

City of dreams

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ABSTRACT: Bigger cities offer more valuable experience and opportunities in exchange for higher housing costs. While higher-ability workers benefit more from bigger cities, they are not more likely to move to one. Our model of urban sorting by workers with heterogeneous self-confidence and ability suggests flawed self-assessment is partly to blame. Analysis of NLSY79 data shows that, consistent with our theory, young workers with high self-confidence are more likely to initially locate in a big city. For more experienced workers, ability plays a stronger role in determining location choices, but the lasting impact of earlier choices dampens their incentives to move.

Key words: cities, sorting, agglomeration, self-confidence, ability, learning

JEL classification: R10, R23

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1. Introduction

Working in a bigger city is associated with higher present and future earnings. This is partly because experience is more valuable when accumulated in a bigger city, even if the worker's job is no longer in one (Glaeser and Maré, 2001, Yankow, 2006, Baum-Snow and Pavan, 2012, De la Roca and Puga, 2017). In addition, workers with prior experience see this more highly rewarded in bigger cities (De la Roca and Puga, 2017). In exchange for these advantages, workers in bigger cities must incur higher housing and congestion costs (Combes, Duranton, and Gobillon, 2016).

The benefits of bigger cities appear to be significantly larger for workers with higher ability within broad education or occupation categories (Baum-Snow and Pavan, 2012, De la Roca and Puga, 2017). Since more able workers benefit more from bigger cities, and given that housing costs there are higher for everyone regardless of ability, one might expect that when workers move, more able ones are more likely to go to a big city. And yet, this is not the case.

There are more jobs requiring a college degree and more workers holding one in bigger cities (Berry and Glaeser, 2005, Moretti, 2012, Davis and Dingel, 2013). However, within broad occupation or education groups, there appears to be little sorting on ability, whether this is measured through cognitive test results (Bacolod, Blum, and Strange, 2009), individual fixed-effects in a wage regression (De la Roca and Puga, 2017), measures of ability derived from a finite-mixture model in a structural estimation setting (Baum-Snow and Pavan, 2012), or individual residuals from a spatial equilibrium condition (Eeckhout, Pinheiro, and Schmidheiny, 2014). Lack of sorting on ability in itself is not entirely surprising, given that many people are not mobile. In the United States, 56% of people live at age 40 in the same city where they were at age 14. Even for college-educated workers, the figure is 40%.¹ However, given that many people do move, one would expect them to take into account how they would fare in different cities depending on their ability.

Our starting point in this paper is that it is not all that easy for individuals to make such a calculation. When young migrants choose a location, even if they consider the heterogeneous rewards of bigger cities depending on ability, they may be fooled by a very imperfect assessment of their own ability. By the time they learn enough about their ability, early decisions have had a lasting impact and reduce their incentives to move.

A large literature in psychology documents that individuals' assessment of their own ability generally has little resemblance to their actual ability (see Dunning, Heath, and Suls, 2004, for a survey). Correlation between people's views of their intelligence and their performance on intelligence tests and other academic tasks is typically between 0.2 and 0.3 (Hansford and Hattie, 1982). In the workplace, the correlation between how people expect to perform complex tasks and how they actually perform them is around 0.2 (Stajkovic and Luthans, 1998). Several complementary explanations for the pervasiveness of flawed self-assessment have been put forth. Not only assessing ability is inherently complex, but also assessing skills accurately often requires the same skills one is trying to assess (e.g., knowing whether one is good at maths requires sufficient

¹These percentages are calculated from our panel data, described below. In addition to low overall mobility, other contributing factors to weak sorting on ability include complementarities between high- and low-skilled workers in production (Eeckhout, Pinheiro, and Schmidheiny, 2014); also complementarities in consumption or public policies that promote a diverse social mix in big cities (Saint-Paul, 2015).

mathematical knowledge). In addition, comparative assessments are very self-centred, relying largely on some loose perception of whether one is able to do something and not so much on how many others can do it substantially better. Even when people have information that would lead them to more accurate self-assessments, they tend to neglect this information, which leads them to worse assessments than they are capable of (Benabou and Tirole, 2002).

We formalize the idea that flawed self-assessment can help explain the limited impact of ability on location decisions through a model of urban sorting. Workers in the model are heterogenous in ability and in self-confidence, where the latter is defined as individuals' assessment of their own ability. Relative to small cities, big cities allow young workers to gain more valuable experience and provide greater opportunities for more senior workers to apply their accumulated experience. Both advantages are stronger for high-ability workers. However, big cities also involve higher living costs. Young workers choose their location based on the benefits and costs of big cities and on their self-confidence, which may or may not correspond to their actual ability. They then accumulate experience depending on their chosen location and ability. In the process, they also learn their own ability. Based on accumulated experience and ability, as well as on the opportunities and costs of big and small cities, senior workers choose whether to relocate or not.

The model predicts various patterns of bilateral sorting between big and small cities along workers' life cycles. Location decisions by young workers are mostly driven by self-confidence. For senior workers, ability plays a stronger role in determining location, but the lasting impact of earlier choices dampens their incentives to move. The imperfect self-assessment of young workers and the lasting consequences of early location choices combine to reduce the aggregate extent of sorting. Nevertheless, some workers who seriously underestimated their own ability relocate from a small to a big city once their labour market experience provides them with better information of their true capabilities. Workers who instead greatly overestimated their ability tend to move away from big cities, unless the opportunities to exploit their experience are much larger there.

We test these and other predictions on panel data from the National Longitudinal Survey of Youth 1979 (NLSY79), which allows us to track individuals' location and labour market activities as well as a rich set of personal characteristics. Our measure of ability is the individual's percentile score in the Armed Forces Qualification Test (AFQT), a cognitive ability test that was administered to respondents when their median age was 19. In our model, we use the term self-confidence to refer to individuals' perception of their own ability. Prior to being provided their results on the AFQT, respondents in the NLSY79 were subject to a self-evaluation test devised by Rosenberg (1965), which has been found to measure well individuals' perception of their own ability to perform in a wide variety of tasks, in particular those that are job-related (Judge, Erez, and Bono, 1998, Chen, Gully, and Eden, 2001). We study individuals' location choices upon completing education (corresponding to the junior period of our model) and ten years later (the senior period).

When we examine the raw relationship between the location choices of individuals in their junior and senior periods and their levels of self-confidence and ability, we find that the data closely match our theoretical predictions. We then estimate logit models to look at the determinants of locating in a small or a big city when junior, while controlling for other drivers of mobility. Our findings confirm that individuals with higher levels of self-confidence are more likely to locate in a

big city upon entering the job market. Instead, high-ability young individuals are not significantly more likely to locate initially in a big city. We then estimate multinomial logit models to examine senior period relocations. We find that self-confidence no longer influences the decision to relocate from small to big cities whereas the level of ability is a significant determinant. While corrections to flawed self-assessment are an important driver of relocations from small to big cities, workers who initially locate in a big city tend to stay there even if their ability is low.

Our findings contribute to the literature on learning in cities. In particular, the model we develop has several elements in common with the model by Glaeser (1999): both are overlapping generations models where bigger cities facilitate learning for young individuals. In our model, we introduce a second important difference between cities of different sizes: bigger cities also provide more opportunities to exploit previously acquired experience. More fundamentally, workers in Glaeser's (1999) model are homogeneous whereas workers in our model are heterogeneous in self-confidence and ability. Having these two elements of heterogeneity allows us to examine sorting patterns over the life cycle and the consequences of flawed self-assessment.

Thus, we also contribute to the literature on sorting across cities. Eeckhout, Pinheiro, and Schmidheiny (2014) and Davis and Dingel (2012) develop static models of sorting. In Eeckhout, Pinheiro, and Schmidheiny (2014) sorting is based on complementarities that are stronger between workers with extreme skill differences. They predict no sorting on average but a greater variance of skills in bigger cities. In Davis and Dingel (2012) there is perfect sorting driven by supermodularity. Behrens, Duranton, and Robert-Nicoud (2014) combine sorting, agglomeration and selection into a common theoretical framework. To keep the model manageable, they assume workers make an irreversible location choice, and obtain perfect sorting by heterogeneous ability, although variations in ex-post luck lead to heterogeneity in the productivity distribution. While in all of these models workers make a single location choice, in our dynamic model they choose their location in each period. Further, we introduce a role for workers' self-confidence so that the interplay between self-confidence, ability and experience shapes the incentives to relocate. Our analysis of the varying importance of ability and self-confidence over the workers' life cycle ties to earlier work on how the preferred urban environment can change, such as Duranton and Puga (2001), who study firms' as opposed to workers' life cycle.

Finally, our findings contribute to the literature on personality psychology and economics reviewed by Almlund, Duckworth, Heckman, and Kautz (2011), who document the power of personality traits both as predictors and as causes of academic and economic success, health, and criminal activity. For many outcomes, personality measures are just as predictive as cognitive measures derived from IQ and achievement tests, even after controlling for family background and cognition. Standard measures of cognition are also heavily influenced by personality traits which vary over the life cycle and can be altered by experience and investment.

Urban economics has paid much attention to education and cognitive skills, but less so to other skills and personality traits. An exception is Bacolod, Blum, and Strange (2009), who show that workers with stronger cognitive and people skills (as inferred from occupations and the skills related to them in the Dictionary of Occupational Titles) are more highly rewarded in bigger cities, while those with greater motor skills and physical strength are not. While it is possible that certain

personality traits could also be more highly rewarded in big cities, we show that this is not the case for self-confidence. Instead, self-confidence matters for location decisions because it reflects individuals' perception of their own ability. In follow-up work, Bacolod, Blum, and Strange (2010) combine their same measures of skills inferred from occupations with test-based measures of skills and personality traits. They show there is little variation on the average prevalence of various skills and personality traits across cities of different sizes, although skills and personality traits do affect the propensity to migrate. While we also examine the role of skills and personality traits on location decisions, our focus is on the role of flawed self-assessment and the varying importance of ability and self-confidence in determining the preferred city size over a worker's life cycle.

The rest of the paper is organized in five sections. Section 2 presents the model of sorting and learning in cities of different sizes and solves for individual location choices. Section 3 describes the data set that is used to obtain the empirical results. These are presented in sections 4, where we compare the prevalent location choices depending on self-confidence and ability with those predicted by the model, and in section 5, where we analyse the determinants of location choice, including self-confidence, ability, and other personal characteristics and experiences. Section 6 concludes.

2. The model

Every worker lives for two periods, a junior and a senior period. In each of these two periods, each worker chooses whether to locate in a big city or in a small city. Subscript B denotes big city variables and subscript S denotes small city variables.

During her junior period, each worker is engaged in a continuum of simple tasks with finite measure 1. She succeeds at completing some of these tasks and fails at completing others. Workers have heterogeneous ability. A worker's ability, denoted by α , is the share of simple tasks she can successfully complete as a junior worker. However, junior workers may have an inaccurate assessment of their own ability. We denote by σ self-confidence, defined as a junior worker's assessment of her own ability (i.e. her belief about α). Looking back at what share of simple tasks she successfully completed while junior, a senior worker can figure out her true ability α accurately.

Successfully completing a simple task as a junior worker yields an immediate return and also experience that will be valuable when senior. The key advantage of locating in a big city for junior workers is that it allows them to accumulate more valuable experience, as suggested by Glaeser and Maré (2001), and consistent with the evidence presented in Baum-Snow and Pavan (2012) and De la Roca and Puga (2017). In particular, successful completion of a simple task yields experience e_B in the big city and experience e_S in the small city, where $0 < e_S < e_B < 1$.

The key advantage of locating in a big city for senior workers is that this offers them greater opportunities to exploit their previously acquired experience, again consistent with the evidence presented in De la Roca and Puga (2017). In particular, during her senior period, each worker may be presented with an opportunity to perform a more complex task and obtain an additional return. Such an opportunity arises with probability Ω_B in the big city compared with probability Ω_S in the small city, where $0 < \Omega_S < \Omega_B < 1$. The probability of completing this complex task when

presented with the opportunity to do so is given by the experience the worker acquired during her junior period.

