Oxford Economic Papers, 71(1), 2019, 119–144
doi: 10.1093/oep/gpy029
Advance Access Publication Date: 27 June 2018

OXFORD

Job creation in a multi-sector labour market model for developing economies

By Arnab K. Basu[a], Nancy H. Chau[b], Gary S. Fields[c], and Ravi Kanbur[d]

[a]Dyson School of Applied Economics and Management, Cornell University, and IZA
[b]Dyson School of Applied Economics and Management, Cornell University, Ithaca, NY 14853, USA, and IZA; e-mail: hyc3@cornell.edu
[c]Department of Economics, Cornell University, IZA, and WIDER
[d]Dyson School of Applied Economics and Management, Department of Economics, Cornell University, and IZA

Abstract

This paper proposes an overlapping generations multi-sector model of the labour market for developing countries with four heterogeneities—heterogeneity within self-employment, heterogeneity in job experience, heterogeneity in pathways to self-employment, and heterogeneity in ability. We revisit an iconic paradox in a class of multi-sector labour market models in which the creation of high-wage employment exacerbates unemployment. Our richer setting allows for generational differences in the motivations for job search to be reflected in two distinct inverted-U-shaped relationships between unemployment and high-wage employment, one for youth and another for adults. In turn, the relationship between overall unemployment and high-wage employment is shown to be non-monotonic and multi-peaked. The model also sheds light on the implications of increasing high-wage employment on self-employed workers. Non-monotonicity in unemployment notwithstanding, increasing high-wage employment leads to an unambiguous increase in high-paying self-employment, and an unambiguous decrease in free-entry (low-wage) self-employment.

JEL classifications: I32, O17.

1. Introduction

Does increasing high-wage employment increase or decrease unemployment? What does increasing high-wage employment do to youth and adult unemployment? What does increasing high-wage employment do to high-paying self-employed and low-wage free-entry work? These questions, and others like them, will be recognized as being important in the policy debates in developing countries. Can our models address them?

The need for labour market models which stylize the reality of developing country conditions in tractable form in order to allow analysis of a range of policy questions has been central to the development economics field for decades. Among the most important contributions are the Lewis model (Lewis, 1954), which won its developer the Nobel Prize, and the Harris–Todaro model (Harris and Todaro, 1970), which was honoured as being one of the top 20 articles published in the *American Economic Review* in the last century. What both these models have at their core is *multiple labour markets*, each working in its own way and connected to the other. Both models also feature *labour market segmentation*, which we define consistent with the literature as arising when: (1) the same worker can earn more in some segments of the economy than he/she could earn in other segments; and (2) access to the better-paying segments is rationed, so that not all workers who would like to work in the 'good jobs' part of the economy and who are capable of performing those jobs can in fact get such jobs.

The iconic and counterintuitive answer of the Harris–Todaro model to the first question posed at the beginning of this introduction is of course that increasing high-wage employment will increase unemployment. But it should be clear that neither the Lewis model nor the Harris–Todaro model can in fact address the remaining questions, because they do not incorporate features of developing countries which underpin those questions. We therefore need models which incorporate these realities in sufficiently tractable form that the full range of questions can be addressed.

In the intervening decades since Lewis and Harris and Todaro did their work, it has become widely (though not universally) accepted that labour markets in developing economies have multiple segments (as opposed to one single set of conditions applying to all) and that labour markets are segmented according to the preceding definition (i.e. (1) the same worker can earn more in some segments of the economy than in others; and (2) access to the better-paying segments is rationed) (Fields, 2014). Lewis (1954) had high-wage work and low-wage work coexisting, but unemployment was missing from his model. Harris and Todaro (1970) had three employment states—high-wage work and unemployment in urban areas, plus low-wage work in rural areas. Fields (1975, 1989) and others (e.g. Steel and Takagi, 1983) had both unemployment and low-wage work in urban areas in addition to high-wage urban employment. Banerjee and Newman (1993) had four occupational options—subsistence work, work as a wage labourer, self-employment, and entrepreneurship—but no unemployment.

Based on evidence accumulated to date, it has also become clear that a number of salient empirical features of developing country labour markets are at odds with the assumptions/implications of these earlier models. In this paper, we build a multi-sector labour market model structured around four additional heterogeneities, which are warranted by empirical studies of developing countries. The four heterogeneities are: (1) duality of self-employment; (2) two generations of workers with different job experience in overlapping generations; (3) different pathways into the two types of self-employment; and (4) a range of abilities to enter upper-tier self-employment and achieve higher earnings from it.

The first heterogeneity observed in the world and modelled here is *duality within self-employment*.[1] Some people are self-employed because (1) they would like to work in the advantaged segments of the labour market, but access to those jobs is rationed; and (2) they

1 Heterogeneity of the informal sector, and the need for recognition by analysts and policymakers, has been stressed by Chen (2006).

cannot afford to search for long for jobs in the advantaged segments, instead preferring to take up easy-entry paid employment or other easy-entry jobs they often create themselves. On the other hand, there are others who had been paid employees in the advantaged segments who then chose to leave such jobs and set up their own self-employment activities. A large empirical literature confirms this duality within informal employment,[2] in a diverse list of countries including Argentina, Brazil, Bolivia (Perry *et al.*, 2007), Cameroon (Nguimkeu, 2014), Côte d'Ivoire (Günther and Launov, 2012), Dominican Republic (Perry *et al.*, 2007), Egypt (Harati, 2013), India (Sahoo and Neog, 2017), and Mexico (Pagés and Stampini, 2009), for example.[3]

The second feature of the world which we incorporate into our model is *differences in worker capital, whether human or physical, that can evolve over time with the accumulation of job experience* (Becker, 1964). Evidence from interviews (Balán *et al.*, 1975; Fields, 1990; Maloney, 2004), as well as individual profiles of self-employed workers (Jütting *et al.*, 2008), argues in favour of a 'lifecycle' model, in which for a young worker, wage employment makes possible the accumulation of skills and savings that can be later used to enter the *upper tier of self-employment*. Similarly in the USA, as well as in Argentina, Brazil, and Mexico, Evans and Leighton (1989) and Bosch and Maloney (2005) respectively find that entry into self-employment is more likely among older workers compared to younger workers. Günther and Launov (2012) find two distinctive segments within informal employment in Côte d'Ivoire each with a different wage equation. The study concludes that returns to education and experience are indeed higher in the higher-paid segment.

The third feature of the world that we bring into our analysis is *heterogeneous pathways to self-employment, respectively free-entry self-employment and high-paying self-employment*. While free-entry self-employment by definition accommodates the poorest and least-skilled workers, workers may be barred from entry into high-paying self-employment because of a lack of capital and skills (Blanchflower and Oswald, 1998; Bandiera *et al.*, 2013). McGrath *et al.* (1995) synthesize earlier studies on the various pathways to self-employment (e.g. Grierson, 1993) and singles out wage employment as one such measure. Based on empirical evidence from Argentina, Mexico, and Brazil, Pagés and Stampini (2009) conclude that worker mobility into self-employment from paid formal jobs is in fact higher than mobility in the reverse direction.[4] Outside Latin America, this pattern of self-employment entry has also been found in Eastern and South Africa (Haan, 2001), Kenya (Higgins and Kalan, 2013), as well as in developed countries such as Denmark (Iversen *et al.*, 2016).

2 The definitions of informal employment in these studies vary. With the exception of Harati (2013), self-employment is included in these studies either as a standalone labour market state, or as part of informal employment defined to include both self-employed workers and informal wage workers.

3 The literature disagrees about the relative importance of the two. See for example Fields (1990) and Maloney (2004).

4 It may be argued that observed transitions from formal paid employment to informal self-employment are results of layoffs and turnover rather than voluntary choice. Perry *et al.* (2007) report evidence from select Latin American countries which found that some workers indeed strictly prefer self-employment over formal paid employment (e.g. independence, flexibility, and higher earnings). Pagés and Stampini (2009) find evidence of a self-employment premium relative to formal jobs.

The fourth feature we incorporate is heterogeneity in an individual's ability to enter into upper-tier self-employment and earn higher income from it. This is a common feature in models of self-employment such as Fiess *et al.* (2010), and reflects the reality that ability in self-employment is worker-specific (e.g. Perry *et al.*, 2007).

In this paper, we build a model incorporating the preceding stylized features of developing country labour markets. The model has four labour market states: three employment sectors—termed wage employment, free-entry self-employment, and high-wage self-employment—plus unemployment. Workers choose among two search strategies: a risky search strategy, which results in wage employment if successful but unemployment if unsuccessful, and a safe search strategy, which results in free-entry self-employment (but at low wages) with certainty. Further, we assume that a worker has to spend some time in the wage employment sector in order to acquire skills and finance to make entrepreneurship feasible. But individuals differ in their abilities as entrepreneurs, and this is a further factor in their decisions on search strategy. This also highlights the time dimension of the model—workers live for two periods, and can make rational choices regarding job search in each of these periods. The distinction between youth and older workers thus emerges as a natural feature of the model.

In the model, we allow for a large number of workers making such choices and facing such constraints. We solve for the market equilibrium of the model. The solution is sufficiently tractable that a range of comparative static exercises can be carried out. These comparative static exercises will in turn provide answers to the three questions we pose at the outset.

