Available online at www.sciencedirect.com

SciVerse ScienceDirect

Procedia - Social and Behavioral Sciences 58 (2012) 820 – 829

Procedia
Social and Behavioral Sciences

8th International Strategic Management Conference

Technology and Job Competence in the Turkish Labor Markets: A Model and Simulations[1]

Ahmet Kara [a 2], Selim Zaim [b]

[a] Istanbul Commerce University, 34672, Istanbul, Turkey
[b] Marmara University 34722, Istanbu,l Turkey

Abstract

This paper presents "system dynamics" simulations of the effects of technology on the level of job competence in a subset of the Turkish labor markets. Through deterministic and stochastic simulations, we demonstrate the possibility of considerable technology-induced improvements in the level of job competence.

Keywords: Job competence; technology, labor markets, simulations

1. Introduction

There are a large number of works in the literature that examine different dimensions of labor processes and firms. Among these works are Bartel (1994), Dess & Picken (1999), Garavan, Morley, Gunnigle, & Collins (2001), Grant (1996), Guest (1997), Hanushek.& Kimko (2000), Kara (2007b), Nonaka (1994),

[1] We acknowledge the financial support from Fatih University.

[2] Corresponding author. Tel.: +90 216 553 9170; fax: + 90 216 553 9172.
E-mail address: tbfakulte@iticu.edu.tr

1877-0428 © 2012 Published by Elsevier Ltd. Selection and/or peer-review under responsibility of the 8th International Strategic Management Conference
doi:10.1016/j.sbspro.2012.09.1060

Turcotte, & Rennison (2004). The issues covered by these works represent a rich spectrum and range from "the link between technology use, human capital, productivity and wages" to "human capital accumulation". As wide as the range of the works in the literature may be, there are still many issues that need to be further explored. Among these issues is the effect(s) of technology on the level of job competence in the labor markets which we examine in this paper. We will follow the stochastic-dynamic work of the kind presented by Kara (2007a, b) so as to model the dynamic relation between technology and job competence in the Turkish labor markets. We will also take into account the deterministic variants of the modeling attempts, such as the one in the work of Kara and Kurtulmuş (2004).

2. The Model and Simulations[3]

2.1 Basic Structure of the Model

Consider a labor market where workers provide a labor service, say L, to firms. Let Q_t^{DL} denote the *quantity demanded* for service L supplied by workers, which indicates the quantity of labor firms are willing and able to hire at time t. Q_t^{DL} depends on the price of labor at time t (w_t^1), prices of other inputs hired/used by firms at time t (w_t^i, i=2,…,m), the level of job competence of workers at time t (K_t) and the degree to which technology is used by workers at time t (T_t).

i.e., $Q_t^{DL} = f^D (w_t^1,\ldots, w_t^m, K_t, T_t),$

which is a labor demand function. $w_t^i \in (0,\infty)$, i = 1,…m. By virtue of the particular way of measuring performance and technology[4], K_t and T_t take on values between 1 and 5, i.e., $K_t \in [1,5]$, and $T_t \in [1,5]$. $Q_t^{DL} \in (0,\infty)$.

Let Q_t^{SL} denote the *quantity supplied* for service L, which indicates the quantity of labor workers are willing and able to supply (sell) at time t. Suppose that Q_t^{SL} depends on the price of labor at time t (w_t^1) and the level of job competences of workers at t and t-1 (K_{t-1} and K_t) .

i.e., $Q_t^{SL} = f^S (w_t^1, K_t, K_{t-1}),$

which is a labor supply function.[5] $K_{t-1} \in [1,7]$, and $Q_t^{SL} \in (0,\infty)$.

For analytical purposes, we will assume that the labor demand and labor supply functions have the following explicit forms:

$$\ln Q_t^{DL} = \alpha_1 \ln K_t + \alpha_2 \ln T_t + \sum_{i=1}^{m} \delta_i \ln \omega_t^i + u_t$$

and

$$\ln Q_t^{SL} = \beta_1 \ln K_t + \beta_2 \ln K_{t-1} + \gamma \ln w_t^1 + v_t$$

---

[3] This model is based on Kara (2010) and benefits from Kara (2007a,b).

[4] These variables are measured on a scale with 1 representing the lowest score that can be assigned, and 5 representing the highest.

[5] The demand and supply equations could be obtained through appropriately formulated profit maximization and utility maximization problems, respectively.

where u_t and v_t are independent normally distributed white noise stochastic terms uncorrelated over time. They have zero means and variances σ_u^2 and σ_v^2 respectively.