The disadvantage of locating in a big city for both junior and senior workers is that it involves higher costs for housing and commuting, which we refer to as urban costs, a fact that is widely documented (see Combes, Duranton, and Gobillon, 2016, for recent estimates of the elasticity of urban costs with respect to city size). These urban costs are γ_B in the big city and γ_S in the small city, with $0 < \gamma_S < \gamma_B$.²

Junior period location

Every worker has four possible lifetime trajectories, each consisting of a junior period location choice i and a senior period location choice j : $(i, j) = \{(S, S), (S, B), (B, S), (B, B)\}$. As a junior worker, she chooses among these trajectories on the basis of her self-assessed ability σ . Afterwards, once her actual ability α is revealed, the worker can choose whether to stick to her previously selected trajectory or to alter her senior period location choice.

In her junior period, the worker solves the problem

$$\max_{i, j \in \{B, S\}} U_{ij}^{\text{JR}}(\sigma) = -\gamma_i + \sigma\pi_1 - \gamma_j + \Omega_j \sigma e_i \pi_2. \quad (1)$$

$U_{ij}^{\text{JR}}(\sigma)$ denotes the the lifetime net return that a junior worker with self-confidence σ expects to obtain from residing in city i in her junior period and in city j in her senior period. By locating in city $i \in \{B, S\}$ during her junior period, the worker incurs an urban cost γ_i . She also completes a share of simple tasks equal to her ability, which she believes to be σ , obtaining an expected return $\sigma\pi_1$. By locating in city $j \in \{B, S\}$ as a senior worker, she incurs an urban cost γ_j . She also faces with probability Ω_j an opportunity to perform a complex task, and succeeds at this complex task with probability equal to the experience she acquired as a junior worker in city i —an experience that, when making her initial choice, she expects to be σe_i —and then obtains a return π_2 .

The key elements of equation (1) are that a big city provides junior workers with both disadvantages (higher urban costs γ_B compared with γ_S) and advantages (more valuable experience e_B compared with e_S), and the advantages are greater for workers with greater ability (which at this point workers believe to be σ). A big city also provides senior workers with both disadvantages (again, higher urban costs γ_B compared with γ_S) and advantages (more opportunities to use previously acquired experience, Ω_B compared with Ω_S), and the advantages are greater for workers with greater ability as well as for workers with greater experience (σe_B instead of σe_S).

The big city has an ‘absolute advantage’ in both experience ($e_S < e_B$) and opportunities ($\Omega_S < \Omega_B$). Whether the big city has a ‘comparative advantage’ in experience or in opportunities depends on whether $\frac{e_B}{e_S}$ is larger or smaller than $\frac{\Omega_B}{\Omega_S}$. This comparative advantage determines the ranking between location trajectories (S, B) and (B, S) . In particular, evaluating $U_{ij}^{\text{JR}}(\sigma)$ from equation (1) at $(i, j) = (S, B)$ and $(i, j) = (B, S)$, we can see that when $\frac{e_B}{e_S} > \frac{\Omega_B}{\Omega_S}$ (i.e. when the big city has a

²Since each worker chooses her own location in each period taking city sizes as given, we initially treat γ_B and γ_S as parameters. In appendix B, we explicitly introduce commuting costs and a spatial housing market in a simple monocentric city model. This makes γ_B and γ_S a function of the population size of each city, with city sizes in turn derived as an equilibrium outcome of the location decisions of all agents.

comparative advantage in experience), $U_{BS}(\sigma) > U_{SB}(\sigma)$ holds for all values of σ . Trajectory (S, B) can then be ruled out, since it is always dominated by (B, S) . Conversely, when $\frac{e_B}{e_S} < \frac{\Omega_B}{\Omega_S}$ (i.e. when the big city has a comparative advantage in opportunities), $U_{BS}(\sigma) < U_{SB}(\sigma)$ holds for all values of σ . Trajectory (B, S) can then be ruled out, since it is always dominated by (S, B) .

Suppose the big city has a comparative advantage in experience. While trajectory (B, S) dominates (S, B) , it will only be selected if it also dominates the other two trajectories, which requires that $U_{BS}(\sigma) > U_{SS}(\sigma)$ and $U_{BS}(\sigma) \geq U_{BB}(\sigma)$ jointly hold.³ Evaluating $U_{ij}^{JR}(\sigma)$ from equation (1) at the values of i and j corresponding to these trajectories, we can see that this happens if and only if conditions

$$\sigma > \alpha_{BS \succ SS} \equiv \frac{\Delta\gamma}{\Delta e \Omega_S \pi_2} \quad (2)$$

and

$$\sigma \leq \alpha_{BB \succ BS} \equiv \frac{\Delta\gamma}{e_B \Delta\Omega \pi_2} \quad (3)$$

are simultaneously satisfied, where

$$\Delta\gamma \equiv \gamma_B - \gamma_S, \quad (4)$$

$$\Delta e \equiv e_B - e_S, \quad (5)$$

$$\Delta\Omega \equiv \Omega_B - \Omega_S. \quad (6)$$

The ability threshold defined by equation (2), $\alpha_{BS \succ SS}$, is such that anyone with ability above this threshold gets a higher expected return by locating in B as a junior worker and relocating to S as a senior worker than by locating in S in both periods (hence the subscript $BS \succ SS$). We use this same notation for all thresholds that follow. Thus, a junior worker will choose trajectory (B, S) if and only if $\alpha_{BS \succ SS} < \sigma$ and $\sigma \leq \alpha_{BB \succ BS}$. Clearly, these two inequalities can only hold simultaneously if $\alpha_{BS \succ SS} < \alpha_{BB \succ BS}$. Using equations (2) and (3), we can see that this requires $\frac{e_B}{\Omega_S} < \frac{\Delta e}{\Delta\Omega}$. The condition that the big city has a comparative advantage in experience, $\frac{e_B}{e_S} > \frac{\Omega_B}{\Omega_S}$, can be rewritten as $\frac{e_S}{\Omega_S} < \frac{\Delta e}{\Delta\Omega}$. Since $e_S < e_B$, the new condition is more stringent. Thus, for some workers to choose trajectory (B, S) , it is not enough that the big city has a comparative advantage in experience, the comparative advantage has to be large enough. In that case, when $\frac{e_B}{\Omega_S} < \frac{\Delta e}{\Delta\Omega}$, workers with self-confidence $\alpha_{BS \succ SS} < \sigma < \alpha_{BB \succ BS}$ locate in the big city when junior in order to acquire valuable experience. They do so with the intention of relocating to the small city in their senior period, since in this case the advantage of the big city in terms of opportunities is comparatively small and they believe their ability is not high enough to compensate the extra cost. Workers with higher self-confidence, $\alpha_{BB \succ BS} < \sigma$ also locate in the big city when junior, but with the intention of remaining there. Finally, workers with low self-confidence $\sigma < \alpha_{BS \succ SS}$ locate in the small city when junior with the intention of remaining there.

Suppose now that the big city has a comparative advantage in opportunities. While trajectory (S, B) dominates (B, S) , it will only be selected if it also dominates the other two trajectories, which requires that $U_{SB}(\sigma) > U_{SS}(\sigma)$ and $U_{SB}(\sigma) \geq U_{BB}(\sigma)$ jointly hold. Evaluating $U_{ij}^{JR}(\sigma)$ from

³We arbitrarily break ties between location trajectories in favour of the small city, hence the strong inequality $U_{BS}(\sigma) > U_{SS}(\sigma)$ and the weak inequality $U_{BS}(\sigma) \geq U_{BB}(\sigma)$.

equation (1) at the values of i and j corresponding to these trajectories, we can see that this happens if and only if conditions

$$\sigma > \alpha_{SB \succ SS} \equiv \frac{\Delta\gamma}{e_S \Delta\Omega \pi_2} \quad (7)$$

and

$$\sigma \leq \alpha_{BB \succ SB} \equiv \frac{\Delta\gamma}{\Omega_B \pi_2 \Delta e} \quad (8)$$

are simultaneously satisfied. These two inequalities can only hold simultaneously if $\alpha_{SB \succ SS} < \alpha_{BB \succ SB}$. Using equations (7) and (8), we can see that this requires $\frac{\Delta e}{\Delta\Omega} < \frac{e_S}{\Omega_B}$. The condition that the big city has a comparative advantage in opportunities, $\frac{e_B}{e_S} < \frac{\Omega_B}{\Omega_S}$, can be rewritten as $\frac{\Delta e}{\Delta\Omega} < \frac{e_B}{\Omega_B}$. Since $e_S < e_B$, the new condition is more stringent. Thus, for some workers to choose trajectory (S, B) , it is not enough that the big city has a comparative advantage in opportunities, the comparative advantage has to be large enough. In that case, when $\frac{\Delta e}{\Delta\Omega} < \frac{e_S}{\Omega_B}$, workers with self-confidence $\alpha_{SB \succ SS} < \sigma < \alpha_{BB \succ SB}$ locate in a small city when junior with the intention of relocating to the big city in their senior period, since the dominant advantage of the big city is now the greater opportunities it provides to use previous experience. Workers with low self-confidence $\sigma < \alpha_{SB \succ SS}$ also locate in a small city when junior, but with the intention of remaining there. Workers with high self-confidence, $\alpha_{BB \succ SB} < \sigma$ locate in the big city when junior not planning to relocate either.

We have seen that for any worker to choose trajectory (B, S) we must have $\frac{e_B}{\Omega_S} < \frac{\Delta e}{\Delta\Omega}$ and for any worker to choose trajectory (S, B) we must have $\frac{\Delta e}{\Delta\Omega} < \frac{e_S}{\Omega_B}$. Thus, when $\frac{e_S}{\Omega_B} \leq \frac{\Delta e}{\Delta\Omega} \leq \frac{e_B}{\Omega_S}$ only trajectories (B, B) and (S, S) are chosen. Evaluating $U_{ij}^{JR}(\sigma)$ from equation (1) at $(i, j) = (B, B)$ and $(i, j) = (S, S)$, we can see that a junior worker then chooses (B, B) over (S, S) if and only if her self-confidence is high enough:

$$\sigma > \alpha_{BB \succ SS} \equiv \frac{2\Delta\gamma}{(\Omega_B e_B - \Omega_S e_S) \pi_2} . \quad (9)$$

Senior period location

After her actual ability is revealed by the share of tasks successfully completed in her junior period, a worker decides whether to stick to her previously selected lifetime trajectory or to reoptimize in terms of senior period location. If the worker's revealed ability matches her initial self-assessment ($\alpha = \sigma$), the previously selected trajectory is necessarily confirmed. If, on the contrary, her revealed ability does not match her initial self-assessment ($\alpha \neq \sigma$), the worker will reoptimize by maximizing her senior period utility

$$\max_{j \in \{B, S\}} U_{ij}^{SR}(\alpha) = -\gamma_j + \Omega_j \alpha e_i \pi_2 , \quad (10)$$

where i has already been determined by her junior choice. This new decision is driven by a combination of the worker's actual ability and the choice she made when junior based on her (possibly flawed) self-assessment, where this junior choice has a lasting effect through its impact on experience. Workers whose junior location choice was $i = S$ relocate to B if and only if $U_{SB}^{SR}(\alpha) > U_{SS}^{SR}(\alpha)$, i.e. for $\alpha > \alpha_{SB \succ SS}$. Workers whose junior location choice was $i = B$ remain in B if and only if $U_{BB}^{SR}(\alpha) > U_{BS}^{SR}(\alpha)$, i.e. for $\alpha > \alpha_{BB \succ BS}$.

The optimal junior and senior location choices as a function of self-confidence σ and ability α can thus be summarized in the following proposition.

Proposition 1. Define low self-confidence as

- $\sigma \leq \alpha_{BB \succ SB} \equiv \frac{\Delta\gamma}{\Omega_B \pi_2 \Delta e}$ if $\frac{\Delta e}{\Delta\Omega} < \frac{e_S}{\Omega_B}$,
- $\sigma \leq \alpha_{BB \succ SS} \equiv \frac{2\Delta\gamma}{(\Omega_B e_B - \Omega_S e_S) \pi_2}$ if $\frac{e_S}{\Omega_B} \leq \frac{\Delta e}{\Delta\Omega} \leq \frac{e_B}{\Omega_S}$,
- $\sigma \leq \alpha_{BS \succ SS} \equiv \frac{\Delta\gamma}{\Omega_S \Delta e \pi_2}$ if $\frac{e_B}{\Omega_S} < \frac{\Delta e}{\Delta\Omega}$.