This paper is related to several strands of the literature on labour markets in developing economies. First, we contribute to models of informal sector employment by explicitly introducing three sources of heterogeneity in the labour market: heterogeneity within self-employment, heterogeneity in pathways to self-employment, and heterogeneity in age, all within a framework where wage employment, self-employment, and unemployment co-exist. Closely related to our work, Bennett and Rablen (2014) model labour markets where informal wage employment, self-employment, and informal entrepreneurship coexist.[5] Nguimkeu (2014) models individuals' choices between easy-entry subsistence informal employment and upper-tier self-employment, where self-employment is subject to credit constraints following Evans and Jovanovic (1989), Bosch and Maloney (2005), and Fiess *et al.* (2010). Unemployment, a central consideration in our analysis, is ruled out in these papers. In addition, heterogeneous pathways to self-employment and heterogeneous job experience are not featured in these papers. We show that these considerations in combination allow

5 Bennett and Rablen (2014) consider a setting with voluntary and involuntary self-employment, formal and informal wage employment, and formal and informal entrepreneurship. Our model incorporates high-wage employment, high-paying self-employment, low-wage free-entry work, and unemployment. A key policy variable in Bennett and Rablen (2014) is a worker's skill vector. The paper examines in a static one-period model the conditions under which different labour market states co-exist, and how changes in a worker's skill vector lead to transitions from one employment state to another at the individual worker's level. In our model, the main policy variable is high-wage employment. We work with an overlapping generations model with two generations of workers at any given time, and investigate the co-determination of individual-level job search strategies by all workers, and the resulting market-level allocation of workers in the different labour market states.

us to make age-specific predictions about how unemployment responds to policy shocks. We show that these age-specific responses are potent enough to generate non-monotonic general equilibrium comparative statics responses of unemployment with respect to an increase in high-wage employment opportunities.[6] Another closely related paper is Banerjee and Newman (1993), which combines individual-level choices (between entrepreneurship and wage employment) and market-level outcomes. Banerjee and Newman (1993) do not account for duality within self-employment, however, or the pathways towards self-employment.

Second, we show that the incorporation of heterogeneous pathways into self-employment can yield insights into the mechanisms that may have driven a number of mixed empirical findings in the literature. For example, Gindling *et al.* (2016) and Loayza and Rigolini (2006) employ cross-country panel data analyses and find evidence of countercyclical behaviour—informal employment (inclusive of self-employment) expands during adverse economic shocks while formal employment contracts. By contrast, Boeri and Garibaldi (2006) and Evans and Leighton (1989) find evidence of procyclicality of self-employment in Brazil and the USA, respectively. In our model, free-entry self-employment is weakly decreasing with respect to exogenous increases in formal employment due, for example, to productivity change, but high-paying self-employment responds to the same changes in the opposite direction.

Third, the Todaro Paradox has inspired a large body of subsequent theoretical and empirical studies (e.g. Arellano, 1981; Zenou, 2011).[7] We revisit the Todaro Paradox in this paper, with the additional emphasis that wage employment is no longer the best employment outcome a worker can expect compared to high-wage self-employment for at least some workers. Nonetheless, wage employment presents a necessary first step to high-wage self-employment for these workers. This new setting calls for an amendment to the policy rationale for expanding wage employment as development strategy: to increase the number of relatively high-paying job opportunities for some workers, as well as to facilitate the transition to even better self-employment options for others. In this regard, our model is complementary to a large body of work to date on the labour market implications of safe and risky search, and the corresponding justifications for policy interventions such as safety nets and wage subsidies, for example (Vodopivec, 2009; Robalino *et al.*, 2011; Margolis *et al.*, 2012; Charlot *et al.*, 2016; Docquier *et al.*, 2017).

2. Model

2.1 Setup of the model

In what follows, we describe the conditions characterizing a multi-sector labour market in a steady state, in the sense that the labour allocations across search strategies *ex ante* and labour market states *ex post*, to be described below, remain constant over time.

6 In Bennett and Rablen (2014), non-monotonicity of a different type arises—an increase in a worker's skill can lead the worker to move from one employment state to a second, then a third, and back to the first.

7 For a survey of this long-standing literature, see for example Lall *et al.* (2006).

2.1.1 Overlapping generations and workforce The economy is made up of overlapping generations of workers with two-period lives (youth and adulthood). Youth are denoted by small letters, adults by capital letters, and total by script capital letters. So, for example, e_j denotes the employment of youth in sector j, E_j denotes the employment of adults in sector j, and $\mathcal{E}_j = e_j + E_j$. Workers work during both periods of their lives, and ρ denotes the discount factor. The number of workers in each generation will be denoted as $\mathcal{L}$. The size of the economy's workforce, including young and adult workers, is thus $2\mathcal{L}$ in every period.

2.1.2 Sectors of employment and wages The economy has three sectors of employment, respectively termed wage employment ($\mathcal{E}_W = E_W + e_W$), free-entry self-employment ($\mathcal{E}_F = E_F + e_F$), and high-paying self-employment ($\mathcal{E}_H = E_H + e_H$). Unemployment ($\mathcal{U} = U + u$) constitutes a fourth labour market state.[8] Once a worker finds employment in a sector, he can keep that employment for the two periods of his life, i.e. there is no involuntary labour turnover.

Wages and employment are determined as follows. In the wage employment sector (W), employers set the wage, w_W, exogenously at a level above that of the free-entry self-employment sector. This may be for institutional reasons (e.g. minimum wages,[9] labour unions[10]), market reasons (i.e. efficiency wages),[11] or a combination of the two. Adults and youth are perfect substitutes in production, and therefore employers are indifferent between hiring an adult and hiring a youth for any job vacancy.[12] Employers demand workers ($\mathcal{E}_W = E_W + e_W$) such that the net labor cost w_W equals the marginal product of the last worker hired:

$$\mathcal{E}_W(w_W,\ a_W) = \{\mathcal{E}_W | \partial G(\mathcal{E}_W,\ a_W)/\partial \mathcal{E}_W = w_W\}, \tag{1}$$

where total revenue in the wage employment sector $G(\mathcal{E}_W,\ a_W)$ exhibits positive and strictly decreasing marginal value product of labor. a_W is a wage employment demand shifter, with $\partial^2 G(\mathcal{E}_W, a_W)/\partial \mathcal{E}_W \partial a_W > 0$. From (1), job creation in the formal sector $\mathcal{E}_W(w_W, a_W)$ occurs whenever a_W rises at constant w_W.[13]

The free-entry sector, F, is one where any worker who desires a job can find one. The free-entry wage is assumed invariant to the number of workers in the sector. This wage is denoted by w_F.

8 This setup can accommodate both an urban labour market or an urban-rural labour market structure. In particular, the free-entry self-employment can be interpreted either as part of the urban informal sector or as a rural agricultural sector. Free-entry self-employment may also be interpreted as free-entry wage employment. In our setting, whether we assume one way or another will not make a difference to the conclusions we draw.

9 See for example Freeman (1996), who presents redistribution as a rationale for the minimum wage, and Fields and Kanbur (2007), who analyse the poverty implications of a minimum wage.

10 See for example, OECD (1996) for a discussion of the role of labour union in developing country labour markets.

11 See Stiglitz (1976) for one of the earliest attempts to use efficiency wage to explain the co-existence of unemployment and a positive wage in wage employment.

12 Günther and Launov (2012) find that experience and education are important determinants of earnings in high-paying segments of informal employment. However, experience and education have very little to no influence on earnings in the low-paying segment.

13 To see this, note from (1) that $\frac{\partial \mathcal{E}_W(w_W, a_W)}{\partial a_W} = -\frac{\partial^2 G(\mathcal{E}_W, a_W)}{\partial \mathcal{E}_W \partial a_W} \Big/ \frac{\partial^2 G(\mathcal{E}_W, a_W)}{\partial \mathcal{E}_W \partial \mathcal{E}_W} > 0$.

The high-paying self-employment sector, H, is not free entry. An important innovation of this paper is that in order to have the skills and resources to enter high-paying self-employment,[14] a worker must have worked in the wage employment sector for at least one period. Therefore, all workers in the high-paying self-employment sector are adults, but not all adults are able to enter this sector, or if able, not all choose to.

Whether a worker with the skills and resources to enter high-paying self-employment chooses to enter or not depends on how high the pay is for that worker, which in turn depends on an individual productivity/utility parameter θ, which is known to the worker (Evans and Jovanovic, 1989).[15] We assume θ in each generation is distributed uniformly and symmetrically around zero, with $\theta \in [-\bar{\theta}, \bar{\theta}]$. If a worker with the required skills and resources chooses to engage in high-paying self-employment, he would earn what he would have earned had he remained in wage employment (w_W) plus the individual-specific money equivalent wage income for him. Only workers who would earn more in high-paying self-employment than in wage employment would choose to leave wage employment in favor of high-paying self-employment.[16]

A worker who enters high-paying self-employment would earn $w_W + \theta$.[17] Given that high-paying self-employment lasts one period—adulthood—the marginal worker who is just indifferent between wage employment and high-paying self-employment is endowed with a $\widehat{\theta}$ defined implicitly as $w_W + \widehat{\theta} = w_W$, or equivalently

$$\widehat{\theta} = 0. \tag{2}$$

2.1.3 Choosing among search strategies In order to select between search strategies, workers (both adult and young) evaluate the expected values associated with each strategy and choose whichever is higher. Let V_i and v_i denote the expected values of search strategy

14 In our formulation, high-paying entrepreneurs are self-employed individuals. We do so to match a salient feature of small and medium-size enterprises in the developing world, namely, that a significant fraction are one-person enterprises. For example, the shares of one-person enterprises in the mid-1990s were 65% in Botswana, 79% in Lesotho, 69% in Swaziland, and 69% in Zimbabwe (Haan, 2001).

15 Following the recent literature on the task composition of jobs, we distinguish the ability to be successful in entrepreneurship from the ability to be more productive in wage employment. Entrepreneurial ability varies across individuals, but productivity in wage employment is assumed to be the same for all individuals.

