



## Stratification and growth in agent-based matching markets

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### ABSTRACT

This paper examines the dynamic impact of matching on economic mobility and growth. To account for complex interactions over time, experimental economies of heterogeneous agents are simulated with the match process acting as a fitness selection mechanism. Even with perfect information and substantial variety in both offspring and entrants, two-sided matching inevitably causes the population to evolve into stratified groups. Corrective measures are possible to improve mobility, but by altering the path of market evolution, a policy may have unintended impacts on growth and inequality.

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### 1. Introduction

Bilateral matching markets – markets that exist to match two disjoint sets of economic agents – are frequent targets of policies designed to promote equal opportunity. And with good reason. Take the classic example of the labor market, in which employees match with employers; or the market for education, in which students match with schools. Participants' family backgrounds are highly influential in these markets because costly preparations beforehand can make an individual much more attractive to potential partners. Also, the match outcomes of the education and labor markets have been shown to contribute significantly to assortative mating (Mare, 1991), and this in turn may further limit intergenerational mobility (see Ermisch et al., 2006, for empirical evidence and Fernández, 2002, for theoretical). Subsidization programs thus provide opportunities for deserving individuals to break out of otherwise perpetual feedback loops of socioeconomic stratification. The question remains, however: if a government makes it an objective to improve mobility by way of intervening into a matching market, might it hinder another objective, the promotion of economic growth, in the process?

Despite the fact that most developed nations have been experiencing ever widening gaps of inequality, empirical evidence of a direct link between mobility and economic growth is limited (Eriksson and Goldthorpe, 1992). In fact, even the relationship between growth and inequality itself remains unclear (Barro, 2000). Meanwhile, the theoretical work on economic mobility and growth tends to focus on the direct effects that mobility and technological development can have on each other. Works such as Bénabou (1996) and Owen and Weil (1998) consider the complementarities between skilled and unskilled workers and the resulting implications for growth, while others such as Galor and Tsiddon (1997) and Hassler and Rodríguez Mora (2000) study the roles played by technological breakthroughs and varying returns to skill. Though these

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relationships are certainly important, the current work approaches the link between mobility and growth from a different angle, stressing the importance of matching markets.

This paper examines the role of bilateral matching markets in driving economic stratification and growth. Also, more particularly, it looks at how redistributive policy alters incentives and outcomes in matching markets, and how this in turn can impact an economy's evolution.

Matching markets play a key part in how an economy develops due to their aforementioned relation to limited mobility, but also because of growth-enhancing human capital investments made by participants. In attempting to improve their prospects on the job market, for example, individuals often improve their productivity by going to school. This type of “pre-marital” investment – preparatory spending incurred by agents in matching markets to appear more attractive to potential partners – has recently been analyzed in work by Peters and Siow (2002) and Peters (2007). By treating pre-marital investment as a behavioral rule for agents in a dynamic environment, this paper considers how redistributive policy affects such preparatory activity. Subsidizing talented individuals so that they invest more has the potential to improve growth, but at the same time also has the potential to distort the incentives of others, possibly hindering growth.

The model economy in this paper features heterogeneous agents who compete in an intergenerational match game for employment: agents known as workers wish to match with agents known as firms. Workers differ in their initial endowments of wealth and productive ability, and firms differ in the wages they are able to pay. To appeal to firms, workers can use their wealth endowments to invest in human capital, augmenting their existing ability and thereby improving their productive potential. After investments take place, the most qualified workers match with the highest paying firms. The wages they earn become the wealth endowment for their direct descendants, while firms' productivity grows as a function of their employees' ability.

A novel feature of the model is its use of the market's matching process as an evolutionary fitness selection mechanism. Workers who are unable to find a match drop out of the population and thus do not contribute to current or future productive capacity. Those who do match are able to pass on their attributes, but in a manner that is not fully deterministic. Because of the stochastic element to inheritance, results are arrived at by way of agent-based simulations. By simulating the model economy's development under alternate policy regimes, it is possible to illustrate the effects of mobility-enhancing policy on economic growth when matching influences market evolution in ways that are not fully deterministic.

Previous works by Tesfatsion (2001) and Tesfatsion and Pingle (2003) also recognize the importance of dynamic properties in match economies and employ agent-based methods of investigation. The focus in these works is on the development of labor market networks when agents employ adaptive search processes. Other agent-based computational works such as Ünver (2001), Ünver (2005), Haruvy et al. (2006) and Haruvy and Ünver (2007) incorporate the use of genetic algorithms and adaptive learning to investigate matters of equilibrium selection in matching markets. Rather than tackling such issues of search or selection, however, all match activity involved in this paper is frictionless, with emphasis instead on intergenerational investment linkages.

Results suggest a robust tendency for agents in matching markets to swiftly move into definitive strata. Once established, deviation from the strata is unlikely, with local mobility occurring primarily among the lower classes while the upper class is more firmly entrenched. The fact that stratification is an inherent property of matching markets comes as no shock, though it does complement previous work on the causes of intergenerational mobility (for recent example, see Anderberg and Andersson, 2007). More surprising are the consequences of correcting that stratification.

After presenting the model's details and results on stratification in Sections 2 and 3 respectively, Section 4 of the paper conducts a policy experiment to compare the economy's growth with and without a transfer scheme that improves intergenerational mobility. Ultimately, the comparison depends critically on the specification of firms' productivity growth. When growth is specified as convergent, so that all firms have some limit to their productive potential, the policy does not cause any significant changes in growth. In that case, some degree of fairness may indeed be promoted without any sacrifice of economic performance. When technology growth is exponential, however, results are very different.

When productivity growth is exponential, altering market evolution via mobility-enhancing transfers can benefit total long-run economic growth, but not in an egalitarian fashion. Because the most qualified workers consistently match with the economy's most preferred jobs, selective redistribution benefits that sector at the expense of less preferred sectors. This widens existing wage gaps and increases the wealth advantage of the upper class, exacerbating inequality and thereby making an economy more dependent on policy.

## 2. The model

Two-sided matching markets are comprised of agents that can be grouped into two disjoint sets. Agents from one set must be matched with complementary agents in order to complete their economic objectives.<sup>1</sup> The population in this model is comprised of  $F = \{f^1, f^2, \dots, f^m\}$  firms on one side of the market and  $W = \{w^1, w^2, \dots, w^n\}$  workers on the other side,  $m < n$ . Workers are attracted to high wages and firms require skilled labor in order to produce the economy's generic consumption good.

<sup>1</sup> A vast literature has been dedicated to these markets and is expertly surveyed in Roth and Sotomayor (1990) and Roth (2008).

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