Define high self-confidence as the opposite. Define

- low ability as $\alpha \leq \alpha_{BB \succ BS} \equiv \frac{\Delta\gamma}{e_B \Delta\Omega \pi_2}$,
- intermediate ability as $\alpha_{BB \succ BS} < \alpha \leq \alpha_{SB \succ SS} \equiv \frac{\Delta\gamma}{e_S \Delta\Omega \pi_2}$,
- high ability as $\alpha_{SB \succ SS} < \alpha$.

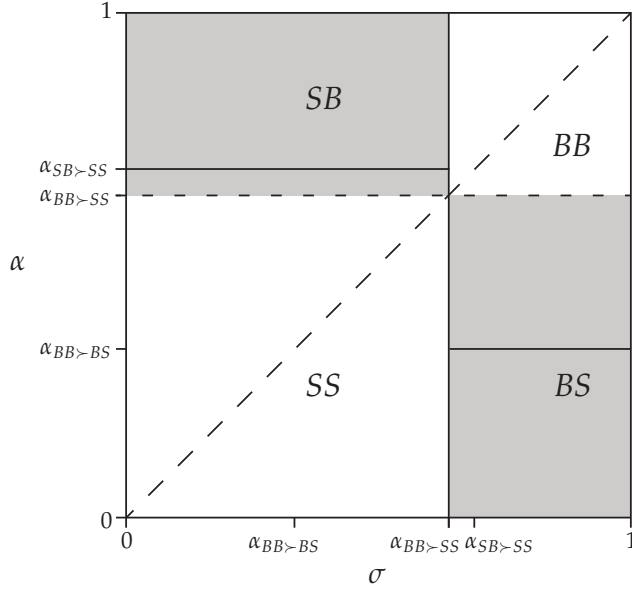
When junior, workers locate in S if they have low self-confidence and locate in B if they have high self-confidence. When senior, workers locate in S if either they have low ability or they have intermediate ability and low self-confidence; they locate in B if either they have high ability or they have intermediate ability and high self-confidence.

Figure 1 represents location choices as a function of self-confidence (σ), measured on the horizontal axis, and ability (α), measured on the vertical axis. Location choices are denoted by the two capital letters in each rectangle, the first representing the junior period location choice and the second the senior period location choice for workers with combinations of σ and α falling in that rectangle. The figure is plotted for parameter values such that $\frac{e_S}{\Omega_B} \leq \frac{\Delta e}{\Delta\Omega} \leq \frac{e_B}{\Omega_S}$ so that, according to proposition 1, low self-confidence is defined as $\sigma \leq \alpha_{BB \succ SS}$.⁴ For these parameter values, no junior worker selects trajectories (B, S) and (S, B) *ex ante* based on her self-assessed ability, but she might still end up following them *ex post* if her initial self-assessment turned out to be wrong. Thus, the vertical line at $\sigma = \alpha_{BB \succ SS}$ has workers with low self-confidence to its left, who locate in S when junior, and workers with high self-confidence to its right, who locate in B when junior.

For the senior period location, we must turn to the value of α relative to $\alpha_{BB \succ BS}$ and $\alpha_{SB \succ SS}$. The horizontal line at $\alpha_{BB \succ BS}$ has workers with low ability below it, and these locate in S in their senior period regardless of their junior period location. The horizontal line at $\alpha_{SB \succ SS}$ has workers with high ability above it, and these locate in B in their senior period regardless of their junior period location. Workers with intermediate ability $\alpha_{BB \succ BS} < \alpha \leq \alpha_{SB \succ SS}$ locate in their senior period wherever they located during their junior period, and this is determined by whether their self-confidence was to the left or right of $\sigma = \alpha_{BB \succ SS}$.

The diagonal of the figure captures situations where self-confidence accurately reflects ability ($\sigma = \alpha$). The figure is drawn for parameter values such that workers with accurate self-assessment locate in the same city in both periods. However, this is not necessarily the case. If parameters are such that $\frac{\Delta e}{\Delta\Omega} < \frac{e_S}{\Omega_B}$, even some workers who assess their ability accurately relocate from S to

⁴The figure is plotted for $e_B = 0.50$, $e_S = 0.24$, $\Omega_B = 0.70$, $\Omega_S = 0.04$, $\pi_2 = 2.75$, and $\Delta\gamma = 0.30$.



(Shaded rectangles mark areas where flawed self-assessment alters location choices.)

Figure 1: Equilibrium location choices by self-confidence and ability

B when they become senior. If parameters are such that $\frac{c_B}{\Omega_S} < \frac{\Delta e}{\Delta \Omega}$, even some workers who assess their ability accurately relocate from B to S when they become senior. Alternative versions of the figure for such parameter values can be found in appendix A. These are the only possibilities and essentially that is the only key difference between them.

The shaded rectangles in the figure mark areas where workers have sufficiently flawed self-assessment that they behave differently than if they had known their true ability from the beginning. Overconfident workers with very low ability locate in B when junior and relocate to S when senior once they realize that their ability is too low to benefit from better opportunities in B . These are workers whose σ and α fall in the bottom right shaded rectangle labelled BS .

Then there are overconfident workers of intermediate ability who when junior are brought to B by their overconfidence. Thanks to the higher experience gained and their intermediate ability, it is beneficial for them to remain in B when senior. These are workers whose σ and α fall in the middle right shaded rectangle labelled BB (each trajectory label refers to the entire rectangle containing it delimited by a continuous line). The proportions of overconfident workers who stick with their initial decision to locate in B and who instead prefer to relocate to S depend on the magnitude of the threshold $\alpha_{BB > BS}$.

Conversely, underconfident workers with very high ability locate in S when junior and move to B when senior once they realize that their ability is high enough to exploit better opportunities there. These are workers whose σ and α fall in the top left shaded rectangle labelled SB .

Then there are underconfident workers of intermediate ability who when junior are brought to S by their underconfidence. This leads them to accumulate less valuable experience than if they had located in B . As a result, having located in S initially leads them to stay there when senior, whereas had they known their true ability they would have located in B both periods. These are

workers whose σ and α fall in the middle left shaded rectangle labelled SS.

3. Data

We use panel data from the “cross-sectional sample” of the National Longitudinal Survey of Youth 1979 (NLSY79). The survey, conducted by the US Department of Labor’s Bureau of Labor Statistics, follows a nationally representative sample of 6,111 men and women who were 14–22 years old when they were first surveyed in 1979. These individuals were interviewed annually through 1994 and were interviewed on a biennial basis since 1996. The NLSY79 contains information on a rich set of personal characteristics and tracks individuals’ labour market activities.

Locations

The confidential geocoded portion of the NLSY79 gathers information on the location of each respondent at multiple points in time. Specifically, for each respondent we know the county and state where they were located at birth, at age 14, and at each interview date since 1979. We use this location information to link the counties of location of each respondent to Core Based Statistical Areas (CBSA) as defined in 2008. A CBSA or metropolitan area is a collection of counties that delimits a local labour market.⁵ We classify individuals as located in a big city if they are within a CBSA with a population over two million in 2010. By this definition, 29 CBSA metropolitan areas are classified as big (from Kansas City with a population of just over 2 million to New York with almost 19 million). This is in line with other papers dealing with urban sorting, which typically classify cities as big when their population is above a threshold of between 1.5 million (Baum-Snow and Pavan, 2012) and 2.5 million (Eeckhout, Pinheiro, and Schmidheiny, 2014). Our results are very similar using these alternative definitions.

Ability

Importantly for us, the NLSY79 contains test results that aim to capture cognitive ability as well as self-evaluation. Our basic measure of ability is the individual’s percentile score in the Armed Forces Qualification Test (AFQT), a cognitive ability test that was administered to NLSY79 respondents in 1980, when their median age was 19. Note that, while AFQT scores are used as a criterion of enlistment eligibility by the US military, the test was administered to all NLSY79 respondents regardless of whether they had any interest in the military in order to update norms for the test based on a nationally representative sample of young people.

Self-confidence

In our model, we use the term self-confidence to refer to individuals’ perception of their own ability. Psychologists often use the term ‘general self-efficacy’ to capture this aspect of self-evaluation. This is defined as “individuals’ perception of their ability to perform across a variety of different

⁵Core Based Statistical Areas (CBSA) are defined by the Office of Management and Budget. These CBSA metropolitan areas have replaced the metropolitan areas that were defined based on the 1990 census.

situations” (Judge, Erez, and Bono, 1998, p. 170). While the NLSY79 does not measure general self-efficacy per se, respondents were administered in 1980 a test that measured their self-esteem using Rosenberg’s (1965) scale. Self-esteem is defined as “the overall value one places on oneself as a person” (Harter, 1990, p. 67). Conceptually, general self-efficacy and self-esteem are somewhat different aspects of self-evaluation in that self-esteem is a broader concept. However, there is a very strong empirical association between them. Summarising extant results on the relationship between Rosenberg’s measure and general self-efficacy, Chen, Gully, and Eden (2001, p. 67) note that “the standard general self-efficacy scale is correlated highly with the Rosenberg (1965) self-esteem scale ($r = .75$ to $.91$)” and conclude that general self-efficacy “does not capture a construct distinct from self-esteem.” Judge, Erez, and Bono (1998) argue that both concepts are strongly related to individuals’ assessment of their own ability to perform on the job.

The Rosenberg (1965) measure is based on a ten-item questionnaire that assesses the self-evaluation of respondents through their expressed level of agreement with various statements (e.g., “I am able to do things as well as most other people”). The original scoring method was to use a 1–4 scale for responses to each question (“strongly agree,” “agree,” “disagree” or “strongly disagree”), reverse coding where appropriate, and then summing over questions. This scoring approach imposes the very strong assumptions that a given response is equally informative about self-assessment for all questions and that an increase in the level of agreement is likewise equally informative for all questions. It also produces a bunching of scores on a few values. Based on the same test responses, the Bureau of Labor Statistics now provides a percentile rank for the Rosenberg self-esteem measure of NLSY79 respondents that follows item response theory (Samejima, 1969, Gray-Little, Williams, and Hancock, 1997). This percentile rank is calculated using an adjusted measure that weighs responses to each question differently depending on how well they help discriminate between individuals with different levels of latent self-esteem. It produces a distribution of self-esteem scores that is approximately Normal.

For us, it is important that this measure pre-dates labour market experience since labour market outcomes could feed back into self-confidence (see the discussion in section 8 of Almlund, Duckworth, Heckman, and Kautz, 2011). It is also worth noting that respondents were subject to the Rosenberg test before they were given their results on the AFQT test of cognitive ability. The low correlation between the AFQT and Rosenberg scores, 0.21, reflects the pervasiveness of flawed self-evaluation and is in line with that reported in psychology studies such as the aforementioned Hansford and Hattie (1982).⁶

Periods

In some empirical specifications, we closely match the time structure of our model by defining two periods (junior and senior) and relate respondents’ location trajectories to their levels of ability and self-confidence. In other specifications, we instead track location changes by respondents on an ongoing basis as they accumulate labour market experience.

⁶While there is sometimes the presumption that women are on average less self-confident than men, Rosenberg’s (1965) self-esteem scores in our data are almost identical for men and women in mean and standard deviation. The correlation between the AFQT and Rosenberg scores is 0.22 for men and 0.20 for women.

For both types of specifications, we begin by studying location choices at the time of entering the labour market. The NLSY79 records detailed information on the educational attainment of respondents over time, so that in each wave, we know their highest grade completed and their schooling enrolment status. We set the junior period for all respondents at the year after the highest level of education is completed.⁷ The median age of individuals in their junior period is 21 for individuals with no post-secondary education and 24 for individuals with post-secondary education. We then determine whether each individual was located in a big metropolitan area or not in this junior period.

When we study location choices in a senior period, we set the senior period for all respondents by adding ten years to their junior period. Thus, the median age of individuals in their senior period is 31 for individuals with no post-secondary education and 34 for individuals with post-secondary education. Again, we determine whether each individual was located in a big metropolitan area or not in this senior period. Alternatively, we track whether each individual was located in a big metropolitan area or not each year after her junior period.

Our starting sample is made of 6,111 individuals. We exclude individuals for whom the AFQT or the Rosenberg self-esteem scores are missing, which reduces the sample to 5,671 individuals. We are able to determine the junior period location of 5,462 individuals. Availability of the demographic controls we use further reduces our sample to 5,298.⁸

4. Observed location choices by self-confidence and ability

We begin by examining how the location choices of individuals vary with self-confidence and ability. To better illustrate location choices graphically and to relate these choices to the theoretical predictions depicted in figure 1, we first divide both the self-confidence and the ability measures into terciles. This yields nine possible combinations of self-confidence and ability terciles. Figure 2 plots in a grid each of those nine combinations of self-confidence and ability, with self-confidence on the horizontal axis and ability on the vertical axis.