16 The model can be readily modified to allow the pool of heterogeneous high-paying self-employed to hire workers from the pool of free-entry self-employed workers at the market wage w_F. As long as there is positive free-entry employment, it can be readily verified, with a few additional notations, that the search strategy choices made by young or old workers, as well as the overall findings of this paper, remain qualitatively unchanged. We assume that workers are sufficiently capital constrained that formal entrepreneurship is not feasible.

17 Since high-paying self-employed workers earn more than wage employees, while free-entry self-employed workers earn less, it follows that the average self-employed worker may earn more or less than wage employees. This is consistent, with evidence presented in Gindling *et al.* (2016) in which penalties and premia of self-employed workers—broadly defined as 'those who self-identify as either an own account worker or an owner/employer'—relative to wage employment have both been observed across countries, as well as within countries but across years (Table A1 in Gindling *et al.* (2016).

$i = r, s$ facing adult and young workers, respectively. Also let J_i and j_i denote the number of adult and young workers, respectively, who adopt the risky search strategy, and also denote $\mathcal{J}_r = J_r + j_r$.

Let us start with an adult worker who is not yet in high-wage employment and who adopts the risky search strategy. The expected value associated with this search strategy is the wage in wage employment, if successful, multiplied by the probability of success:

$$V_r = \pi w_W. \tag{3}$$

Observe that since adults have only one period of work life remaining, the possibility of entering high-paying self-employment does not arise, and therefore $V_r(\pi)$ is independent of the payoff to that worker of being in high-paying self-employment.

Employers are assumed to choose randomly from among the pool of workers who have adopted the risky search strategy, who will be called risky job seekers, to fill any job opening in the wage employment sector. Each risky job seeker faces the same probability of being hired for wage employment as any other; this probability is given by

$$\pi = \frac{\textit{job openings in wage employment}}{\textit{total number of risky job seekers}}. \tag{4}$$

Both the numerator and the denominator on the right-hand side are determined by a set of complicated relationships that will be explained in detail later.

For an adult worker who adopts the safe search strategy, the expected value is simply the wage in the free-entry sector:

$$V_s = w_F. \tag{5}$$

Now for a young worker who adopts the risky strategy, the expected value v_r depends on whether he is a high θ or a low θ worker. For a high θ worker who adopts the risky search strategy, he finds wage employment at w_W as a young worker with probability π, knowing that a period later, he will move into high-paying self-employment at $w_W + \theta$. If he adopts the risky search strategy and is unsuccessful, which occurs with probability $1 - \pi$, the young worker is unemployed for one period, but retains the option to choose between the two search strategies once again a period later as an adult. The associated option value is $\max\{V_r, V_s\}$, appropriately discounted by the discount factor ρ. Now for a low θ young worker who adopts the risky search strategy, with probability π he will obtain a job in the high-wage sector in the first period of his life and will retain that job in the second period of his life, thus earning w_W in both periods. If such a worker is unsuccessful in period 1, which occurs with probability $1 - \pi$, the worker is unemployed for that period, and a period later, he can again choose between the risky and the safe strategies, with associated value $\max\{V_r, V_s\}$, appropriately discounted. In summary, for a young person entering the labour market for the first time,

$$v_r(\pi, \theta) = \begin{cases} \pi[w_W + \rho(w_W + \theta)] + (1 - \pi)\rho\max\{V_r(\pi), V_s\} & \textit{if } \theta > \widehat{\theta} \\ \pi[w_W(1 + \rho)] + (1 - \pi)\rho\max\{V_r(\pi), V_s\} & \textit{otherwise} \end{cases} \tag{6}$$

Observe that $v_r(\pi, \theta)$ is continuous in θ, strictly increasing in θ among high θ workers, and independent of θ among low θ workers. In other words, comparing high and low θ workers, high θ workers derive larger benefits from the risky strategy than do low θ workers.

Turning now to a young worker who adopts the safe search strategy in period 1, this worker is guaranteed a period 1 income of w_F in the free-entry sector. In period 2, the worker chooses between the two search strategies again, and this offers $\max\{V_r(\pi),\ V_s\}$. To a young worker, the expected value of adopting the safe search strategy in period 1 (though not necessarily in period 2) is thus

$$v_s(\pi) = w_F + \rho \max\{V_r(\pi), V_s\}. \tag{7}$$

This concludes the setup of the model.

3. Equilibrium

A steady-state equilibrium in this economy is a time-invariant allocation of adult and young workers' *ex ante* search strategies ($\mathcal{J}_r^* = J_r^* + j_r^*$), and a time-invariant allocation of adult and young workers' *ex postx post* employment outcomes ($\mathcal{E}_W^* = E_W^* + e_W^*$, $\mathcal{E}_F^* = E_F^* + e_F^*$, $\mathcal{E}_H^* = E_H^* + e_H^*$, and $\mathcal{U}^* = U^* + u^*$) such that (1) each worker chooses a search strategy that maximizes expected utility (eqs (3), (5)–(7)) conditional on the probability of wage employment facing risky job seekers (eq. (4)); (2) employers make wage employment decisions according to eq. (1); (3) workers in high-paying self-employment receive wages according to eq. (2); and (4) workers in free-entry self-employment receive w_F.

We begin our analysis with an examination of the choice between risky and safe search strategies by adult as well as young workers.

3.1 Search behavior as a function of age and payoff to high-paying self-employment (θ)

Given the returns in the preceding section, which types of worker—young or old, high θ or low θ—will adopt the risky search strategy in which order?

The first to adopt risky search are the young high θ workers starting with the highest θ individual (i.e. the one with $\theta = \bar{\theta}$), followed next by other high θ young workers with successively lower θ's, until we have gotten to the young individual whose $\theta = 0$. The reason the first group of risky job seekers are young workers rather than adult workers is that young workers have two periods of high-paying work after a successful risky search, compared to adult workers who have only one period of work life remaining. The reason young workers engage in risky search in decreasing order of θ is that young workers with higher θ's would earn more in high-paying self-employment than would lower θ workers.

The next workers in line to adopt the risky search strategy are young low θ workers. Within that group, start with one individual, whose value of θ is indeterminate. More and more individuals within this group will engage in risky search until all do. The reason θ does not matter is that young low θ workers seek wage employment with the intention of staying in wage employment for two periods and not entering self-employment, and so the specific value of θ, which determines how much they would earn in self-employment, is irrelevant. The reason these low θ young workers will adopt risky search before any adult workers do, even the highest θ adult, is that low θ young workers have two periods of high-paying work after a successful risky search, compared to an adult worker who receives a payoff for one period only.

The last workers to choose risky search are older workers. The values of θ do not matter for these adult workers, since the successful ones will work in wage employment for one

period only, after which they must retire; they will never have the chance to work in high-wage self-employment.

The proof that workers will engage in risky search in the order discussed in the three preceding paragraphs is as follows. The expected value gain from adopting the risky search strategy rather than the safe search strategy is $v_r(\pi,\ \theta) - v_s(\pi)$ for young workers, and $V_r(\pi) - V_s$ for adult workers. The difference between these two expected value gains $v_r(\pi,\ \theta) - v_s(\pi) - [V_r(\pi) - V_s]$ for all $\theta \in [-\bar{\theta}, \bar{\theta}]$ and $\pi \leq 1$ can be written as

$$\begin{aligned} &v_r(\pi,\ \theta) - v_s(\pi) - [V_r(\pi) - V_s] \\ &\quad = \pi\rho[w_W - \max\{\pi w_W, w_F\} + \max\{0, w_W + \theta - w_W\}] \\ &\quad = \pi\rho[\min\{(1-\pi)w_W, w_W - w_F\} + \max\{0,\ \theta\}]. \end{aligned}$$

The last line can be seen to be a positive number as long as the wage in the free-entry sector, w_F, does not exceed the wage in wage employment w_W—an assumption we have maintained from the outset—which proves that young workers will engage in risky search before adult workers do. In addition, the last term in the last line is increasing in θ for high θ workers, for whom $\max\{0,\ \theta\} = \theta$, which proves that young high θ workers engage in risky search before young low θ workers. Then, young low θ workers start engaging in risky search. For them, $\max\{0,\ \theta = 0$. As well, for them, the difference $v_r(\pi,\ \theta) - v_s(\pi) - [V_r(\pi) - V_s]$ is simply $\pi\rho\ \min\{(1-\pi)w_W,\ w_W - w_F\}$ plus zero, also a positive number. This proves that young low θ workers will engage in risky search after young high θ workers do, but θ does not affect which workers are so engaged. Thus, we have shown that the expected value gain from risky search for all young workers exceeds the expected value gain from risky search for all adult workers, and therefore adult workers will adopt risky search only after all young workers have already adopted risky search. The order in which adult workers choose risky search is indeterminate because $V_r(\pi)$ and V_s are both independent of θ. ■

Following this order, we then have five regimes:

I. Some or all young high θ workers adopt risky search.
II. All young high θ workers and some but not all low θ workers adopt risky search.
III. All young workers and no adult workers adopt risky search.
IV. All young workers and some but not all adult workers adopt risky search.
V. All workers, young and adult alike, adopt risky search.

The set of five search behaviour regimes discussed above is an exhaustive characterization of all of the possible equilibrium combinations of search behaviours among adult and young job seekers in this model. In this section, our tasks are two-fold. For each regime, we will first present closed-form solutions for the equilibrium *ex ante* allocation of workers between the two search strategies and the associated probability of wage employment, conditional on the equilibrium occurring in that specific regime. Next, we seek the conditions under which an equilibrium will indeed arise in each of the five regimes.

