by the individual's gender. Preference shocks are joint normal with elements of the variance-covariance matrix given by σ_{jk}^{ϵ}, $j, k = 7, 8$.