In panel (a) of figure 2 we characterize the bivariate distribution by showing the frequency of each of the nine possible combinations of self-confidence and ability terciles in the NLSY79 sample. Recall that our model makes no assumption about this bivariate distribution, it simply predicts individuals' location decisions in their junior and senior periods conditional on self-confidence and ability. A first striking feature of the distribution is that individuals are far from being concentrated on the three diagonal cells: 12.2% of the total are in the bottom tercile of both self-confidence and ability, 9.7% are in the middle tercile of both self-confidence and ability, and 15.1% are in the top tercile of both self-confidence and ability. Also, individuals in the middle tercile of ability are

⁷We exclude educational periods that take place after a spell of more than two years away from education. For example, if an individual completes an undergraduate university degree, works for three or more years, and then goes back to university to pursue postgraduate studies, we take the year after completing the undergraduate degree as this individual's junior period, not the year after completing the postgraduate degree. In addition, for individuals who complete their highest level of education before turning 18, we use the year in which they turn 18 as their junior period. We exclude individuals who are older than 30 when they complete their highest level of education without any gap.

⁸Since the NLSY79 became biennial after 1994, for some individuals there is no interview ten years after their junior period and we must use the preceding or subsequent year.

similarly likely to be in the bottom (11.5%) as in the top (12.1%) tercile of self-confidence. None of these percentages is far from the 11.1% that would correspond to a uniform bivariate distribution. At the same time, it is much less frequent for individuals to be in the top tercile of self-confidence and in the bottom tercile of ability (6.1% of the total) than at the opposite extreme (9.6%). Overall, the correlation between self-confidence and ability percentiles is only 0.21.

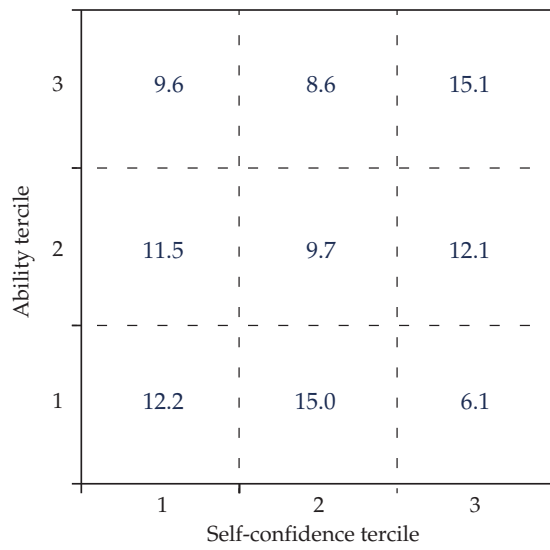
In panel (b) of figure 2, we define a junior period (upon completing education) and a senior period (ten years later) and, using the same labels as in our theoretical figure 1, we assign to each grid cell the most prevalent location trajectory observed in the data for that combination of self-confidence and ability terciles. If individuals chose a location trajectory independently of their ability and self-confidence, the prevalence of each trajectory in each of these nine cells should be the same regardless of ability and self-confidence. Instead, different trajectories turn out to be more or less prevalent depending on the values of ability and self-confidence.⁹

Looking first at the three cells along the diagonal of figure 2 (representing individuals whose self-confidence and ability are well aligned), we observe that individuals in the bottom or middle tercile of both self-confidence and ability (bottom-left and centre-centre cells) tend to locate in small cities when junior and to remain there. Similarly, individuals in the top tercile of both self-confidence and ability (top-right cell) tend to locate in big cities when junior and to remain there. This assortative matching between cities and workers with an accurate self-assessment matches well with our theoretical predictions, represented in figure 1.

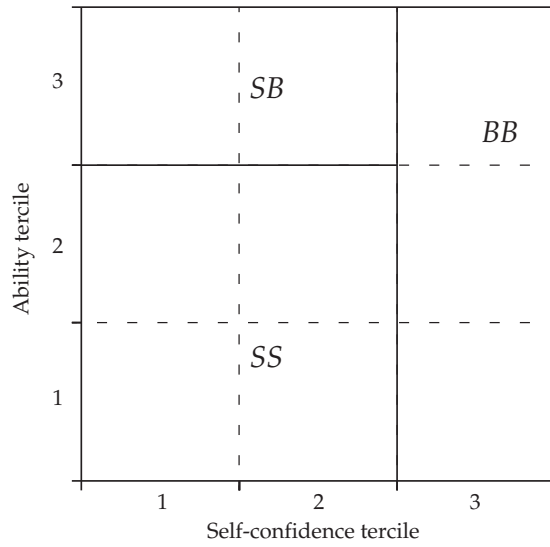
Turning to individuals whose self-assessment is less accurate, consider next individuals in the top tercile of ability. If their self-confidence falls in the bottom or middle tercile (top-left and top-centre cells), these high-ability individuals tend to locate in small cities when junior and then relocate to big cities when senior. This is in contrast to high-ability individuals in the top tercile of self-confidence (top-right cell), who tend to start in big cities and remain there. Looking back at figure 1, we can see this is again consistent with our theoretical predictions: once individuals with low self-confidence find they have high ability, they move away from the small city where their underconfidence led them to locate initially; had their self-assessment been more accurate, they would have located in the big city from the beginning.

Individuals with intermediate levels of ability and high or low levels of self-confidence also follow the location choices predicted by our model. Those in the top tercile of self-confidence (centre-right cell) start in big cities and remain there. According to our model, having made the investment of locating in a big city when junior led by their high self-confidence and having acquired valuable experience as a result, these individuals find it worthwhile to remain in a big city in order to put that experience to use. Those with lower self-confidence (centre-left and centre-centre cells) but similar intermediate ability, instead tend to initially locate in a small city and stay there.

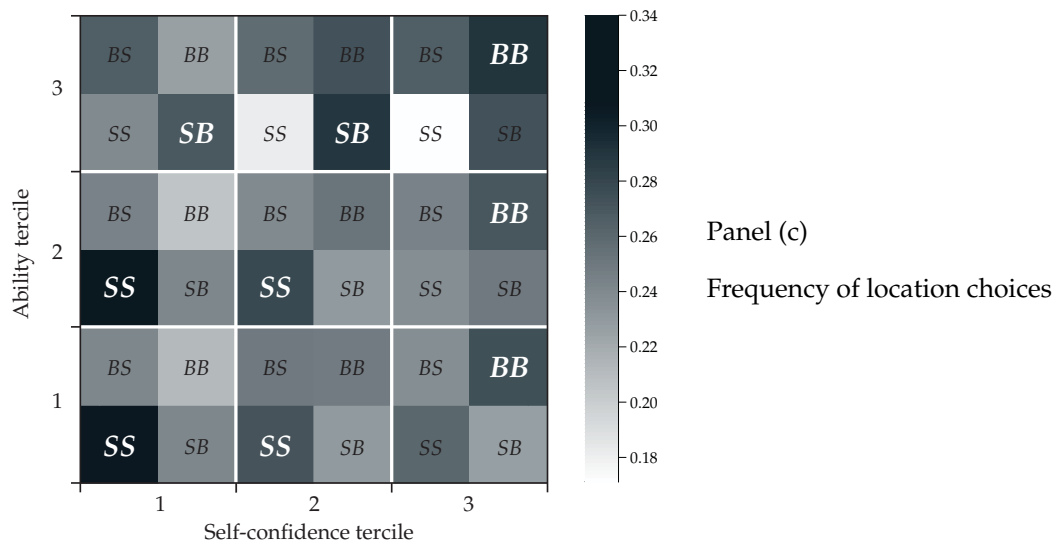
⁹As usual when measuring localisation, the relevant benchmark is not a uniform distribution but the distribution that would arise under random location choices (see e.g. Ellison and Glaeser, 1997, Duranton and Overman, 2005). Thus, we measure the prevalence of each location trajectory relative to a random-location benchmark in which each individual follows each location trajectory with the same probability as the share of that trajectory in the aggregate population regardless of ability and self-confidence.



Panel (a)
Bivariate distribution of self-confidence and ability



Panel (b)
Prevalent location choice



Panel (c)
Frequency of location choices

Figure 2: Observed location choices by self-confidence and ability tertiles

Looking finally at individuals in the bottom tercile of ability with an inaccurate self-assessment, if their self-confidence lies in the middle tercile (bottom-centre cell) they tend to locate in small cities in both periods. This again matches the predictions of our model, where individuals with low ability that overestimate this moderately choose to locate in a small city when junior and have no strong reason to move later. The only cell out of nine in figure 2 that differs from the theoretical prediction of figure 1 is the bottom-right cell. This corresponds to individuals in the top tercile of self-confidence and in the bottom tercile of ability. In our model, extremely overconfident individuals are led by their high self-confidence to locate in big cities during their junior period. This is matched by the prevalent choice in the data. The difference is that the model predicts that these individuals, once they realize their mistake, will relocate to the small city; however, in practice, they typically remain in a big city. Thus, the data suggest that, while corrections to very flawed self-assessment lead underconfident high-ability individuals to relocate from small to big cities, overconfident low-ability individuals tend to stick to their initial choice of locating in big cities. The empirical result for this cell (the most infrequent combination of ability and self-confidence terciles, with only 6.1% of the total) can be still accommodated by the model if $\alpha_{BB>BS} \equiv \frac{\Delta\gamma}{e_B \Delta\Omega \pi_2}$ is sufficiently low, which would happen if e_B and $\Delta\Omega$ are large. Then, workers with low ability whose overconfidence drives them to the big city when junior choose to remain there ($\alpha_{BB>BS}$ is low enough that $\alpha > \alpha_{BB>BS}$ holds even for many low-ability workers). While their low ability made it difficult to accumulate much experience, the fact that it was acquired in the big city makes this valuable (large e_B). And remaining in the big city then allows to put it to use, taking advantage of the much greater opportunities that the big city provides (large $\Delta\Omega$).

Panel (b) of figure 2 only shows the most prevalent location choice in each of the nine cells combining self-confidence and ability terciles. In panel (c) of figure 2 we provide a richer description of the data by showing, in addition to the prevalent location choice, the incidence of all choices in each cell. Each of the nine cells is now split into four quadrants corresponding to every possible two-period location trajectory (*SS* in the bottom left, *SB* in the bottom right, *BS* in the top left, and *BB* in the top right) with darker shades representing a higher frequency of that trajectory compared to the overall population. The prevalent location choice in each of the nine cells is marked in white over the corresponding quadrant of that cell.¹⁰ We can then see that strategy *SS* becomes gradually less prevalent as we move upwards and rightwards, while strategy *BB* becomes gradually more prevalent.

Overall, we find that the location choices of individuals in their junior and senior periods vary with self-confidence and ability in a way that closely matches our theoretical predictions. Workers with an accurate self-assessment tend to locate in small cities if they have low ability and in big cities if they have high ability. Workers with a flawed self-assessment instead make initial location choices that are related to their self-confidence rather than their ability. For workers with intermediate ability, any errors in self-assessment are necessarily moderate. Thus, their initial location choices become self-perpetuating even if they do not correspond with the worker's ability (according to the model, because they affect the value of acquired experience). Workers with high

¹⁰We are grateful to Jesse Shapiro, our discussant at the NBER Summer Institute, for suggesting this additional panel and to referees for suggesting some clarifying modifications.

or low ability can make larger errors in self-assessment. These are more likely to be corrected, at least for underconfident high-ability workers who, despite lacking the self-confidence to initially locate in a big city, tend to eventually move to one. All of these conclusions are so far based on raw data, without taking into account other characteristics and experiences of individuals. We next turn to incorporating these.

5. Determinants of location in big and small cities

We now test key implications of our model by examining whether self-confidence and ability affect the location decisions of individuals across cities of different sizes, while controlling for other drivers of location and mobility.