3.1.1 Regime I: only young high θ workers adopt risky search A regime I equilibrium occurs when only young high θ workers adopt risky search, and the rest of the young workers and all adult workers adopt safe search. Denote the θ of the young high θ worker who is just indifferent between risky search and safe search as $\tilde{\theta}$. For this high θ worker, the expected value associated with risky search $v_r(\pi,\ \tilde{\theta})$ is equal to that of safe search $v_s(\pi)$. Furthermore, in a regime where only young high θ workers adopt risky search, our discussion in Section 2.2 implies that for an adult the expected value associated with risky search

$(V_r(\pi) = \pi w_W)$ must be less than that of safe search $(V_s = w_F)$. Thus, the θ of the indifferent worker, $\tilde{\theta}$, is implicitly defined by:

$$\begin{aligned}
&v_r\left(\pi,\ \tilde{\theta}\right) = v_s(\pi)\\
&\iff \pi\left[w_W + \rho\left(w_W + \tilde{\theta}\right)\right] + (1-\pi)\rho\max\{V_r(\pi), V_s\} = w_F + \rho\max\{V_r(\pi), V_s\} \qquad (8)\\
&\iff \pi\left[w_W + \rho\left(w_W + \tilde{\theta}\right)\right] + (1-\pi)\rho V_s = w_F + \rho V_s\\
&\iff \pi\left[w_W + \rho\left(w_W + \tilde{\theta}\right)\right] + (1-\pi)\rho w_F = w_F + \rho w_F\\
&\iff \pi = \frac{w_F}{w_W + \rho\left(w_W + \tilde{\theta} - w_F\right)}.
\end{aligned}$$

Given $\tilde{\theta}$, the total number of risky job seekers is equal to the number of high θ workers with θ at least as high as $\tilde{\theta}$, or:

$$\mathcal{J}_r = \mathcal{L}\left(\frac{\bar{\theta} - \tilde{\theta}}{2\bar{\theta}}\right) \qquad (9)$$

To determine the probability of wage employment in this regime (π), recall (4):

$$\pi = \frac{\textit{job openings in wage employment}}{\textit{total number of risky job seekers}}.$$

The denominator, total number of risky job seekers, is as given by (9). The numerator, job openings in wage employment, is given by total wage employment demand $\mathcal{E}_W$ net of the number of wage employment stayers in each period. In regime I, in which only young high θ workers adopt risky search and do so with the intention of leaving wage employment to enter high-paying self-employment after one period of wage employment, the number of wage employment stayers is equal to zero. Thus,

$$\textit{job openings in wage employment} = \mathcal{E}_W - 0 = \mathcal{E}_W. \qquad (10)$$

Substituting (9) and (10) into the definition of π, we have

$$\pi = \frac{2\ \bar{\theta}\ \mathcal{E}_W}{\mathcal{L}\left(\bar{\theta} - \tilde{\theta}\right)} \qquad (11)$$

in regime 1. Equations (8) and (11) are a pair of simultaneous equations in two unknowns $\tilde{\theta}$ and π. In what follows, we will use an asterisk to denote equilibrium values. Solving (8) and (11), and substituting the solution $\tilde{\theta}^*$ back into (9), we obtain the equilibrium number of job seekers $\mathcal{J}_r^*$:

$$\mathcal{J}_r^* = \frac{\mathcal{E}_W(w_W + \ \rho(w_W + \ \bar{\theta} - w_F))}{w_F + \ 2\mathcal{E}_W\rho\bar{\theta}/\mathcal{L}}. \qquad (12)$$

In addition, the corresponding equilibrium probability of wage employment is:

$$\pi^* = \frac{w_F + 2\rho\bar{\theta}\mathcal{E}_W/\mathcal{L}}{w_W + \rho\left(w_W + \bar{\theta} - w_F\right)} \qquad (13)$$

if $\mathcal{E}_W$ is strictly positive, and zero otherwise. The closed-form solutions in (12) and (13)

show the equilibrium number of risky job seekers and the associated wage employment probability in a regime I equilibrium.

3.1.2 Regime II: all young high θ Workers and Some Young Low θ workers adopt risky search A regime II equilibrium occurs when all young high θ workers plus some young low θ workers adopt risky search, while the rest of the young workers and all adult workers adopt safe search. In such an equilibrium, for a young low θ worker, the expected value of risky search $v_r(\pi,\ \theta)$ is equal to the expected value of safe search $v_s(\pi)$; this condition is analysed further below. Meanwhile, for an adult worker, the expected value of risky search must be less than the expected value of safe search. Thus, $\max\{V_r(\pi),\ V_s = V_s = w_F$.

Further analysing the condition for young workers, it follows that for all low θ young workers—that is, those for whom $\theta < \widehat{\theta} = 0$—we have that

$$\begin{aligned} & v_r\left(\pi,\ \tilde{\theta}\right) = v_s(\pi) \\ & \iff \pi[w_W(1+\rho)] + (1-\pi)\rho\max\{V_r(\pi), V_s\} = w_F + \rho\max\{V_r(\pi), V_s\} \\ & \iff \pi[w_W(1+\rho)] + (1-\pi)\rho w_F = w_F + \rho w_F \\ & \iff \pi[w_W(1+\rho) - \rho w_F] = w_F \\ & \iff \pi = \frac{w_F}{w_W + \rho(w_W - w_F)} = \widehat{\pi}. \end{aligned} \tag{14}$$

Equation (14) shows that for a young low θ worker to be indifferent between the two search options, the wage employment likelihood must be exactly equal to $\widehat{\pi}$ as shown. Note that the free-entry wage, the wage employment wage, and the discount factor all play a role in the determination of this threshold wage employment probability. In particular, when faced with a higher free-entry wage, a lower wage employment wage, or a lower discount factor, a higher-wage employment likelihood will be required if a low θ young worker is to continue to remain indifferent between the two search options. This will happen provided that there are few enough job openings in wage employment that young low θ workers are able to allocate themselves among search strategies in order to equalize the expected values associated with the two of them.

In regime II where all $\mathcal{L}/2$ young high θ workers adopt risky search with the intention of leaving wage employment to enter high-paying self-employment after one period of wage employment and where all $\mathcal{L}/2$ young low θ workers who adopt risky search enter wage employment with the intention of staying two periods, the number of wage employment stayers is equal to the total number of low θ workers in wage employment. With $\mathcal{J}_r$ being the total number of risky job seekers, the number of low θ risky job seekers is $\mathcal{J}_r - \mathcal{L}/2$. A fraction π of these will obtain wage employment when young and will remain in wage employment as adults. It follows that job openings in wage employment will arise for two reasons—to replace older workers who retire and to replace young high θ workers who start in high-wage employment and move to self-employment—in which case:

$$\textit{job openings in wage employment} = \mathcal{E}_W - \pi(\mathcal{J}_r - \ \mathcal{L}/2). \tag{15}$$

Taking the ratio of job openings in wage employment as given by (15) to the total number of risky job seekers gives the following value of π from (4):

$$\pi = \frac{\mathcal{E}_W - \pi(\mathcal{J}_r - \mathcal{L}/2)}{\mathcal{J}_r}. \tag{16}$$

Equations (14) and (16) are a pair of simultaneous equations in two unknowns $\mathcal{J}_r$ and π. Solving, we obtain the equilibrium number of job seekers $\mathcal{J}_r^*$ in regime II:

$$\mathcal{J}_r^* = \frac{1}{2}\left(\frac{\mathcal{E}_W}{\pi^*} + \frac{\mathcal{L}}{2}\right) = \frac{1}{2}\left(\frac{\mathcal{E}_W(w_W(1+\rho) - \rho w_F)}{w_F} + \frac{\mathcal{L}}{2}\right). \tag{17}$$

From (14), the corresponding equilibrium wage employment probability in regime II is:

$$\pi = \frac{w_F}{w_W + \rho(w_W - w_F)} = \widehat{\pi}. \tag{18}$$

To recall, $\widehat{\pi}$ is the largest value of π consistent with a regime I equilibrium for the last indifferent risky job seeker with $\tilde{\theta} = \widehat{\theta} = 0$. Equations (17) and (18) are respectively the closed-form solutions for the number of risky job seekers and the corresponding wage employment likelihood in regime 2.

3.1.3 Regime III: all young workers and no adult workers adopt risky search A regime III equilibrium occurs when all young workers adopt risky search, while all adult workers adopt safe search. In this equilibrium it must first of all be the case that the expected values of risky search among high and low θ young workers are higher than their respective expected values of safe search. As shown in Section 2, the expected value gains from risky search among young high θ workers are never lower than those of young low θ workers, and so it suffices to require the expected value of risky search among young low θ workers to be higher than the expected value of safe search. Equivalently, using (6) and (7) for young workers whose θs are less than the critical value $\widehat{\theta}$,

$$\begin{aligned}
&v_r(\pi,\ \theta) \geq v_s(\pi)\\
&\iff \pi[w_W(1+\rho)] + (1-\pi)\rho\max\{V_r(\pi), V_s\} \geq w_F + \rho\max\{V_r(\pi), V_s\}\\
&\iff \pi[w_W(1+\rho)] + (1-\pi)\rho w_F \geq w_F + \rho w_F\\
&\iff \pi[w_W(1+\rho) - \rho w_F] \geq w_F\\
&\iff \pi \geq \widehat{\pi}.
\end{aligned} \tag{19}$$

Since no adults adopt risky search in this regime, it must also be the case that the expected value of risky search for an adult worker is less than his expected value of safe search $V_r(\pi) = \pi w_W < V_s = w_F$:

$$V_r(\pi) < V_s \iff \pi < \frac{w_F}{w_W}. \tag{20}$$

Henceforth, we will denote the right-hand side of (20) above as

$$\frac{w_F}{w_W} \equiv \bar{\pi}$$

and understand $\bar{\pi}$ as the wage employment probability that renders an adult worker indifferent between the safe and risky search strategies in regime III.