Based on the empirical work done by Kara and Zaim (2011), the following parameter values have been obtained.

$\alpha_1 = 0.372$
$\alpha_2 = 0.667$
$\beta_1 = 1$
$\beta_2 = 0.25$.

The effects of input prices on labor demand are assumed to be negligible.

To theorize about the dynamic trajectory of the level of job competence, we will postulate an adjustment dynamic of the following form linking adjustments, over time, of the level of job competence to the strength of demand relative to supply.

$$K_{t+1} / K_t = (Q_t^{DL} / Q_t^{SL})^{k} ,$$

where k is the coefficient of adjustment. Taking the logarithmic transformation of both sides, we get:

$$\ln K_{t+1} = \ln K_t + k\,(\ln Q_t^{DL} - \ln Q_t^{SL}).$$

We will call this the dynamic adjustment equation. Substituting the functional expressions (forms) for $\ln Q_t^{DL}$ and $\ln Q_t^{SL}$ specified above, setting the values of T_t, and w_t^{I}, i=1,…,m, to their average values T_t^{avr}, w_t^{iavr}, i=1,…,m and rearranging the terms in the equation, we get,

$$\ln K_{t+1} + (k\beta_1 - k\alpha_1 - 1) \ln HK_t + k\beta_2 \ln HK_{t-1} = k(\alpha_2 \ln T_t^{avr} + \sum_{i=1}^{m} \delta_i \ln \omega_t^{iavr}$$
$$- \gamma \ln w_t^{1avr}) + k(u_t - v_t),$$

which is a second order stochastic difference equation, the solution of which has two components, namely a particular solution and a complementary function. Following a procedure outlined in Kara (2007a,b), these two components could be derived. We will skip the details of the derivation and state the two components and the general solution.

The particular solution:

$$K^* = \exp\left\{ \frac{\mathrm{k}(\alpha_2 \ln T_t^{avr} + \sum_{i=1}^{m} \delta_i \ln \omega_t^{mavr} - \gamma \ln \omega_t^{1avr})}{k(\beta_1 + \beta_2 - \alpha_1)} + \right.$$

$$\left. + \frac{\lambda_1}{\lambda_1 - \lambda_2} \sum_{j=0}^{\infty} \lambda_1^j z_{t-j} + \frac{\lambda_2}{\lambda_2 - \lambda_1} \sum_{j=0}^{\infty} \lambda_2^j z_{t-j} \right\}$$

where

$$\lambda_1 \lambda_2 = k\beta_2$$
$$\lambda_1 + \lambda_2 = -k(\beta_1 - \alpha_1 - 1)$$

In case where λ_1 and λ_2 are conjugate complex numbers, i.e., λ_1 , $\lambda_2 = h \pm vi$ = r(cos θ ± i sin θ), the intertemporal equilibrium job competence is:

$$K^* = \exp\left\{ \frac{\mathrm{k}(\alpha_2 \ln T_t^{avr} + \sum_{i=1}^{m} \delta_i \ln \omega_t^{mavr} - \gamma \ln \omega_t^{1avr})}{k(\beta_1 + \beta_2 - \alpha_1)} + \right.$$

$$\left. \sum_{j=0}^{\infty} r^j \frac{\sin \theta (j+1)}{\sin \theta} z_{t-j} \right\}$$

where r is the absolute value of the complex number, and sin θ = v/r and cosθ =h/r.

The complementary function:

Solving the reduced form of the second order difference equation, $\ln K_{t+1}$ + (kβ$_1$ – kα$_1$ – 1) ln HK_t + $k\beta_2$ ln HK_{t-1} = 0, and substituting the parameter values, we obtain the complementary function, which is,

0.5(Bcosθt+Csinθt)

where B and C are nonzero constants. sinθ = 0.464/0.5 and cosθ = 0.186/0.5.