We first estimate logit models to look at the determinants of locating in a small or a big city the year after completing education. A first implication of our model is that junior workers sort on self-confidence instead of on ability, so that we should expect more confident workers to have a higher probability of locating in big cities initially. In column (1) of table 1 we estimate a logit model where the dependent variable takes value one if the individual lives in a big city during his or her junior period. In all columns of table 1 we report exponentiated coefficients (odds ratios), so that values above one indicate a positive effect and values below one a negative effect. Standard errors are clustered at the metropolitan area level and ***, **, and * indicate that a coefficient is significantly different from 1 (where 1 corresponds to an odds ratio implying no effect) at the 1, 5, and 10 percent levels. Results show that individuals with higher levels of self-confidence are more likely to locate in a big city when junior. The corresponding coefficient on the self-confidence percentile reveals that an increase of one standard deviation in the self-confidence percentile (28.9 points) raises the probability of locating in a big city by 11%.¹¹ Instead, individuals with higher levels of ability are not any more likely to locate initially in a big city.

Turning to other drivers of location, we see that having college education raises the probability of locating in a big city when junior by 115% (calculated by subtracting 1 from the estimated coefficient 2.147) relative to having at most primary education. We also include a set of conventional demographic controls. Having children is associated with a drop in the probability of locating in a big city of 36%, and Hispanics are 90% more likely to live in a big city during their junior period.

Many people are closely attached to the place where they grew up. Upon completing their education, 70% of the individuals in our sample are in the same city where they were at age 14. 56% remain in the same location at age 40. Thus, we include as a control an indicator variable that takes value one if the individual was living in a small city at age 14. This turns out to hugely decrease the probability of locating in a big city upon completing education.¹² However, our results regarding the role of ability and self-confidence are very similar whether we control for location at age 14 or not.

¹¹This figure is calculated by subtracting 1 from the estimated coefficient for the self-confidence percentile and multiplying this by the standard deviation of the variable: $(1.00391 - 1) \times 28.878 = 0.113$.

¹²Empirically, it is not possible to distinguish the strong attachment that individuals may have to the place where they grew up from the existence of high migration costs.

Table 1: Determinants of location in big and small cities, junior period

| | Living in big city upon completing education | Living in small city at age 14, moved to big city upon completing education | Living in big city at age 14, moved to bigger city upon completing education |
|----------------------------------|--|---|--|
| | (1) | (2) | (3) |
| Self confidence percentile | 1.004 (0.002)** | 1.004 (0.002)* | 1.006 (0.003)* |
| Cognitive ability percentile | 1.001 (0.002) | 1.002 (0.003) | 0.999 (0.008) |
| Male | 0.906 (0.077) | 0.853 (0.109) | 1.259 (0.390) |
| Hispanic | 1.903 (0.696)* | 2.437 (1.106)** | 1.939 (1.333) |
| Black | 1.430 (0.378) | 1.785 (0.696) | 0.703 (0.408) |
| High school graduate | 0.931 (0.130) | 0.547 (0.130)** | 1.036 (0.664) |
| Some college | 0.987 (0.160) | 0.755 (0.194) | 1.589 (0.972) |
| College graduate | 2.147 (0.527)*** | 1.570 (0.476) | 1.323 (0.832) |
| Never married | 1.311 (0.222) | 1.504 (0.317)* | 1.451 (0.712) |
| One or more children | 0.639 (0.081)*** | 0.618 (0.105)*** | 0.772 (0.444) |
| Full time working spouse | 1.016 (0.160) | 0.875 (0.181) | 0.412 (0.237) |
| Living in a small city at age 14 | 0.018 (0.004)*** | | |
| N | 5,298 | 1,556 | 393 |
| Pseudo R^2 | 0.462 | 0.074 | 0.056 |

Notes: All specifications include a constant and birth year indicators. All columns report odds ratios (exponentiated coefficients) from logit estimations, where coefficients above one indicate a positive effect and coefficients below one a negative effect. Standard errors in parentheses are clustered at the metropolitan area level. ***, **, and * indicate significance at the 1, 5, and 10 percent levels. In column (1), the dependent variable takes value one if the individual lived in a big city one year after completing her highest level of continuous education. In column (2), the sample is restricted to individuals who lived in a small city at age 14 and in another city one year after completing their highest level of education. The dependent variable is the same as in column (1). In column (3), the sample is restricted to individuals who lived in a big city at age 14 and in another city one year after completing their highest level of education. The dependent variable takes value one if the individual lived in a bigger city when junior than the city at age 14. White, female, ever married and high school dropouts are the omitted categories. A 'big city' is defined as a Core Based Statistical Area (CBSA) with population greater than 2,000,000 in 2010.

Given the high proportion of individuals who do not move, we next focus on individuals who change locations between the age of 14 and their junior period. In column (2), we restrict the sample to individuals who lived in a small city at age 14 and in another city one year after completing their highest level of education. As in column (1), the dependent variable takes value one if the individual lives in a big city during his or her junior period. We find that more self-confident individuals are more likely to move from a small city at age 14 to a big city upon completing education, whereas individuals with higher levels of ability are not more likely to follow this path. Similar to the estimates in column (1), an increase of one standard deviation in the self-confidence percentile (28.89) raises the probability of locating in a big city by 11%. While Hispanics, single and childless individuals are more likely to move from a small to a big city, having college no longer increases the probability of making this move.

In column (3), we restrict the sample to individuals who lived in a big city at age 14 and in another city one year after completing their highest level of education. Now the dependent variable takes value one if the individual lives in an even bigger city when junior than the city at age 14. Individuals with higher levels of self-confidence are more likely to move to bigger cities: a one standard deviation in the self-confidence percentile (30.55) raises the probability of locating in a bigger city by 18%.¹³

A common conclusion from columns (2) and (3) is that, when looking at the location choices of migrants —a group for whom particular tastes to any location play a much more moderate role than for stayers, higher levels of self-confidence (and not higher levels of ability) increase the odds of locating in a big city when junior. Also, the finding that the coefficient on the college graduate indicator is significantly above one in column (1) but not in columns (2) and (3) indicates that non-movers who grew up in a big city are more likely to graduate from college;¹⁴ however, individuals who do move are not any more likely to go to a bigger city if they graduate from college than if they do not.

Turning to location choices later in life, our model implies that ability should matter for the location of senior workers, since experience will improve their self-assessment. However, the model also suggests that senior sorting on ability can be quite imperfect, since initial location choices will have long-term consequences. This implies that, conditional on early location choices, high-ability workers should be more likely to relocate from small to big cities while low-ability workers should be more likely to relocate from big to small cities. Further, conditional on the initial location choice, self-confidence should no longer drive location decisions in the senior period. To test these implications, we estimate two multinomial logit models in which the dependent variable captures types of moves across cities of different sizes between the junior and senior periods. Like before, we report exponentiated coefficients (relative risk ratios), where coefficients above one indicate a positive effect and coefficients below one a negative effect, and cluster standard

¹³Note that the drop in sample sizes reduces power, especially in column (3). In column (2), 45% of individuals who lived in a small city moved to another city when junior and, of the 1,556 individuals who moved, 408 (26%) moved to a big city. In column (3), only 21% of individuals who lived in a big city moved to another city when junior and, of the 393 individuals who moved, only 60 (15%) moved to a bigger city.

¹⁴The proportion of eventual college graduates is 29% among those living in a big city at age 14 compared with 25% among those living in a small city.

errors at the metropolitan area level.

In columns (1a) and (1b) of table 2 we focus exclusively on workers who were living in a small city upon completing education and study whether they moved, respectively, to another small city or to a big city subsequently. The dependent variable takes value one if the individual relocated to another small city when observed in his or her senior period, value two if the individual relocated to a big city, and value zero if the individual remained in a small city. We pay special attention to whether the sign and intensity of the effects differ between both types of migrants, given that migrants as a whole are less likely to be strongly attached to a specific location as opposed to non-migrants. Results show that the level of self-confidence no longer influences the decision to relocate in any direction, whereas the level of ability is a crucial relocation driver from small to big cities but not across small cities. The estimated coefficient on the effect of ability in column (1b) implies that a one standard deviation increase in the ability percentile (28.3 points) raises the probability of moving to a big city by 19%. Thus, among the set of residents in small cities, it is the most able who move to a big city when senior. Other coefficients show that having post-secondary education (an associate's or bachelor's degree), being childless or being partnered with a full-time working spouse increase the odds of moving from a small city when junior to a big city when senior. None of these determinants increase the odds of moving to another small city. Results in column (1a) also show that blacks, singles and individuals partnered with a full-time working spouse are less likely to move to another small city.

In columns (2a) and (2b) of table 2 we focus exclusively on workers who were living in a big city during their junior period and study whether they moved, respectively, to a smaller city or to a bigger city subsequently.¹⁵ The dependent variable takes value one if the individual relocated to a smaller city when observed in his or her senior period, value two if the individual relocated to a bigger city, and value zero if the individual remained in a big city. Results reveal that neither self-confidence nor ability are key determinants of the relocation decision of senior workers from big cities in any direction. This is consistent with one of our conclusions from figure 2: if big-city experience is highly valuable and differences in opportunities between small and big cities are large, then workers who located in a big city when junior tend to stay even if their ability is low.

Two additional controls are worth noting. Unemployment is often a major factor that affects mobility decisions of individuals. We proxy an individual's exposure to unemployment as the fraction of the time the individual spent not working since his or her junior period.¹⁶ Our findings show that the share of the time spent idle in a small or a big city increases the probability of moving to a small or a smaller city, respectively, but does not affect the likelihood of moving to a big or bigger city. The coefficients in columns (1a) and (2a) imply that a one standard deviation increase in the share of time spent not working raise the probability of moving to a small or smaller city by 15% and 19%, respectively. Similarly to table 1, we include as a control an indicator

¹⁵The number of observations in both estimations add up to the number of workers for whom we observe their senior period location and for whom we can construct all labour market controls, 4,688. This is lower than the number of observations in column (1) of table 1 due to sample attrition over the ten years that separate both periods.

¹⁶To construct the fraction of the time spent not working, we add all periods the individual spent in unemployment or out of the labour force. For individuals who moved, we compute both variables at the last observation prior to the move. For non-movers, we calculate both variables at a mid-point between their junior and senior periods, i.e., we add five years to the junior period.

Table 2: Determinants of location in big and small cities, senior period

| | In a small city upon completing education | | In a big city upon completing education | |
|------------------------------------|--|------------------------------------|---|---------------------------------------|
| | moved to another small city 10 years later | moved to a big city 10 years later | moved to a smaller city 10 years later | moved to a bigger city 10 years later |
| | (1a) | (1b) | (2a) | (2b) |
| Self confidence percentile | 1.001 (0.002) | 1.000 (0.002) | 0.999 (0.002) | 1.001 (0.004) |
| Cognitive ability percentile | 1.003 (0.003) | 1.007 (0.003)** | 0.998 (0.003) | 1.002 (0.006) |
| Male | 1.200 (0.132)* | 0.973 (0.132) | 1.049 (0.151) | 0.935 (0.182) |
| Hispanic | 0.698 (0.253) | 1.245 (0.668) | 0.633 (0.230) | 1.230 (0.564) |
| Black | 0.627 (0.133)** | 0.931 (0.323) | 0.581 (0.149)** | 0.420 (0.221)* |
| High school graduate | 1.090 (0.204) | 0.892 (0.212) | 0.990 (0.237) | 0.836 (0.385) |
| Some college | 1.284 (0.278) | 1.657 (0.465)* | 1.241 (0.299) | 1.393 (0.727) |
| College graduate | 1.332 (0.328) | 2.090 (0.586)** | 1.685 (0.447)** | 2.271 (1.001)* |
| Never married | 0.669 (0.113)** | 0.865 (0.206) | 0.713 (0.136)* | 1.424 (0.456) |
| One or more children | 0.872 (0.106) | 0.634 (0.110)** | 0.831 (0.135) | 0.870 (0.324) |
| Full time working spouse | 0.817 (0.089)* | 1.271 (0.152)** | 0.906 (0.123) | 1.204 (0.326) |
| % weeks out of work | 1.006 (0.002)** | 1.004 (0.003) | 1.009 (0.003)** | 0.999 (0.004) |
| Same city when junior as at age 14 | 0.216 (0.035)** | 0.332 (0.062)** | 0.358 (0.094)** | 0.259 (0.108)** |
| N | | 2,914 | | 1,774 |
| Pseudo R^2 | | 0.096 | | 0.072 |

Notes: All specifications include a constant and birth year indicators. All columns report relative risk ratios (exponentiated coefficients) from multinomial logit estimations, where coefficients above one indicate a positive effect and coefficients below one a negative effect. Standard errors in parentheses are clustered at the metropolitan area level. ***, **, and * indicate significance at the 1, 5, and 10 percent levels. In columns (1a) and (1b) the sample includes individuals who lived in a small city one year after completing education and the dependent variable takes value one if the individual moved to another small city and value two if she moved to a big city ten years later. In columns (2a) and (2b) the sample includes individuals who lived in a big city one year after completing education and the dependent variable takes value one if the individual moved to a smaller city and value two if she moved to a bigger city ten years later. White, female, ever married and high school dropouts are the omitted categories. A 'big city' is defined as a Core Based Statistical Area (CBSA) with population greater than 2,000,000 in 2010.

variable that takes value one if the individual lived in the same city at age 14 and at the age upon completing education. Again, this control captures the degree of persistence in location patterns for individuals and decreases notably the odds of moving across the board, regardless of the type of move. However, none of our key results on self-confidence and ability varies when we exclude this control from the specifications.