Since

$$\widehat{\pi} \equiv \frac{w_F}{w_W(1+\rho) - \rho w_F}$$

and given that a maintained assumption of the model is that $w_W > w_F$, it follows that $\widehat{\pi}$ is less than $\bar{\pi}$. For a range of values of $\pi \in [\widehat{\pi}, \bar{\pi})$, (19) and (20) together imply that all $\mathcal{L}$ young workers adopt risky search, while all $\mathcal{L}$ adult workers choose the safe search strategy.

In regime III, where all young workers adopt risky search and no adult workers do, the total number of wage employment stayers is equal to the total number of low θ workers in wage employment, or π times half of the total young workforce $\mathcal{L}/2$. It follows that:

$$\textit{job openings in wage employment} = \mathcal{E}_W - \pi\mathcal{L}/2. \tag{21}$$

Taking the ratio of (21) to total number of risky job seekers, we obtain using (4):

$$\pi = \frac{\mathcal{E}_W - \pi\mathcal{L}/2}{\mathcal{J}_r} \tag{22}$$

In a regime III equilibrium, where the total number of risky job seekers is equal to the total number of young workers $\mathcal{L}$:

$$\mathcal{J}_r^* = \mathcal{L}. \tag{23}$$

Substituting the above into (22), the equilibrium wage employment probability in regime III is thus

$$\pi^* = \frac{2\mathcal{E}_W}{3\mathcal{L}}. \tag{24}$$

Equations (23) and (24) are the closed-form solutions for the number of risky job seekers and the wage employment probability in a regime III equilibrium.

3.1.4 Regime IV: all young workers and some adult workers adopt risky search A regime IV equilibrium occurs when all young workers plus some adult workers adopt risky search. In such an equilibrium, the expected value of risky search for an adult worker is equal to the expected value of safe search. Thus,

$$V_r(\pi) = V_s \iff \pi = \frac{w_F}{w_W} = \bar{\pi}. \tag{25}$$

Equation (25) shows that for an adult worker to be indifferent between risky and safe search, the wage employment likelihood must be exactly equal to $\bar{\pi}$ as shown. Note that the ratio of the free-entry wage and the wage employment wage completely determines this threshold wage employment probability. Thus, a higher free-entry wage or a lower wage employment wage will result in an increase in the equilibrium likelihood that the risky search strategy will prove successful, the magnitude of the increase being just enough that an adult worker remains indifferent between risky search as compared with safe search. Unlike (14), which pertains to the choice of search strategy for young low θ workers, the discount factor ρ plays no role in the choice of search strategy for adult workers, who have only one period of working life remaining.

To determine the number of job openings in wage employment, note that in regime IV there are three types of workers in wage employment in every period: young high θ workers

who leave after one period to enter high-paying self-employment, young low θ workers who stay in wage employment for two periods, and adult workers who retire after one period. The numbers of workers in these three groups are respectively $\pi\mathcal{L}/2$, $\pi\mathcal{L}/2$, and $\pi(\mathcal{J}_r - \mathcal{L})$ adult workers who retire after one period. It follows that the total number of wage employment stayers is simply given by the number of low θ young workers in wage employment, $\pi\mathcal{L}/2$, and thus:

$$job\ openings\ in\ wage\ employment = \mathcal{E}_W - \pi\mathcal{L}/2. \tag{26}$$

π, the probability of wage employment, from (4), is therefore:

$$\pi = \frac{\mathcal{E}_W - \pi\mathcal{L}/2}{\mathcal{J}_r}. \tag{27}$$

Combining (25) and (27), we obtain the equilibrium number of risky job seekers in regime IV as

$$\mathcal{J}_r^* = \frac{\mathcal{E}_W}{\pi^*} - \frac{\mathcal{L}}{2} = \frac{\mathcal{E}_W w_W}{w_F} - \frac{\mathcal{L}}{2}. \tag{28}$$

And from (4), the corresponding wage employment probability as

$$\pi^* = \frac{w_F}{w_W} = \bar{\pi}. \tag{29}$$

3.1.5 Regime V: all adopt risky search In this final regime, all workers, young and adult, adopt risky search. In an equilibrium in this regime, the expected value of risky search of an adult worker is strictly greater than the expected value of safe search, i.e.

$$V_r(\pi) \geq V_s \iff \pi \geq \frac{w_F}{w_W} = \bar{\pi}. \tag{30}$$

Furthermore, in such an equilibrium, the total number of risky job seekers is equal to

$$\mathcal{J}_r = (2 - \pi)\mathcal{L} \tag{31}$$

as discussed before. Of these risky job seekers, $\mathcal{L}/2$ are young high θ workers, $\mathcal{L}/2$ are young low θ workers, and $(1 - \pi)\mathcal{L}$ are adult workers who failed to find wage employment while young. It follows that the number of wage employment stayers in this regime is equal to π times the number of young low θ risky job seekers, or $\pi\mathcal{L}/2$. In regime V, therefore:

$$job\ openings\ in\ wage\ employment = \mathcal{E}_W - \pi\mathcal{L}/2. \tag{32}$$

Taking the ratio of job openings in wage employment to risky job seekers, the probability of wage employment, from (4), is:

$$\pi = \frac{\mathcal{E}_W - \pi\mathcal{L}/2}{total\ number\ of\ risky\ job\ seekers}. \tag{33}$$

Equations (31) and (33) are a pair of simultaneous equations in two unknowns, $\mathcal{J}_r$ and π. Solving, we obtain:

$$0 = (\pi^*)^2 - \frac{5}{2}\pi^* + \frac{\mathcal{E}_W}{\mathcal{L}}$$

which is a quadratic equation in π^*. The two roots are given by

$$\frac{5}{4} \pm \sqrt{\left(\frac{5}{4}\right)^2 - \frac{\mathcal{E}_W}{\mathcal{L}}}.$$

Picking the root that does not exceed unity, the equilibrium wage employment probability and the number of risky job seekers are

$$\pi^* = \frac{5}{4} - \sqrt{\left(\frac{5}{4}\right)^2 - \frac{\mathcal{E}_W}{\mathcal{L}}}, \tag{34}$$

and

$$\mathcal{J}_r^* = \frac{3\mathcal{L}}{4} + \sqrt{\left(\frac{5\mathcal{L}}{4}\right)^2 - \mathcal{E}_W \mathcal{L}}. \tag{35}$$

3.1.6 Boundaries of the five regimes Having established the five equilibria, the boundaries that mark the beginning and the end of each of the five regimes can be expressed purely in terms of wage employment according to the following jointly exhaustive and mutually exclusive ranges of wage employment, $\mathcal{E}_W/\mathcal{L}$:

$$\begin{cases} \textit{Regime I} \quad \textit{if} \quad \dfrac{\mathcal{E}_W}{\mathcal{L}} \in \left(0, \dfrac{\widehat{\pi}}{2}\right) \\ \textit{Regime II} \quad \textit{if} \quad \dfrac{\mathcal{E}_W}{\mathcal{L}} \in \left[\dfrac{\widehat{\pi}}{2}, \dfrac{3\widehat{\pi}}{2}\right) \\ \textit{Regime III} \quad \textit{if} \quad \dfrac{\mathcal{E}_W}{\mathcal{L}} \in \left[\dfrac{3\widehat{\pi}}{2}, \dfrac{3\bar{\pi}}{2}\right) \\ \textit{Regime IV} \quad \textit{if} \quad \dfrac{\mathcal{E}_W}{\mathcal{L}} \in \left[\dfrac{3\bar{\pi}}{2}, \bar{\pi}\left(\dfrac{5}{2} - \bar{\pi}\right)\right) \\ \textit{Regime V} \quad \textit{if} \quad \dfrac{\mathcal{E}_W}{\mathcal{L}} \in \left[\bar{\pi}\left(\dfrac{5}{2} - \bar{\pi}\right), \dfrac{3}{2}\right]. \end{cases}$$

The formal proofs are relegated to the appendix. Intuitively, the above shows that successive increases in wage employment opportunities pull in workers to engage in risky search, starting from workers with the highest returns to risky search (high-ability young workers in regime I), to those with the lowest returns (adult workers not in high-paying self-employment in regime V), sequentially covering each of the five regimes along the way. Uniqueness of equilibrium in each regime can also be established, and the details are available in the appendix.

4. Comparative statics

In this section, we present the comparative statics properties of the labour market equilibrium with respect to different values of wage employment demand through changes in $\mathcal{E}_W$ across the five regimes of interest. Specifically, we focus on the three questions set out in the outset of this paper: (1) unemployment; (2) wage employment; and (3) high-paying self-employment and free-entry self-employment in the five successive regimes.