The general solution:

The general solution is the sum of the two components above, i.e.,

$$K^* = \exp\left\{ \frac{k(\alpha_2 \ln T_t^{avr} + \sum_{i=1}^{m} \delta_i \ln \omega_t^{mavr} - \gamma \ln \omega_t^{1avr})}{k(\beta_1 + \beta_2 - \alpha_1)} + \sum_{j=0}^{\infty} r^j \frac{\sin\theta(j+1)}{\sin\theta} z_{t-j} \right\}$$

$+0.5(B\cos\theta t + C\sin\theta t)$

Substituting the values of the parameters involved and assuming that k=1, we get,

$$\ln K^* = 1 + \sum_{j=0}^{\infty} 0.5^j \frac{\sin\theta(j+1)}{\sin\theta} z_{t-j} + 0.5^t(B\cos\theta t + C\sin\theta t).$$

Since the absolute value of the complex number involved is 0.5, which is less than 1, as $t \to \infty$, $0.5^t(B\cos\theta t + C\sin\theta t)$ will converge toward zero, and hence the general solution converges toward the particular solution,

$$\ln K^* = 1 + \sum_{j=0}^{\infty} 0.5^j \frac{\sin\theta(j+1)}{\sin\theta} z_{t-j}$$

Thus,

$$E(\ln K^*) = 1 + \sum_{j=0}^{\infty} 0.5^j \frac{\sin\theta(j+1)}{\sin\theta} E(z_{t-j})$$

Since, by virtue of the assumptions about u_t, and v_t, $E(u_t) = 0$, and $E(v_t) = 0$,

$E(z_t) = k(E(u_t) - E(v_t)) = 0$. Thus,
$E(\ln K^*) = 1$,

which is nothing but the intertemporal expected equilibrium job competence in logarithmic terms. In view of the logarithmically transformed competence scale of ln1=0 to ln5 ≅ 1.60, an intertemporal equilibrium expected competence of 1 is low. It can be shown, through a procedure similar to the one outlined and exemplified in the appendix of Kara (2007a), that the logarithmically expressed low competence is also stable over time in the particular sense that it has a stationary distribution with a constant mean and variance.

Can the low competence equilibrium be avoided? In the following section, we will show that the positive changes in the use of technology in the workplaces could increase the level of job competence.

2.2. Simulations

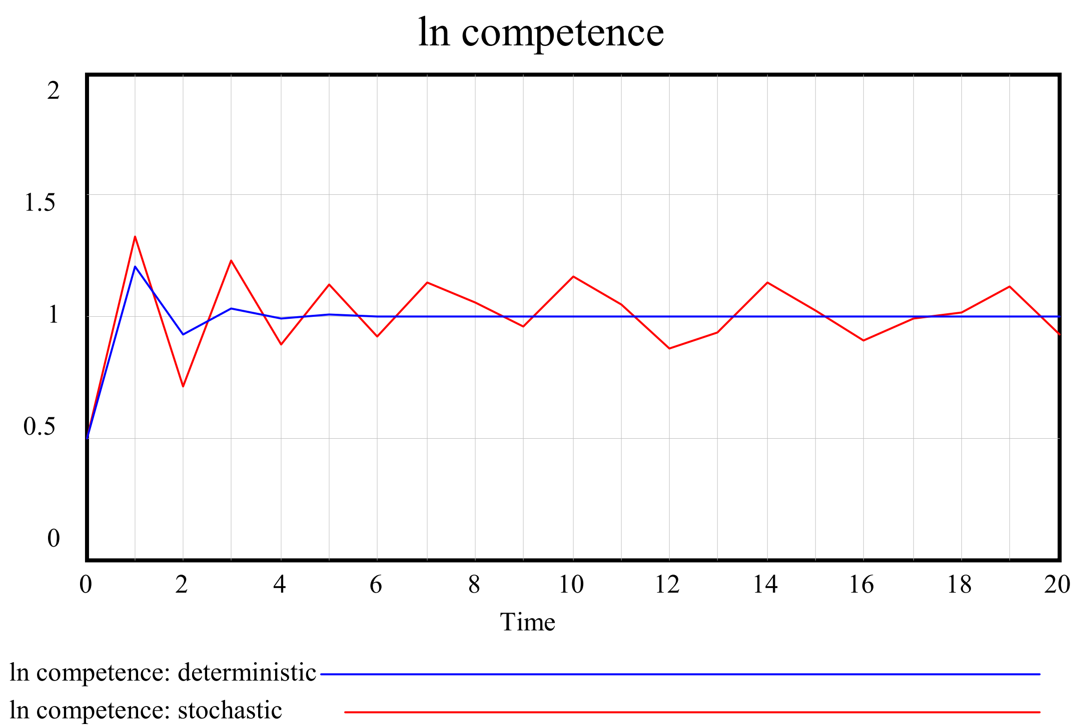
Based on these parameter values and the model described above, we have undertaken system dynamics simulations of the level of competence with various levels of technology utilization. The results are as follows:[6]

---

[6] The software we have used is VENSIM.