So far, we have kept close to the structure of our model by defining a senior period and studying location choices at that point. We now exploit the lifetime careers of workers in the NLSY79 and examine how self-confidence and ability affect location choices on an ongoing basis after completing education and joining the workforce. In table 3, we estimate the probability of migration from an individual's location when junior (i.e., a small or big city) using a multiple-exit discrete duration model. We focus only on first-time moves, and thus, an individual can move at most once and then drops from the population at risk of migrating for the first time. In columns (1a) and (1b), the dependent variable takes value one in the last annual observation prior to migration if the individual relocated to another small city, value two in the last annual observation prior to migration if the individual relocated to a big city, and value zero for all periods an individual remained in a small city. Analogously, in columns (2a) and (2b), the dependent variable takes value one in the last annual observation before migration if the individual relocated to a smaller city, value two in the last annual observation before migration if the individual relocated to a bigger city, and value zero for all periods an individual remained in a big city.¹⁷ In this setup, several explanatory variables such as labour market experience, job tenure or marital status, change over time and may affect differently the probability of moving at the time of the migration event. In addition, in all specifications we include indicator variables on the years elapsed since the junior period to capture duration dependence in an additive and flexible way.

Results are very similar to those in table 2. Levels of self-confidence do not have an effect on the probability of migrating in general, while higher levels of ability increase the likelihood of moving from a small to a big city but not to another small city. The magnitude of the effect in column (2b) does not vary. Furthermore, levels of ability do not have an effect on the probability of outmigrating from big cities.¹⁸ When looking at time-varying labour market variables, we find that experience does not influence the decision to relocate and that an additional year of tenure reduces the odds of migrating in any direction, as individuals become more attached to their job. Other controls generally exhibit similar magnitudes and levels of significance as in table 2.¹⁹

¹⁷See Jenkins (1995) for a description on how discrete duration models can be framed as a sequence of binary models.

¹⁸In alternative specifications, available upon request, we interact labour market experience with self-confidence and ability and find that more able individuals are more likely to move from a big city to a bigger city, consistent with the predictions of our model. Results also suggest that, for some types of moves, more able individuals tend to leave their city when junior rather sooner than later (the interaction between ability and experience has a negative effect on the odds of outmigrating).

¹⁹Note that we have not included the fraction of time the individual spent not working since his or her junior period given its collinearity with labour market experience. Also we start counting experience and tenure from the individual's junior period (thus, excluding part-time jobs while studying).

Table 3: Determinants of location in big and small cities using lifetime careers

| | In a small city upon completing education | | In a big city upon completing education | |
|--------------------------------------|---|---------------------|---|------------------------|
| | moved to another small city | moved to a big city | moved to a smaller city | moved to a bigger city |
| | (1a) | (1b) | (2a) | (2b) |
| Self confidence percentile | 1.000 (0.001) | 1.000 (0.002) | 1.000 (0.001) | 1.000 (0.003) |
| Cognitive ability percentile | 1.001 (0.001) | 1.007 (0.002)*** | 0.997 (0.003) | 1.005 (0.004) |
| Experience | 0.995 (0.014) | 1.007 (0.024) | 0.986 (0.015) | 1.045 (0.035) |
| Tenure | 0.909 (0.013)*** | 0.895 (0.028)*** | 0.924 (0.018)*** | 0.895 (0.036)*** |
| Male | 1.106 (0.074) | 0.962 (0.098) | 1.034 (0.073) | 0.869 (0.169) |
| Hispanic | 0.886 (0.203) | 1.830 (0.377)*** | 0.685 (0.113)** | 0.765 (0.315) |
| Black | 0.625 (0.075)*** | 1.368 (0.246)* | 0.623 (0.092)*** | 0.881 (0.344) |
| High school graduate | 0.826 (0.075)** | 0.847 (0.154) | 1.069 (0.151) | 1.004 (0.333) |
| Some college | 0.878 (0.095) | 1.427 (0.252)** | 1.268 (0.247) | 1.415 (0.524) |
| College graduate | 0.875 (0.109) | 1.413 (0.323) | 1.254 (0.172)* | 1.562 (0.608) |
| Never married | 0.883 (0.082) | 0.884 (0.104) | 0.819 (0.068)** | 1.054 (0.346) |
| One or more children | 0.772 (0.059)*** | 0.682 (0.092)*** | 0.863 (0.073)* | 0.907 (0.257) |
| Full time working spouse | 1.072 (0.091) | 1.357 (0.199)** | 1.243 (0.121)** | 1.572 (0.451) |
| Same city when junior as at age 14 | 0.363 (0.025)*** | 0.446 (0.051)*** | 0.421 (0.034)*** | 0.399 (0.125)*** |
| Years since junior period indicators | Yes | Yes | Yes | Yes |
| N | 34,943 | | 24,579 | |
| Pseudo R^2 | 0.095 | | 0.070 | |

Notes: All specifications include a constant and birth year indicators. All columns report relative risk ratios (exponentiated coefficients) from multinomial logit estimations, where coefficients above one indicate a positive effect and coefficients below one a negative effect. Standard errors in parentheses are clustered at the metropolitan area level. ***, **, and * indicate significance at the 1, 5, and 10 percent levels. In columns (1a) and (1b) the sample includes individuals who lived in a small city one year after completing education and the dependent variable takes value one if the individual moved to another small city and value two if she moved to a big city. In columns (2a) and (2b) the sample includes individuals who lived in a big city one year after completing education and the dependent variable takes value one if the individual moved to a smaller city and value two if she moved to a bigger city. White, female, ever married and high school dropouts are the omitted categories. A 'big city' is defined as a Core Based Statistical Area (CBSA) with population greater than 2,000,000 in 2010.

Robustness and alternative explanations

A key prediction of our framework is that young individuals with higher levels of self-confidence tend to be overrepresented in big cities. In our model, this happens as individuals with high self-confidence see themselves as particularly able, and ability is more highly rewarded in big cities. An alternative interpretation is that the sorting by self-confidence that we observe during the junior period is not related to an inaccurate assessment of ability, but instead reflects an intrinsic additional value of self-confidence in big cities. To address this concern, we now explicitly test whether self-confidence reinforces the advantages of big cities.

Our strategy builds on De la Roca and Puga (2017), who show that high ability is more highly rewarded in big than in small cities, as reflected in steeper earnings profiles. In an analogous way, we examine whether more self-confident workers also exhibit steeper wage profiles in big cities. We present results of this exercise in table 4. We begin in column (1) with a simplified version of the main estimation in De la Roca and Puga (2017) and regress log earnings on worker fixed-effects, time-varying job characteristics (measures of tenure, three-digit occupation and three-digit sector indicators), indicator variables for groups of cities of different sizes where individuals currently work, measures of overall work experience and work experience acquired in big cities, and interactions between these measures of experience and worker fixed-effects.²⁰

The positive and significant coefficient on big-city experience shows that experience acquired in big cities is significantly more valuable than experience acquired elsewhere, consistent with what we assume in our model. Specifically, comparing the coefficients on overall experience and experience acquired in big cities indicates that the first year of experience is 57% more valuable if accumulated in a big city instead of in a small one.

Worker fixed-effects capture time-invariant worker characteristics that are valuable in the job market. As in De la Roca and Puga (2017), an interaction between big-city experience and worker fixed-effects enters with a positive and significant coefficient in the regression, which they interpret as evidence that there is a positive interaction between ability and the long-term benefits of acquiring work experience in a big city. In column (2), we add interactions between both experience types and the Rosenberg self-confidence measure. The key coefficient of interest here is the one on the interaction between big-city experience and self-confidence. The fact that it is quantitatively small and not statistically significant indicates that, while earnings grow faster in big cities than in small cities, the effect is not stronger for more self-confident workers. This provides support for our interpretation that young workers sort according to their self-confidence not because self-confidence itself is more highly rewarded in big cities, but because high self-confidence reflects a high self-assessment of ability, and ability is more highly rewarded in big cities.

Since in our data we have a direct measure of cognitive ability in the AFQT percentile score, in column (3) we interact big-city experience with cognitive ability instead of the worker fixed effect. The positive and significant coefficient shows that cognitive ability, as measured by the

²⁰We construct time-consistent three-digit occupation codes using crosswalks provided in Autor and Dorn (2013). We also construct time-consistent three-digit sector codes using the IPUMS long-term classification 1990 (Ruggles, Genadek, Goeken, Grover, and Sobek, 2015). We consider only earnings observations from the junior period and after to conform with the timing in our model.

Table 4: Estimation of the relationship between earnings earnings, ability and self confidence

| | Log earnings | | | |
|--|-----------------------|-----------------------|-----------------------|-----------------------|
| | (1) | (2) | (3) | (4) |
| Big city experience | 0.0164 (0.0025)*** | 0.0163 (0.0025)*** | 0.0159 (0.0025)*** | 0.0157 (0.0025)*** |
| Big city experience \times experience | 0.0004 (0.0001)*** | 0.0004 (0.0001)*** | 0.0004 (0.0001)*** | 0.0004 (0.0001)*** |
| Big city experience \times worker fixed effect | 0.0168 (0.0051)*** | 0.0179 (0.0052)*** | | |
| Big city experience \times cognitive ability | | | 0.0065 (0.0036)* | 0.0076 (0.0036)** |
| Big city experience \times self confidence | | 0.0047 (0.0034) | | 0.0052 (0.0034) |
| Experience | 0.0285 (0.0018)*** | 0.0286 (0.0018)*** | 0.0275 (0.0018)*** | 0.0277 (0.0018)*** |
| Experience ² | 0.0004 (0.0001)*** | 0.0004 (0.0001)*** | 0.0003 (0.0001)*** | 0.0003 (0.0001)*** |
| Experience \times worker fixed effect | 0.0528 (0.0077)*** | 0.0532 (0.0080)*** | | |
| Experience ² \times worker fixed effect | 0.0010 (0.0002)*** | 0.0010 (0.0002)*** | | |
| Experience \times cognitive ability | | | 0.0310 (0.0050)*** | 0.0304 (0.0051)*** |
| Experience ² \times cognitive ability | | | 0.0005 (0.0002)*** | 0.0005 (0.0002)*** |
| Experience \times self confidence | | 0.0010 (0.0048) | | 0.0028 (0.0047) |
| Experience ² \times self confidence | | 0.0001 (0.0002) | | 0.0000 (0.0002) |
| Tenure | 0.0288 (0.0014)*** | 0.0288 (0.0014)*** | 0.0290 (0.0014)*** | 0.0290 (0.0014)*** |
| Tenure ² | 0.0010 (0.0001)*** | 0.0010 (0.0001)*** | 0.0010 (0.0001)*** | 0.0010 (0.0001)*** |
| City size indicators | Yes | Yes | Yes | Yes |
| 2 digit occupation & sector indicators | Yes | Yes | Yes | Yes |
| Worker fixed effects | Yes | Yes | Yes | Yes |
| Observations | 46,736 | 46,736 | 46,736 | 46,736 |
| R ² | 0.2656 | 0.2657 | 0.2580 | 0.2581 |

Notes: All specifications include a constant. Coefficients are reported with robust standard errors in parenthesis, which are clustered by worker. ***, **, and * indicate significance at the 1, 5, and 10 percent levels. A 'big city' is defined as a Core Based Statistical Area (CBSA) with population greater than 2,000,000 in 2010. Worker fixed effect computation follows De la Roca and Puga (2017).