Table 1. *Ex post* labour market equilibrium

Regime	$\mathcal{U}^*/\mathcal{L}$	$\mathcal{E}_H^*/\mathcal{L}$	$\mathcal{E}_F^*/\mathcal{L}$
I	$\frac{\mathcal{E}_W}{\mathcal{L}}\frac{w_W+\rho\left(w_W+\bar{\theta}-w_F\right)}{\left(w_F+\frac{2\rho\bar{\theta}\mathcal{E}_W}{\mathcal{L}}\right)}-\frac{\mathcal{E}_W}{\mathcal{L}}$	$\frac{\mathcal{E}_W}{\mathcal{L}}$	$2-\frac{\mathcal{E}_W}{\mathcal{L}}-\frac{\mathcal{E}_W}{\mathcal{L}}\frac{w_W+\rho\left(w_W+\bar{\theta}-w_F\right)}{w_F+\frac{2\bar{\theta}\rho\mathcal{E}_W}{\mathcal{L}}}$
II	$\frac{1-\hat{\pi}}{2}\left(\frac{1}{\hat{\pi}}\frac{\mathcal{E}_W}{\mathcal{L}}+\frac{1}{2}\right)$	$\frac{\hat{\pi}}{2}$	$2-\frac{1+\hat{\pi}}{2\hat{\pi}}\frac{\mathcal{E}_W}{\mathcal{L}}-\frac{1+\hat{\pi}}{4}$
III	$\left(1-\frac{2}{3}\frac{\mathcal{E}_W}{\mathcal{L}}\right)$	$\frac{1}{3}\frac{\mathcal{E}_W}{\mathcal{L}}$	$1-\frac{2}{3}\frac{\mathcal{E}_W}{\mathcal{L}}$
IV	$(1-\bar{\pi})\left(\frac{1}{\bar{\pi}}\frac{\mathcal{E}_W}{\mathcal{L}}-\frac{1}{2}\right)$	$\frac{\bar{\pi}}{2}$	$(2-\bar{\pi})-\left(\frac{1}{\bar{\pi}}\frac{\mathcal{E}_W}{\mathcal{L}}-\frac{1}{2}\right)$
V	$\left(-\frac{1}{4}+\sqrt{\left(\frac{5}{4}\right)^2-\frac{\mathcal{E}_W}{\mathcal{L}}}\right)\left(\frac{3}{4}+\sqrt{\left(\frac{5}{4}\right)^2-\frac{\mathcal{E}_W}{\mathcal{L}}}\right)$	$\frac{1}{2}\left(\frac{5}{4}-\sqrt{\left(\frac{5}{4}\right)^2-\frac{\mathcal{E}_W}{\mathcal{L}}}\right)$	0

Source: Authors' calculation.

4.1 Unemployment

Unemployment as an *ex post* labour market outcome arises whenever some worker engages in risky search and fails to find wage employment. The likelihood of this event facing a risky job seeker is $1-\pi^*$. With the total number of risky job seekers being given by $\mathcal{J}_r^*$, total unemployment $\mathcal{U}^*=u^*+U^*$ is equal to $(1-\pi^*)\mathcal{J}_r^*$. Table 1 shows the equilibrium level of total unemployment normalized by the size of the total workforce. Among the $\mathcal{U}^*$ unemployed workers, total youth unemployment is $1-\pi^*$ times the number of risky young job seekers. Since only young workers engage in risky search in regimes I–III, $u^*=(1-\pi^*)j_r^*=(1-\pi^*)\mathcal{J}_r^*$. In regimes IV and V, all young workers engage in risky search; it follows that $u^*=(1-\pi^*)\mathcal{L}$ in those regimes. Thus, collecting results from Section 3 for each of the five regimes on $\pi^*$and $\mathcal{J}_r^*$, the fraction of youth who are unemployed is given by:

$$\frac{u^*}{\mathcal{L}}=\begin{cases}\dfrac{\mathcal{E}_W}{\mathcal{L}}\dfrac{w_W+\rho\left(w_W+\bar{\theta}-w_F\right)}{\left(w_F+\dfrac{2\bar{\theta}\rho\mathcal{E}_W}{\mathcal{L}}\right)}-\dfrac{\mathcal{E}_W}{\mathcal{L}} & \text{if } \dfrac{\mathcal{E}_W}{\mathcal{L}} \text{ in Reg. I}\\ \dfrac{1-\widehat{\pi}}{2}\left(\dfrac{1}{\widehat{\pi}}\dfrac{\mathcal{E}_W}{\mathcal{L}}+\dfrac{1}{2}\right) & \text{if } \dfrac{\mathcal{E}_W}{\mathcal{L}} \text{ in Reg. II}\\ \left(1-\dfrac{2}{3}\dfrac{\mathcal{E}_W}{\mathcal{L}}\right) & \text{if } \dfrac{\mathcal{E}_W}{\mathcal{L}} \text{ in Reg. III}\\ (1-\bar{\pi}) & \text{if } \dfrac{\mathcal{E}_W}{\mathcal{L}} \text{ in Reg. IV}\\ \left(-\dfrac{1}{4}+\sqrt{\left(\dfrac{5}{4}\right)^2-\dfrac{\mathcal{E}_W}{\mathcal{L}}}\right) & \text{if } \dfrac{\mathcal{E}_W}{\mathcal{L}} \text{ in Reg. V}\end{cases} \tag{36}$$

Meanwhile, total adult unemployment is given by $U^*=\mathcal{U}^*-u^*$, or

$$\frac{U^*}{\mathcal{L}}=\begin{cases}0 & \text{if } \dfrac{\mathcal{E}_W}{\mathcal{L}} \text{in Reg. I, II or III}\\ (1-\bar{\pi})\left(\dfrac{1}{\bar{\pi}}\dfrac{\mathcal{E}_W}{\mathcal{L}}-\dfrac{3}{2}\right) & \text{if } \dfrac{\mathcal{E}_W}{\mathcal{L}} \text{ in Reg. IV}\\ \left(-\dfrac{1}{4}+\sqrt{\left(\dfrac{5}{4}\right)^2-\dfrac{\mathcal{E}_W}{\mathcal{L}}}\right)^2 & \text{if } \dfrac{\mathcal{E}_W}{\mathcal{L}} \text{ in Reg. V}\end{cases} \tag{37}$$

Figures 1a and 1b illustrate total unemployment, youth unemployment, and adult

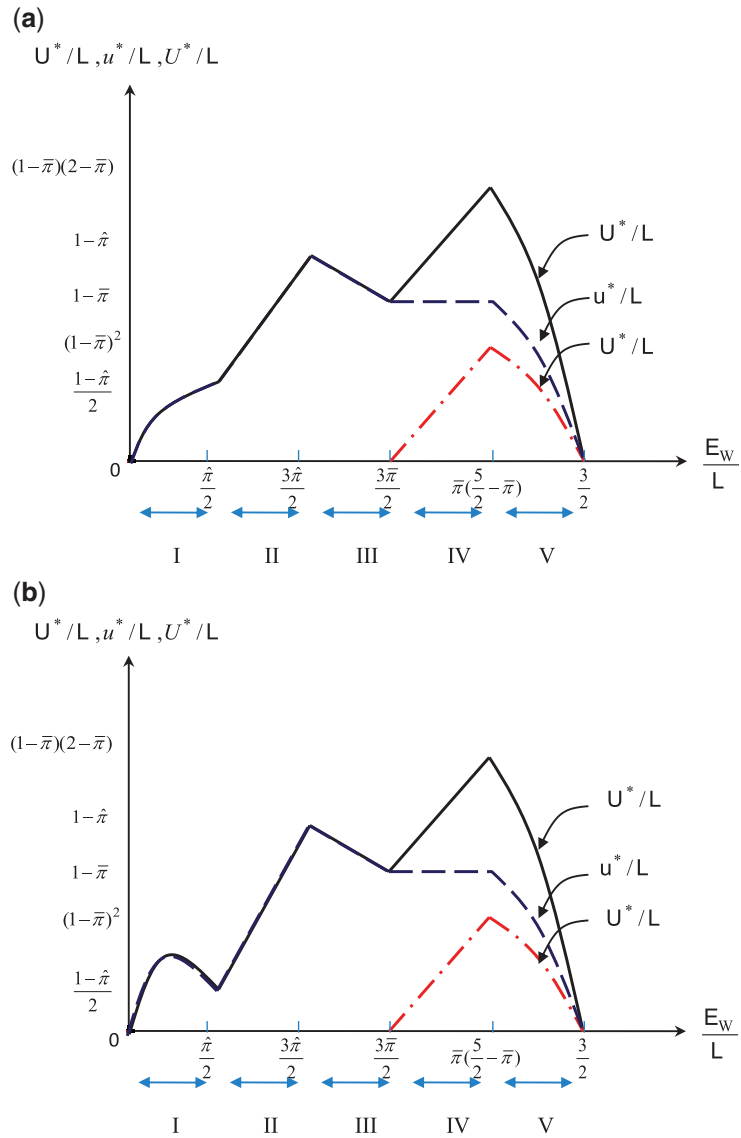

Fig. 1. (a) Unemployment (total, adult, and youth) with small spread in θ. (b) Unemployment (total, adult, and youth) with large spread in θ.

unemployment as functions of wage employment demand $\mathcal{E}_W/\mathcal{L}$. In Fig. 1a, the spread of θ is assumed to be sufficiently small, while in Fig. 1b, a sufficiently larger spread is assumed.[18] Focusing first on Fig. 1a, total unemployment $\mathcal{U}^*$ is twin-peaked—strictly increasing in regimes I and II, strictly decreasing in regime III, strictly increasing again in regime IV, and finally decreasing to zero in regime V. The intuition behind the non-monotonicity of $\mathcal{U}$

18 The proofs of these claims are relegated to Appendix B.

with respect to $\mathcal{E}_W/\mathcal{L}$ is as follows. In regimes I and II, where only young workers are risky job seekers, an increase in wage employment demand $\Delta\mathcal{E}_W$ encourages more than $\Delta\mathcal{E}_W$ young workers to engage in risky job search, thereby adding to youth unemployment.[19] Up to this point, adult workers do not engage in risky search, and as such adult unemployment is equal to zero.

