



Worker heterogeneity, the job-finding rate, and technical change



Suren Basov^a, Ian King^{b,*}, Lawrence Uren^b

^a La Trobe University, Australia

^b The University of Melbourne, Australia

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ABSTRACT

We examine the implications of changes in the skill distribution on the equilibrium matching process and the job finding rate, using a directed search approach. Worker abilities are selected from a distribution while firms face heterogeneous entry costs and direct their job offers to workers. We identify conditions under which technical progress increases or decreases the job finding rate, allowing for entry and the effects of technical changes on heterogeneity. We find that the effects of skill-neutral technical progress on job finding rates are unambiguously non-negative, but the effects of skill-biased changes depend on the elasticity of vacancy costs. However, both skill-neutral and skill-biased technical changes are Pareto improving, *ex ante*, if all agents are risk neutral.

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1. Introduction

In this paper we examine the role that worker heterogeneity plays in the impact that technical changes have on unemployment. Specifically, we consider how different types of technical change affect unemployment through their effects on worker heterogeneity. This is a channel that has not been given much attention to date but which we believe can be quite important. The framework we use, to analyse this issue, is that of directed search – where firms make job offers to workers with different productivity levels, and workers are capacity-constrained, having only a finite number of hours to offer any one firm. We focus on the conditions under which technical change can increase unemployment, even without “creative destruction” effects on job separations, by altering the distribution of worker productivities and the consequent visit probabilities that vacancies assign to different workers. We identify these conditions and briefly examine the implications for policy.

A significant number of studies have investigated the effects of technical change on unemployment. To understand the nature of the contribution of the current study, it is useful to recall the basic formula for the steady state unemployment rate in a standard search and matching model:

$$u = \frac{\sigma}{\sigma + \xi}$$

Here, σ denotes the rate at which firms and workers separate (i.e., the rate at which existing matches dissolve) and ξ denotes the average job finding rate for workers (i.e., the rate at which new matches are made). The literature, for the most part,

* Corresponding author. Tel.: +61 3 8344 3833; fax: +61 3 8344 6899.

E-mail address: ipking@unimelb.edu.au (I. King).

has focussed on the distinction between disembodied technical progress (which raises the productivity of all jobs, including old jobs, as in [Pissarides, 1990](#)) and embodied technical progress (which raises the productivity only of new jobs, as in [Aghion and Howitt, 1994](#)). Much of the debate has centred on the relative importance of these two types of technical change, and the consequent implications for unemployment. On the whole, if technical progress is disembodied, it tends to reduce unemployment by inducing vacancy entry (driving ξ up) while leaving the separation rate σ relatively unaffected. Embodied technical progress, on the other hand, can increase both ξ and σ – through creative destruction – leading to ambiguous and possibly positive effects on unemployment. Empirically, [Pissarides and Vallenti \(2007\)](#) argue that nearly all technical progress is disembodied.

In our study, we consider technical progress that is disembodied in the sense that it affects the productivity of all workers, but potentially more for some than for others: skill-biased technical progress. Putting aside the issue of creative destruction through changes in σ , we show that skill-biased technical change can, under certain conditions, decrease ξ . This can occur because, with directed search, ξ depends not only on the number of vacancies but also on the distribution of worker productivities and, hence, the probabilities that vacancies assign to approaching particular workers. In the presence of worker heterogeneity, each worker (with productivity y) has a specific equilibrium job finding rate $\xi(y)$. Technical change can potentially reduce the values of $\xi(\cdot)$ for some values of productivity, even if productivity itself is increased for all workers. This can potentially reduce the average job finding rate ξ and, hence, increase the equilibrium unemployment rate.

To demonstrate the point, we construct a directed search model, based on [Julien et al. \(2000\)](#), but with worker heterogeneity and idiosyncratic entry costs for vacancies. Workers, in this model, draw productivity values from a known distribution and apply to all existing vacancies. Each vacancy then chooses a worker to approach with a job offer, based on each worker's productivity and on the number of other vacancies that are expected to compete for the worker, in equilibrium. Each worker's wage is determined, *ex post*, by his productivity level and the number of vacancies that approach him. The crucial variable, in this setting, is the probability that each firm assigns, in equilibrium, to approaching workers of each type. As the distribution of worker productivities changes, in general, this changes the probabilities that vacancies assign and, thereby, changes the average job finding rate.

We characterize the equilibrium of this model, and identify three different channels through which heterogeneity of the workforce influences the job finding rate, which we call the *employability channel*, the *effective labor force channel*, and the *miscoordination channel*. The first two channels arise because, in general, when workers are heterogeneous, it is possible that some workers may face the prospect that firms assign a zero probability of approaching them.¹ We call the workers, who make low productivity draws and face this prospect, “unemployable”. The third channel applies to workers who are “employable” in the sense that vacancies assign positive probabilities to approaching them, and reflects the heterogeneity of that fraction of the workforce. We derive a statistic, which we denote by κ , that conveniently summarizes that heterogeneity. This statistic attains its minimal value of unity when the employable workforce is *homogeneous*, and is greater than one whenever any heterogeneity exists. We also show that the average job finding rate is strictly decreasing in κ .

These three channels are distinct from a fourth (well-understood) channel that affects the job finding rate when technical change occurs: the entry of new vacancies in response to higher productivity levels of workers. We separate out the effects of technical change on the job finding rate, through heterogeneity, by considering two cases: with and without entry effects. For clarity, we also consider two different types of technical change: skill neutral (where all worker productivities are increased, but relative productivities are unchanged) and skill-biased (where the technical change favours workers at the higher end of the distribution).

We find that (as one should expect) in the absence of any entry effects, skill-neutral technical change has no effect at all on the job finding rate. In this case, due to the nature of skill-neutral change, none of the three heterogeneity channels are influenced by the change. When the entry channel is opened, skill-neutral technical change unambiguously increases the job finding rate. Skill-biased technological change, on the other hand, influences the job finding rate through all four channels, in general. Consequently, analysis of this type of technical change is more challenging. For this reason, when analysing skill-biased changes, we restrict attention in this paper to two different specific worker productivity distributions: the Pareto distribution (in the body of the text) and the binomial distribution (in the Appendix).² We found that, in the absence of entry, skill-biased technical change unambiguously reduces the job finding rate, by increasing the heterogeneity of the workforce. When entry is allowed, however, the effect of skill-biased technical change on the job finding rate depends on the heterogeneity of firm entry costs. If entry costs are homogeneous then the positive entry effect dominates the three negative heterogeneity effects, and skill-biased technical change unambiguously increases the job finding rate. However, when entry costs are heterogeneous then the overall effect depends on the elasticity of the vacancy cost function. If vacancy costs rise sharply enough then the positive entry effect of skill-biased technical change is dominated by the negative heterogeneity effects, resulting in a lower job finding rate overall.

We also consider the welfare effects of technical progress. We find that, despite the potentially negative affects of skill-biased technical change on unemployment, under reasonable restrictions on the parameters of the model, the overall effects of all the technical changes we consider in this paper are *ex-ante*³ Pareto improving, with or without entry.

¹ This can occur even if these workers offer positive productivity, and when vacancy costs are sunk for firms. Intuitively, in this situation, firms prefer the risky option of approaching higher productivity workers, even when they could alternatively hire a lower productivity worker with certainty.

² For an analysis with general distributions, see [Basov et al. \(2010\)](#).

³ By *ex-ante* Pareto improving we mean that the economy after the change is preferred by both firms and workers, prior to learning their productivity draw.

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