AFQT percentile score, is more highly rewarded in big cities. Column (4) repeats the exercise adding interactions between both experience types and the Rosenberg self-confidence measure to the specification in column (3). We obtain a slightly larger return on big-city experience for more able workers (plus the coefficient becomes statistically significant at the 5% level) and reach similar conclusions on the role of self-confidence: conditional on ability, more self-confident workers do not experience steeper earnings profiles in big cities.

Another source of concern is that several of the variables that we include as controls in our specifications may be chosen simultaneously with the decision to locate in a small or big city. For example, individuals may favour a career-oriented life and thus choose to go to college, remain single, postpone childbearing and locate in a big city. On the contrary, other individuals may prioritise a family-oriented life and decide not to attend college, marry at a young age, have children and locate in a small city.²¹ To address this simultaneity concern, we examine whether a location choice (i.e., living in a big or small city) is an essential part of these lifestyle bundles that individuals may choose early in life. In table 5, we estimate a multinomial logit model where the dependent variable reflects four possible outcomes or lifestyle bundles. Specifically, it takes value one if at the age of 25 the individual had no college, was married with kids and lived in a small city; it takes value two if he or she had the same traits as for value one but lived instead in a big city; it takes value three if the individual had college education, remained single, childless and lived in a small city; and it takes value four if he or she had the same traits as for value three but lived instead in a big city. Again, we report exponentiated coefficients (relative risk ratios), where values above one indicate a positive effect and values below one a negative effect, and cluster standard errors at the metropolitan area level.

Results indicate that ability is a crucial determinant for individuals to pursue a career life (bundles in columns 1c and 1d) instead of a family life (bundles in columns 1a and 1b). The estimated coefficients on ability are large, statistically significant and imply that a one standard deviation increase in the ability percentile (28.73) raises the odds of pursuing a career life by 150% to 175% relative to the baseline. On the contrary, a one standard deviation decrease in the ability percentile raises the odds of following a family life by 29% to 39%. However, the decision to locate in a small or in a big city as part of these two lifestyle choices is less clear. The differential effect of ability on choosing a family life and living in a small city (column 1a) rather than choosing a family life and living in a big city (column 1b) is not statistically significantly different at conventional levels, whereas the differential effect of ability on choosing a career life and living in a small or in a big city is only marginally significant at the 10% level of confidence (P -value of 0.094).

Our findings on the role of self-confidence reinforce the prediction in our model that self-confidence matters for whether an individual locates in a small or in a big city early in life. Individuals with low levels of self-confidence are more likely to start a family life in a small city but not in a big city relative to the baseline. Similarly, individuals with high levels of self-confidence are more likely to start a career life in a big city but not in a small city. In fact, a one standard deviation increase in the self-confidence percentile (28.93) raises the odds of starting a career life in a big city by 20%.

²¹We are grateful to a referee for raising this issue on lifestyle choices and the simultaneity of the location decision.

Table 5: Self confidence and ability by lifestyle choices at age 25

| | No college, married, with children, living in a small city | No college, married, with children, living in a big city | College, single, childless, living in a small city | College, single, childless, living in a big city |
|----------------------------------|--|--|--|--|
| | (1a) | (1b) | (1c) | (1d) |
| Self confidence percentile | 0.997 (0.001)* | 0.999 (0.002) | 1.002 (0.002) | 1.007 (0.002)*** |
| Cognitive ability percentile | 0.986 (0.002)*** | 0.990 (0.002)*** | 1.052 (0.003)*** | 1.061 (0.004)*** |
| Male | 0.459 (0.038)*** | 0.326 (0.040)*** | 1.040 (0.139) | 0.938 (0.099) |
| Hispanic | 0.921 (0.199) | 1.231 (0.334) | 0.779 (0.291) | 0.972 (0.388) |
| Black | 0.415 (0.054)*** | 0.481 (0.083)*** | 2.011 (0.566)** | 2.241 (0.950)* |
| Living in a small city at age 14 | 6.421 (1.704)*** | 0.157 (0.036)*** | 3.242 (0.877)*** | 0.242 (0.057)*** |
| % of individuals | 19.1 | 8.0 | 6.5 | 7.0 |
| N | | 5,175 | | |
| Pseudo R^2 | | 0.187 | | |

Notes: All specifications include a constant and birth year indicators. Relative risk ratios (exponentiated coefficients) are reported, where coefficients above one indicate a positive effect and coefficients below one a negative effect. Standard errors in parentheses are clustered at the metropolitan area level. ***, **, and * indicate significance at the 1, 5, and 10 percent levels. A 'big city' is defined as a Core Based Statistical Area (CBSA) with population greater than 2,000,000 in 2010.

The results of table 5 show that, while ability matters for the lifestyle choices an individual follows (combinations of education, marriage and procreation), it does not make it more likely that the individual locates in a big than in a small city for the same lifestyle bundle. Conversely, self-confidence does influence location choices for a given lifestyle bundle.

One may also worry about our self-confidence measure capturing other relevant aspects of personality. We have seen that, as predicted by our model, individuals with high self-confidence are more likely to locate in a big city when young. However, high self-confidence may partly reflect other personality traits that could make a person more predisposed towards living in a big city. In particular, high self-confidence tends to be positively related to extraversion (Robins, Tracy, Trzesniewski, Potter, and Gosling, 2001). In turn, extravert individuals may be more likely to choose dense locations where they will tend to be less socially isolated. This pattern, where those who locate in urban areas as opposed to rural areas tend to be more extraverted, has been observed in some studies of the location choices of doctors and clergy (Francis and Rutledge, 2004, Jones *et al.*, 2013). Other studies, however, argue that the relationship between extraversion and location preferences is not as clear-cut, since big cities also favour anonymity which may help attract more introvert individuals. For instance, Marshall (1970) finds that measures of introversion at the individual level are highly correlated with a preference for privacy but not with a preference for solitude; and one of the strongest correlates of a preference for privacy is the size of the city

Table 6: Determinants of location in big cities with other personality traits

| | Children of NLSY79 | |
|------------------------------------|---|---------------------|
| | Probability of living in a big city upon completing education | |
| | (1) | (2) |
| Self confidence percentile | 1.005 (0.002)** | 1.005 (0.002)** |
| Math ability percentile | 0.997 (0.003) | 0.997 (0.003) |
| Reading recognition percentile | 1.006 (0.003)** | 1.006 (0.003)* |
| Reading comprehension percentile | 0.998 (0.004) | 0.998 (0.004) |
| Male | 1.016 (0.119) | 1.018 (0.115) |
| Hispanic | 2.232 (0.747)** | 2.255 (0.757)** |
| Black | 1.690 (0.370)** | 1.688 (0.382)** |
| High school graduate | 0.817 (0.134) | 0.823 (0.133) |
| Some college | 1.083 (0.233) | 1.103 (0.230) |
| College graduate | 3.307 (0.846)*** | 3.439 (0.877)*** |
| Never married | 1.047 (0.240) | 1.040 (0.237) |
| One or more children | 0.695 (0.109)** | 0.700 (0.107)** |
| Working spouse | 0.909 (0.185) | 0.923 (0.186) |
| Living in small city at age 15 | 0.008 (0.002)*** | 0.008 (0.002)*** |
| Extraversion percentile | | 0.999 (0.002) |
| Agreeableness percentile | | 1.000 (0.003) |
| Conscientiousness percentile | | 0.998 (0.002) |
| Emotional stability percentile | | 0.997 (0.003) |
| Openness to experiences percentile | | 1.004 (0.003) |
| Observations | 3,194 | 3,194 |
| Pseudo R^2 | 0.572 | 0.573 |

Notes: Both columns report logit estimations where the dependent variable takes value one if the individual lives in a big city one year after completing her highest level of continuous education. Odd ratios (exponentiated coefficients) are reported; coefficients above one indicate a positive effect and coefficients below one indicate a negative effect. Standard errors in parentheses are clustered at the metropolitan area level. ***, **, and * indicate significance at the 1, 5, and 10 percent levels. Math, reading recognition and reading comprehension percentiles use results from Peabody International Achievement tests. Personality percentiles are obtained using the Ten Item Personality Inventory (TIPI) measure. All specifications include a constant and birth year indicators (not reported). White, female, ever married and high school dropouts are the omitted categories. A 'big city' is defined as a Core Based Statistical Area (CBSA) with population greater than 2,000,000 in 2010.

an individual lives in, with more private individuals being significantly more likely to live in a bigger city. In any case, we would like to check that the relationship between self-confidence and the probability of living in a big city upon completing education is not driven by other personality traits correlated with self-confidence. We thus re-estimate our logistic regressions including measures of personality traits as additional controls.

Personality is most commonly assessed using a taxonomy of traits known as the big-five: extraversion, agreeableness, conscientiousness, neuroticism and openness to experiences. Unfortunately, the NLSY79 does not assess the big-five personality traits of its respondents. However, a related panel data set, the NLSY79 Children and Young Adults, does. This is a separate survey conducted to all offspring of NLSY79 female respondents. As part of this survey, young adults were administered the Ten Item Personality Inventory (TIPI) test, a ten-item questionnaire that measures the big five personality traits. In addition, they were also subject to the same Rosenberg test that we use to measure self-confidence in our main sample. While NLSY79 Children and Young Adults respondents were not subject to the AFQT test that we use to measure cognitive ability in our main sample, they were administered various other cognitive ability tests, in particular the Peabody International Achievement Test (PIAT) for math, reading recognition and reading comprehension. Given that the AFQT combines four sections of the ASVAB test that measure math knowledge, arithmetic reasoning, paragraph comprehension and word knowledge, we include in our estimation the PIAT percentile scores for math, reading recognition and reading comprehension as measures of cognitive ability in place of the AFQT percentile score.²²

Since the NLSY79 Children and Young Adults follows offspring of women in our main data set, individuals are much younger, which prevents us from performing a full replication of our results with these data. In particular, the vast majority of respondents are too young to study the determinants of their location choices ten years after completing their education.²³ Hence, we cannot estimate the specifications for senior location choices in tables 2 and 3. We can, however, estimate the specification for junior location choice in column (1) of table 1. Results are reported in table 6.

In column (1) we reproduce the specification of column (1) of table 1, with the three ability measures replacing the unavailable AFQT percentile scores. As before, self-confidence is a significant determinant of the probability of locating in a big city upon completing education with a slightly larger magnitude than in table 1. Of the three ability measures, only reading recognition (arguably a measure of education rather than of intrinsic ability) is a statistically significant determinant of living in a big city upon completing education. In column (2), we add to the specification the big-five personality traits. This shows that self-confidence remains a significant determinant of the probability of locating in a big city upon completing education, even after controlling for the big-five personality traits. There is a small positive correlation of 0.11 between the measure of extraversion and the measure of self-confidence. However, extraversion does not significantly

²²Respondents in the NLSY79 Children and Young Adults are administered the ability tests several times during childhood, starting at age 6. We use the latest test, for which the median age is 14.

²³The median age of NLSY79 Children and Young Adults respondents in our most recent survey year is 27, compared with a median age of 49 for NLSY79 respondents.

affect the probability of locating in a big city. Neither do the other personality traits that are part of the big five. And the magnitude of the coefficient on self-confidence remains unchanged.

A final related concern is that self-confidence may be capturing attitude towards risk, with more self-confident individuals perhaps more willing to take risks. To the extent that locating in a big city may be seen as a risky investment, that association could be driving in part the relationship between self-confidence and junior location in a big city. The NLSY79 includes a measure of attitude towards risk.²⁴ Respondents are asked to grade their willingness to take risks on a scale from 0 to 10. We use the individual's percentile in this scale (with a higher percentile associated with a lower willingness to take risks) as a measure of risk aversion. Table C.1 in appendix C replicates table 2 adding to each column the risk aversion percentile. For three out of the four possible moves, we observe that more risk averse individuals are less prone to migrate. Further, more risk averse individuals are less likely to change city size, as seen in column (2a) for moves from big to smaller cities, and especially for moves from small to big cities as seen in column (1b). This finding is consistent with earlier research examining the positive association between willingness to take risks and migration (Jaeger, Dohmen, Falk, Huffman, Sunde, and Bonin, 2010, Bauernschuster, Falck, Heblich, Suedekum, and Lameli, 2014). And yet, controlling for risk aversion does not alter the coefficients on self-confidence and ability.