As $\mathcal{E}_W$ rises even further, regime III now applies, where all young workers and no adult workers adopt risky search. Raising wage employment demand in the interior of this regime increases the number of wage employment jobs, while the number of risky job seekers remains constant at $\mathcal{L}$ in this regime. According to (24), an increase in $\mathcal{E}_W$ thus serves to raise the likelihood of wage employment, π^*. Consequently, youth unemployment falls, adult unemployment remains at zero, and thus total unemployment strictly decreases within regime III.

As wage employment demand rises further, we come to a point where we leave regime III and enter regime IV. Additional wage employment demand now induces adult workers to participate in risky search. In this regime, a given increase in wage employment demand $\Delta\mathcal{E}_W$ encourages risky search among adult workers by more than $\Delta\mathcal{E}_W$, raising adult unemployment. Meanwhile, youth unemployment remains unchanged at $(1-\bar{\pi})\mathcal{L}$, since the increase in wage employment demand and adult risky search behavior balance each other out in such a way that the likelihood of wage employment is constant and equal to $\bar{\pi}$ in regime IV; see (29). Thus, total unemployment necessarily increases, giving rise to a second peak in total unemployment at the threshold wage employment demand between regimes IV and V—that is, at $\mathcal{E}_W/\mathcal{L} = \bar{\pi}(5/2-\bar{\pi})$, when all adult and young workers are engaged in risky search. Thereafter, any further increase in wage employment demand produces a strict decline in total unemployment. The reasons are two-fold. First, with all job seekers already participating in risky search, raising wage employment raises the number of young workers that successfully achieve wage employment while young, but *decreases* the total number of remaining adults who can participate in risky search upon reaching adulthood. As shown in (35), the total number of risky job seekers $\mathcal{J}_r^*$ decreases with $\mathcal{E}_W$. Furthermore, from (34), the likelihood of wage employment π^* rises with wage employment demand here. Taken together, total unemployment $(1-\pi^*)\mathcal{J}_r^*$ must be decreasing in wage employment demand here.

We turn now to Fig. 1b. As discussed, the difference between Figs 1a and 1b is in the spread of θ. In particular, still continuing with the maintained assumption that θ is distributed uniformly on $[-\bar{\theta},\ \bar{\theta}]$ the larger $\bar{\theta}$ is, the more spread out the distribution of the payoff θ to high-paying self-employment in regime I will be. With a more spread-out θ distribution, the same increase in wage employment demand draws in a proportionally smaller number of risky job seekers.[20] Since unemployment is given by the total number of risky job seekers minus the number of available job openings $\mathcal{J}_r^* - \mathcal{E}_W$, unemployment can in fact decrease with $\mathcal{E}_W/\mathcal{L}$ in regime I if $\mathcal{J}_r^*$ does not rise fast enough with $\mathcal{E}_W$, as would be

19 Appendix B provides a proof of this claim for regime I. In regime II, $\frac{1}{\mathcal{L}}\frac{\partial\mathcal{U}^*}{\partial\mathcal{E}_W} = \frac{1-\bar{\pi}}{2\bar{\pi}\mathcal{L}} > 0$

20 To see this, differentiate $\mathcal{J}_r^*$ with respect to $\mathcal{E}_W/\mathcal{L}$ to obtain $\frac{\text{dlog}\mathcal{J}_r^*}{\text{dlog}(\mathcal{E}_W)} = \frac{w_F}{\left(w_F+\frac{2\bar{\theta}\rho\mathcal{E}_W}{\mathcal{L}}\right)}$ an expression that is strictly decreasing in $\bar{\theta}$.

the case when the distribution of θ is sufficiently spread out. This is precisely the case that Fig. 1b illustrates. Interestingly, this implies that the $\mathcal{U}^*$ schedule is now triple-peaked.[21]

4.2 The number working in high-paying self-employment

High-paying self-employment in this economy $\mathcal{E}_H^*$ consists of workers who (a) were in wage employment as youth, which enabled them to acquire the financial and human capital needed to enter self-employment; and (b) choose to enter self-employment because they can earn more there than they could in wage employment. Condition (b) limits us to high θ individuals only. Thus, $\mathcal{E}_H^*$ is given simply by π^* times the total number of young high θ individuals who undertake risky search. In regime I, the number of young high θ individuals who undertake risky search is equal to $\mathcal{J}_r^*$ itself. From regime II onwards, the total number of young high θ individuals who undertake risky search is equal to $L_{high\ \theta} = \mathcal{L}/2$. Thus, collecting results on $\pi^*$and $\mathcal{J}_r^*$ from Section 3 for each of the five regimes:

$$\frac{\mathcal{E}_H^*}{\ell} = \begin{cases} \dfrac{\mathcal{E}_W}{\mathcal{L}} & \text{if } \dfrac{\mathcal{E}_W}{\mathcal{L}} \text{ in Reg. I} \\ \dfrac{\widehat{\pi}}{2} & \text{if } \dfrac{\mathcal{E}_W}{\mathcal{L}} \text{ in Reg. II} \\ \dfrac{1}{3}\dfrac{\mathcal{E}_W}{\mathcal{L}} & \text{if } \dfrac{\mathcal{E}_W}{\mathcal{L}} \text{ in Reg. III} \\ \dfrac{\bar{\pi}}{2} & \text{if } \dfrac{\mathcal{E}_W}{\mathcal{L}} \text{ in Reg. IV} \\ \dfrac{1}{2}\left(\dfrac{5}{4} - \sqrt{\left(\dfrac{5}{4}\right)^2 - \dfrac{\mathcal{E}_W}{\mathcal{L}}}\right) & \text{if } \dfrac{\mathcal{E}_W}{\mathcal{L}} \text{ in Reg. V} \end{cases} \tag{38}$$

Since only adult workers can enter high-paying self-employment, $e_H^* = 0$, and as such $\mathcal{E}_H^* = E_H^*$. Figure 2 plots high-paying self-employment as a function of wage employment demand $\mathcal{E}_W/\mathcal{L}$. As shown, high-paying self-employment is strictly increasing in wage employment demand in regimes I, III, and V, and independent of wage employment demand in regimes II and IV. To see the intuition behind these variations in comparative statics responses, note first that in regime I, every wage employment job is occupied by a young high θ worker. It follows therefore that any increase in $\mathcal{E}_W$ will increase high-paying self-employment $\mathcal{E}_H^*$ one for one. Next, in regimes III and V, respectively all young workers, and all young and adult workers, are risky job seekers. Raising $\mathcal{E}_W$ here increases the likelihood of wage employment for all risky job seekers, including high θ young workers who plan to enter high-paying self-employment as adults. It follows that raising $\mathcal{E}_W$ in these regimes increases high-paying self-employment.

By contrast, in regimes II and IV, note from (18) and (29) that conditional on undertaking risky job search the likelihoods of wage employment are respectively constant at $\pi^* = \widehat{\pi}$ and $\pi^* = \bar{\pi}$. It follows straightforwardly that increases in $\mathcal{E}_W/\mathcal{L}$ within these regimes will have no effect on the number of high-paying self-employed individuals since only high θ individuals enter high-paying self-employment, and the number of such individuals is $\mathcal{L}/2$, a constant in both regimes II and IV.

21 Appendix B demonstrates that $\mathcal{U}^*$ is inverted-U-shaped with respect to $\mathcal{E}_W/\mathcal{L}$ in the interior of regime I when $\bar{\theta}$ is sufficiently large.

4.3 The number working in free-entry self-employment

Free-entry self-employment is given by the number of job seekers who adopt the safe search strategy. Among young workers, this is simply given by $\mathcal{L} - j_r^*$. From (41),

$$\frac{e_F^*}{\mathcal{L}} = \begin{cases} 1 - \dfrac{\mathcal{E}_W}{\mathcal{L}} \dfrac{w_W + \rho(w_W + \bar{\theta} - w_F)}{\left(w_F + \dfrac{2\bar{\theta}\rho\mathcal{E}_W}{\mathcal{L}}\right)} & \text{if } \dfrac{\mathcal{E}_W}{\mathcal{L}} \text{ in Reg. I} \\ 1 - \dfrac{1}{2}\left(\dfrac{1}{\hat{\pi}}\dfrac{\mathcal{E}_W}{\mathcal{L}} + \dfrac{1}{2}\right) & \text{if } \dfrac{\mathcal{E}_W}{\mathcal{L}} \text{ in Reg. II} \\ 0 & \text{if } \dfrac{\mathcal{E}_W}{\mathcal{L}} \text{ in Reg. III} \end{cases} \tag{39}$$

This relationship falls monotonically in regimes I and II, reaching zero at the end of regime II and remaining at zero thereafter. Turning to adult workers, there are two subgroups. The first adopted risky search while young but failed to gain wage employment; the number in this category is $(1 - \pi^*)j_r^*$. The second chose safe search when young; their number is $\mathcal{L} - j_r^*$. The total number of adult job seekers is thus $(1 - \pi^*)j_r^* + \mathcal{L} - j_r^* = \mathcal{L} - \pi^* j_r^*$. (The remaining adult workers are not job seekers, because they have already found their best possible employment situation.) Of the $\mathcal{L} - \pi^* j_r^*$ adult job seekers, some (J_r^*) choose risky