2.1.1 Simulations with the average level of technology utilization: ln T= 1.32.

Ln competence	Values	
Time	Deterministic	Stochastic
0	0.5	0.5
1	1.20293	1.33046
2	0.923101	0.71587
3	1.0345	1.22668
4	0.990152	0.882178
5	1.00781	1.12847
6	1.00078	0.920965
7	1.00358	1.13854
8	1.00246	1.05531
9	1.00291	0.955806
10	1.00273	1.16229
11	1.0028	1.04532
12	1.00277	0.865107
13	1.00278	0.934601
14	1.00278	1.13703
15	1.00278	1.02611
16	1.00278	0.904617
17	1.00278	0.990562
18	1.00278	1.01299
19	1.00278	1.12237
20	1.00278	0.924785



Figurre 1

2.2. Simulations with a low level of technology utilization: ln T= 0.5.

ln competence

Time	Stochastic value
0	0.5
1	0.459538
2	0.191652
3	0.564442
4	0.274884
5	0.499305
6	0.300506
7	0.514618
8	0.432768
9	0.332711
10	0.539418
11	0.422354
12	0.242179
13	0.311658
14	0.514097
15	0.403175

16	0.281679
17	0.367623
18	0.390049
19	0.499433
20	0.301847

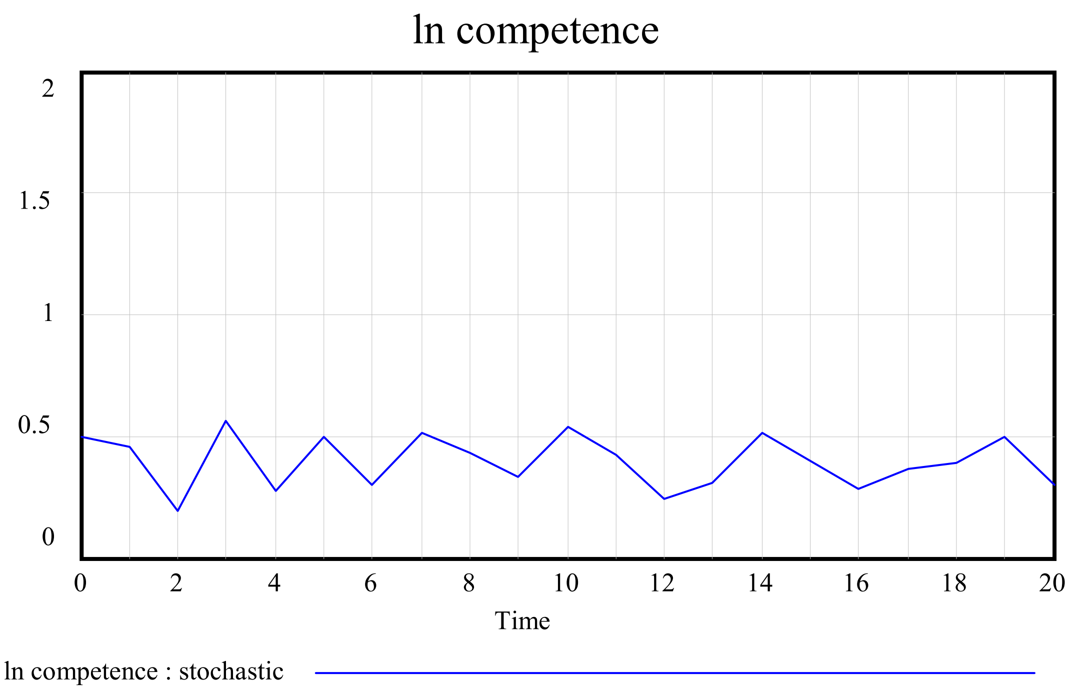


Figure 2.

2.3. Simulations with a high level of technology utilization: ln T= 1.5.

ln competence

Time	Stochastic value
0	0.5
1	1.52164
2	0.830942
3	1.37205
4	1.01549
5	1.26658
6	1.05716
7	1.2755
8	1.19197
9	1.09258
10	1.29902

11	1.18207
12	1.00185
13	1.07134
14	1.27378
15	1.16286
16	1.04136
17	1.1273
18	1.14973
19	1.25911
20	1.06153