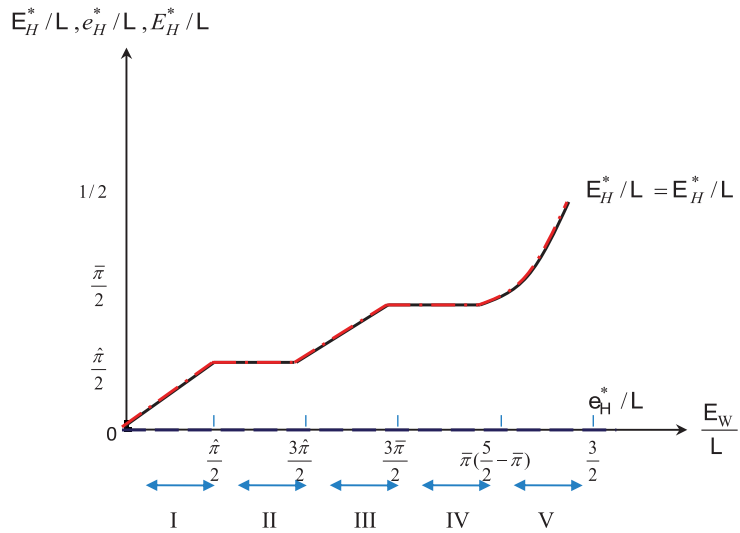

Fig. 2. High-paying self-employment (total, adult, and youth).

search as adults, leaving $\mathcal{L} - \pi^* j_r^* - J_r^*$ as safe job searchers among adults. All of these safe job searchers end up in free-entry self-employment. We thus have:

$$\frac{E_F^*}{\mathcal{L}} = \begin{cases} 1 - \dfrac{\mathcal{E}_W}{\mathcal{L}} & \text{if } \dfrac{\mathcal{E}_W}{\mathcal{L}} \text{ in Reg. I} \\ 1 - \dfrac{1}{2}\left(\dfrac{\mathcal{E}_W}{\mathcal{L}} + \dfrac{\widehat{\pi}}{2}\right) & \text{if } \dfrac{\mathcal{E}_W}{\mathcal{L}} \text{ in Reg. II} \\ 1 - \dfrac{2}{3}\dfrac{\mathcal{E}_W}{\mathcal{L}} & \text{if } \dfrac{\mathcal{E}_W}{\mathcal{L}} \text{ in Reg. III} \\ (2 - \bar{\pi}) - \left(\dfrac{1}{\bar{\pi}}\dfrac{\mathcal{E}_W}{\mathcal{L}} - \dfrac{1}{2}\right) & \text{if } \dfrac{\mathcal{E}_W}{\mathcal{L}} \text{ in Reg. IV} \\ 0 & \text{if } \dfrac{\mathcal{E}_W}{\mathcal{L}} \text{ in Reg. V} \end{cases} \tag{40}$$

This number decreases monotonically in the first four regimes, reaching zero at the end of regime IV and remaining at zero in regime V.

Summing adult and young workers in free-entry employment as given by (39) and (40), we have:

$$\frac{\mathcal{E}_F^*}{\mathcal{L}} = \begin{cases} 2 - \dfrac{\mathcal{E}_W}{\mathcal{L}} - \dfrac{\mathcal{E}_W}{\mathcal{L}}\dfrac{w_W + \rho(w_W + \bar{\theta} - w_F)}{\left(w_F + \dfrac{2\bar{\theta}\rho\mathcal{E}_W}{\mathcal{L}}\right)} & \text{if } \dfrac{\mathcal{E}_W}{\mathcal{L}} \text{ in Reg. I} \\ & \text{if } \dfrac{\mathcal{E}_W}{\mathcal{L}} \text{ in Reg. II} \\ 2 - \dfrac{1 + \widehat{\pi}}{2\widehat{\pi}}\dfrac{\mathcal{E}_W}{\mathcal{L}} - \dfrac{1 + \widehat{\pi}}{4} & \text{if } \dfrac{\mathcal{E}_W}{\mathcal{L}} \text{ in Reg. III} \\ 1 - \dfrac{2}{3}\dfrac{\mathcal{E}_W}{\mathcal{L}} & \text{if } \dfrac{\mathcal{E}_W}{\mathcal{L}} \text{ in Reg. IV} \\ (2 - \bar{\pi}) - \left(\dfrac{1}{\bar{\pi}}\dfrac{\mathcal{E}_W}{\mathcal{L}} - \dfrac{1}{2}\right) & \text{if } \dfrac{\mathcal{E}_W}{\mathcal{L}} \text{ in Reg. V} \\ 0 & \end{cases} \tag{41}$$

which is strictly decreasing with respect to $\mathcal{E}_W/\mathcal{L}$ in regimes I–IV before reaching zero and remaining at zero in regime V. Figure 3 illustrates.

4.4 Summary of the effects of increased demand for labour in wage employment

What we found in this section is that as the amount of wage employment increases:

1. Unemployment *changes non-monotonically*, rising in some regimes and falling in others (Figs 1a and 1b).
2. High-paying self-employment *increases strictly* in some regimes and *is unchanged* in others (Fig. 2).
3. Free-entry self-employment *decreases monotonically* or is *unchanged* depending on the regime (Fig. 3).

Since the two forms of self-employment respond in opposite ways to an increase in wage employment, it is easy to check using Table 1 that self-employment—when defined to be

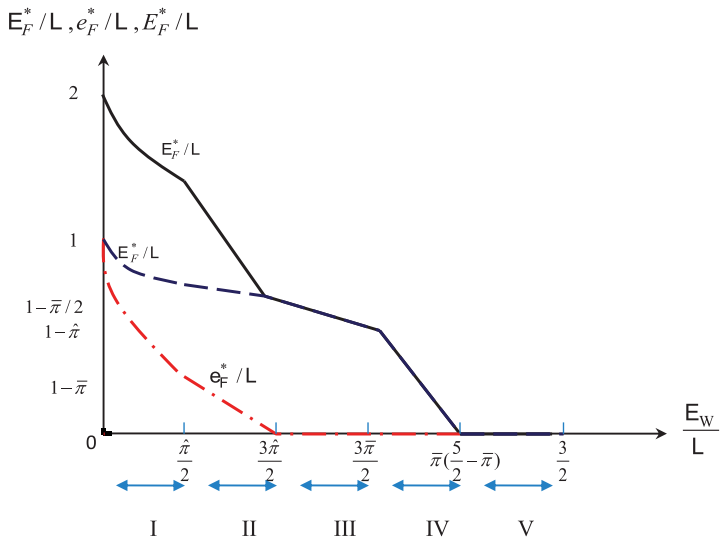

Fig. 3. Free-entry self-employment (total, adult, and youth).

the sum of high-paying self-employment and free-entry self-employment—can either decrease (regimes 1–4) or increase (regime 5) as the amount of wage employment increases.

5. Conclusion

This paper has incorporated four key heterogeneities into a canonical multi-sector labour market model: heterogeneity within self-employment, heterogeneity in job experience, heterogeneity in pathways to self-employment, and heterogeneity in ability. We have shown that these heterogeneities can be brought together in tractable fashion to characterize equilibrium in a model whose features come closer to the realities of developing economies. The model has allowed us to ask questions which cannot be addressed in the standard model. Further, our richer setting shows that by accounting for generational differences in the motivations for job search, unemployment exhibits two distinct inverted-U relationships with high-wage employment, one for youth and another for adults. Interestingly, non-monotonicity in unemployment notwithstanding, increasing high-wage employment leads to an unambiguous increase in high-paying self-employment, and an unambiguous decrease in free-entry (low-wage) self-employment.

These results highlight three sets of insights that are to date underappreciated in multi-sectoral models of labour markets in developing economies. First, the original Harris–Todaro insights on the effectiveness of policies on labour market outcomes hold well when the relevant group of workers contemplating risky search is homogeneous in terms of ability, and has a static decision time frame so that their assessment of the gains and opportunity costs of risky search are both homogeneous and one shot. In our setting, regime IV fits this description exactly. By introducing heterogeneous ability, we introduce regime I, in which the marginal risky job seeker has high ability, and makes the decision on whether to engage in risky search depending on the relative costs and ability-specific gains from doing so. By introducing two age groups, we introduce regime II, in which the benefits and

opportunity cost of risky search depend explicitly on the dynamic considerations. In regime III, we are at a corner where policies do not affect the extent of risky search for either generation: young workers are all choosing risky search and adult workers are all choosing safe search. On the other hand, in regime V, we have the other corner solution: all job seekers, young and old alike, engage in risky search.

Second, our model also illustrates how aggregate labour market outcomes can mask much more nuanced comparative statics at the group/subgroup level. The unemployment responses of youth and adult workers to rising wage employment are good examples, where the two are shown to move in the same direction in one regime (V) and in different directions in others (regimes I–IV).

Finally, our model provides a starting point for understanding a wide array of policies in a multi-sector labour market setting. For example, how does raising the free-entry self-employment wage impact labour market outcomes? Alternatively, what about an increase in the wage employment wage? In an earlier Working Paper version of this study, available upon request, we work out these responses and show that the four heterogeneities we introduce here can give rise to a number of new insights on the impact of policies on labour market outcomes.[22]

We hope our model has reinforced the value of multi-sector labour market modelling for developing countries while also demonstrating which earlier results are sustained and which are contradicted in an enriched structure. We look forward to extending this line of analysis in future work.

Supplementary material

Supplementary material is available online at the OUP website. This material consists of an online appendix.

Acknowledgements

We thank Juan David Robalino for outstanding research assistance in the preparation of this version of the paper and two anonymous referees for insightful comments and suggestions.

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22 For example, it is straightforward to show that an increase in the free-entry self-employment wage weakly increases high-paying self-employment. This counterintuitive result arises because of an interesting intergroup spillover effect, where for example when low-ability young workers are lured away from formal wage employment, high-ability young workers in turn enjoy a higher chance of formal wage employment, and ultimately a higher chance of high-paying self-employment.

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