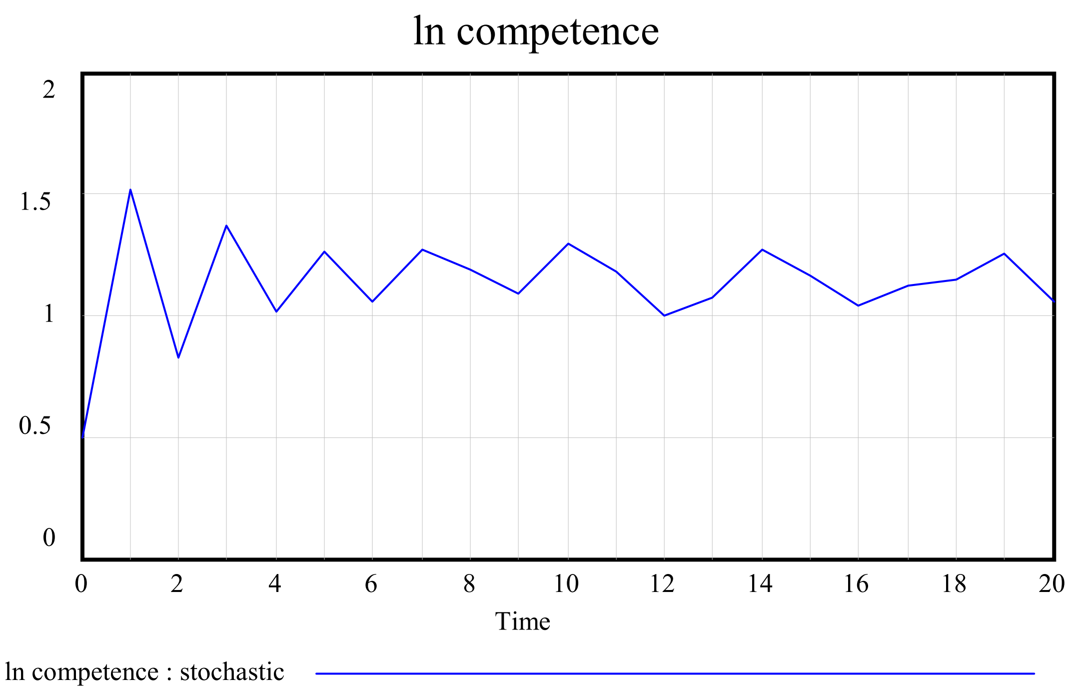


Figure 3.

5. Concluding Remarks

Simulations clearly demonstrate the positive impact of technology on the levels of job competence. However, whether the benefits of the increased job competence outweigh the costs of increased use of technology is an open question this paper has not addressed. Studying this question in a dynamic sector-specific context is likely to produce answers of theoretical and practical significance.

References

Bartel, A.P. (1994). Productivity gains from the implementation of employee training programs. Industrial Relations, 33: 411-425.

Dess, G.D. & Picken, J.C. (1999). Beyond productivity: How leading companies achieve superior performance by leveraging their human capital. New York: American Management Association.

Garavan, T.N., Morley, M., Gunnigle, P. & Collins, E. (2001). Human capital accumulation: the role of human resource development. Journal of European Industrial Training, 25:48-68.

Grant, R.M. (1996). Towards a knowledge-based theory of the firm. Strategic Management Journal, 17 (Winter Special Issue), 108-122.

Guest, D.E. (1997). Human resource management and performance: A review and research agenda. International Journal of Human Resource Management, 8: 265-276.

Hanushek, E.A.& Kimko, D.D. (2000). Schooling, labor force quality and the growth of nations. American Economic Review, 90: 1184-1208.

Kara A. and Kurtulmuş, N. (2004). Intertemporal equilibria in the public banking sector in Turkey. Journal of Economic and Social Research, 6 (1), pp 19-32.

Kara, A. (2007a). Discrete stochastic dynamics of Income inequality in education: an applied stochastic model and a case study. Discrete Dynamics in Nature and Society, Vol 2007, pp. 1-15.

Kara, A. (2007b). "*A Labor Market Model*", Fatih University, Mimeo (unpublished).

Kara, A. (2010). "*Social Capital-Induced Human Capital: A Computational Discrete Stochastic Labor Market Model and an Application*," Fatih University and Istanbul Commerce University, Mimeo.

Kara, A. and Zaim, S. (2011)."Technology and Dynamic Mismatches in the Turkish Labor Markets: A Computational Model and an Application" Fatih University Project. Mimeo.

Nonaka, I. (1994). A dynamic theory of organisational knowledge creation. Organisation Science, 5: 14-38.

Turcotte, J. & Rennison, L.W. (2004). The Link between Technology Use, Human Capital, Productivity and Wages: Firm-level Evidence. International productivity Monitor 9: 25-36.