6. Conclusions

Flawed self-assessment can help explain why more able young workers are not more likely to move to a big city, even though bigger cities provide higher-ability workers with valuable learning experience and richer opportunities to exploit such experience. The reason is that workers whose self-confidence at an early stage of their career is not aligned with their ability may make location decisions they would not have made if they had known their actual ability to start with. By the time they learn enough about their actual ability, those early decisions have had a lasting impact, reducing their incentives to move and affecting their lifetime earnings. We have formalized this argument using a model of sorting across cities by workers who differ in self-confidence and ability, derived location and relocation patterns by self-confidence and ability, and shown that they are empirically relevant using data for the United States. Our findings confirm the power of personality traits as predictors and as causes of economic success, even after controlling for education, experience and cognition.

We find that self-confidence affects the location decisions of young workers more than their actual ability. For older workers, ability plays a stronger role in determining location, but the lasting impact of earlier choices limits the scope for relocation. Thus, some overconfident young workers start their career in a big city, while they would have chosen a small one had they correctly self-assessed their actual ability. That initial misjudged decision then becomes self-validating: having already incurred an excessive cost to gain more valuable experience, they find that they

²⁴Unfortunately, this risk measure was collected only very recently, in 2010, whereas our measures of ability and self-confidence were collected at the beginning of the survey, when most respondents were teenagers. This is not ideal, since the measure may be affected by the consequences of earlier location choices, and also leads to a large drop in the number of observations. For these reasons, we do not use this as our baseline specification.

can fully exploit this only by remaining in the big city also when older. Analogously, some underconfident young workers end up spending their whole life in a small city, even though a correct initial assessment of their ability would have made them self-select into a big city instead. Workers who seriously underestimate their own ability may nevertheless relocate from a small to a big city, once their labour market experience provides them with better information of their true capabilities. Relocations from big to small cities appear to be driven instead by lack of success in the big city rather than by corrections to flawed self-assessment. Young workers who are confident enough of their own abilities locate in bigger cities to pursue their dreams, but those dreams do not come true for everyone.

References

- Almlund, Mathilde, Angela L. Duckworth, James J. Heckman, and Tim D. Kautz. 2011. Personality psychology and economics. In Eric A. Hanushek, Stephen Machin, and Ludger Woessmann (eds.) *Handbook of the Economics of Education*, volume 4. Amsterdam: North-Holland, 1–181.
- Alonso, William. 1964. *Location and Land Use; Toward a General Theory of Land Rent*. Cambridge, MA: Harvard University Press.
- Autor, David and David Dorn. 2013. The growth of low skill service jobs and the polarization of the US labor market. *American Economic Review* 103(5): 1553–1597.
- Bacolod, Marigee, Bernardo Blum, and William C. Strange. 2009. Skills and the city. *Journal of Urban Economics* 65(2): 127–135.
- Bacolod, Marigee, Bernardo Blum, and William C. Strange. 2010. Elements of skill: Traits, intelligences, education, and agglomeration. *Journal of Regional Science* 50(1): 245–280.
- Bauernschuster, Stefan, Oliver Falck, Stephan Heblich, Jens Suedekum, and Alfred Lameli. 2014. Why are educated and risk-loving persons more mobile across regions? *Journal of Economic Behavior & Organization* 98: 56–69.
- Baum-Snow, Nathaniel and Ronni Pavan. 2012. Understanding the city size wage gap. *Review of Economic Studies* 79(1): 88–127.
- Behrens, Kristian, Gilles Duranton, and Frédéric Robert-Nicoud. 2014. Productive cities: Sorting, selection, and agglomeration. *Journal of Political Economy* 122(3): 507–553.
- Benabou, Roland and Jean Tirole. 2002. Self-confidence and personal motivation. *Quarterly Journal of Economics* 117(3): 871–915.
- Berry, Steven and Edward L. Glaeser. 2005. The divergence in human capital levels across cities. *Papers in Regional Science* 84(3): 407–444.
- Brueckner, Jan K. 1987. The structure of urban equilibria: A unified treatment of the Muth-Mills model. In Edwin S. Mills (ed.) *Handbook of Regional and Urban Economics*, volume 2. Amsterdam: North-Holland, 821–845.
- Chen, Gilad, Stanley M. Gully, and Dov Eden. 2001. Validation of a new general self-efficacy scale. *Organizational Research Methods* 4(1): 62–83.

- Combes, Pierre-Philippe, Gilles Duranton, and Laurent Gobillon. 2016. The costs of agglomeration: House and land prices in French cities. Processed, Wharton School, University of Pennsylvania.
- Davis, Donald R. and Jonathan I. Dingel. 2012. A spatial knowledge economy. Working Paper 18188, National Bureau of Economic Research.
- Davis, Donald R. and Jonathan I. Dingel. 2013. The comparative advantage of cities. Processed, Columbia University.
- De la Roca, Jorge and Diego Puga. 2017. Learning by working in big cities. *Review of Economic Studies* 84(1): 106–142.
- Dunning, David, Chip Heath, and Jerry M. Suls. 2004. Flawed self-assessment: Implications for health, education, and the workplace. *Psychological Science In The Public Interest* 5(3): 69–106.
- Duranton, Gilles and Henry G. Overman. 2005. Testing for localization using micro-geographic data. *Review of Economic Studies* 72(4): 1077–1106.
- Duranton, Gilles and Diego Puga. 2001. Nursery cities: Urban diversity, process innovation, and the life cycle of products. *American Economic Review* 91(5): 1454–1477.
- Duranton, Gilles and Diego Puga. 2015. Urban land use. In Gilles Duranton, Vernon Henderson, and William Strange (eds.) *Handbook of Regional and Urban Economics*, volume 5. Amsterdam: North-Holland, 467–560.
- Eeckhout, Jan, Roberto Pinheiro, and Kurt Schmidheiny. 2014. Spatial sorting. *Journal of Political Economy* 122(3): 554–620.
- Ellison, Glenn and Edward L. Glaeser. 1997. Geographic concentration in US manufacturing industries: A dartboard approach. *Journal of Political Economy* 105(5): 889–927.
- Francis, Leslie J. and Christopher J. F. Rutledge. 2004. Personality and preference for rural ministry: Replication and reconsideration. *Pastoral Psychology* 53(1): 43–48.
- Glaeser, Edward L. 1999. Learning in cities. *Journal of Urban Economics* 46(2): 254–277.
- Glaeser, Edward L. and David C. Maré. 2001. Cities and skills. *Journal of Labor Economics* 19(2): 316–342.
- Gray-Little, Bernadette, Valerie S. L. Williams, and Timothy D. Hancock. 1997. An item response theory analysis of the Rosenberg Self-Esteem Scale. *Personality and Social Psychology Bulletin* 23(5): 443–451.
- Hansford, Brian C. and John A. Hattie. 1982. The relationship between self and achievement/performance measures. *Review of Educational Research* 52(1): 123–142.
- Harter, Susan. 1990. Causes, correlates and the functional role of global self-worth: A life-span perspective. In John Kolligian and Robert J. Sternberg (eds.) *Competence Considered*. New Haven, CT: Yale University Press, 67–98.
- Jaeger, David A., Thomas Dohmen, Armin Falk, David Huffman, Uwe Sunde, and Holger Bonin. 2010. Direct evidence on risk attitudes and migration. *Review of Economics and Statistics* 92(3): 684–689.
- Jenkins, Stephen P. 1995. Easy estimation methods for discrete-time duration models. *Oxford Bulletin of Economics and Statistics* 57(1): 129–138.

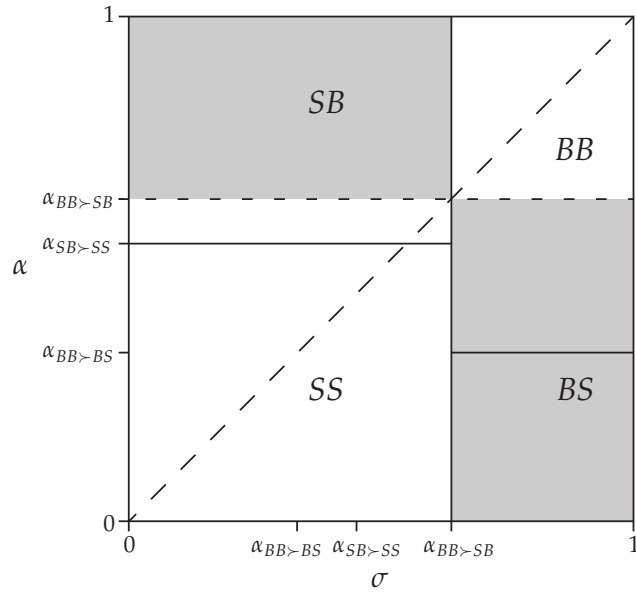
- Jones, Michael P., Diann Eley, Lisa Lampe, Carissa M. Coulston, Gin S. Malhli, Ian Wilson, Brian Kelly, Nicholas J. Talley, Cathy Owen, Gerry Corrigan, Barbara Griffin, John Humphreys, Beatrice Alba, and Pamela Stagg. 2013. Role of personality in medical students' initial intention to become rural doctors. *Australian Journal of Rural Health* 21(2): 80–89.
- Judge, Timothy A., Amir Erez, and Joyce E. Bono. 1998. The power of being positive: The relation between positive self-concept and job performance. *Human Performance* 11(2/3): 167–187.
- Marshall, Nancy J. 1970. Personality correlates of orientation toward privacy. In *EDRA 2: Proceedings of the 2nd Annual Environmental Design Research Association Conference*. 316–319.
- Mills, Edwin S. 1967. An aggregative model of resource allocation in a metropolitan area. *American Economic Review Papers and Proceedings* 57(2): 197–210.
- Moretti, Enrico. 2012. *The New Geography of Jobs*. New York, NY: Houghton Mifflin Harcourt.
- Muth, Richard F. 1969. *Cities and Housing*. Chicago: University of Chicago Press.
- Robins, Richard W., Jessica L. Tracy, Kali Trzesniewski, Jeff Potter, and Samuel D. Gosling. 2001. Personality correlates of self-esteem. *Journal of Research in Personality* 35(4): 463–482.
- Rosenberg, Morris. 1965. *Society and the Adolescent Self-Image*. Princeton: Princeton University Press.
- Ruggles, Steven, Katie Genadek, Ronald Goeken, Josiah Grover, and Matthew Sobek. 2015. *Integrated Public Use Microdata Series: Version 6.0*. Minneapolis, MN: University of Minnesota.
- Saint-Paul, Gilles. 2015. Bobos in paradise: Urban politics and the new economy. Discussion Paper 9423, Institute for the Study of Labor (IZA).
- Samejima, Fumi. 1969. Estimation of latent ability using a response pattern of graded scores. *Psychometrika Monograph Supplement* 17.
- Stajkovic, Alexander D. and Fred Luthans. 1998. Self-efficacy and work-related performance: A meta-analysis. *Psychological Bulletin* 124(2): 240–261.
- Yankow, Jeffrey J. 2006. Why do cities pay more? An empirical examination of some competing theories of the urban wage premium. *Journal of Urban Economics* 60(2): 139–161.

Appendix A. Alternative equilibrium location choices by self-confidence and ability

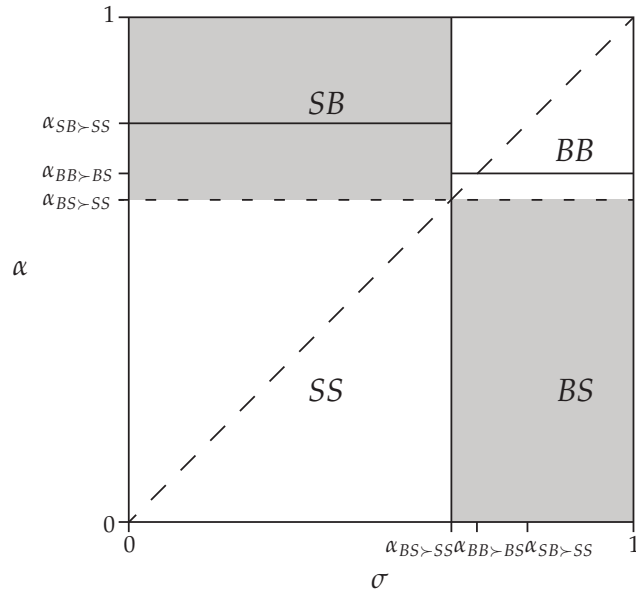
Figure 1 in the main text describes location choices under parameter values such that $\frac{e_S}{\Omega_B} \leq \frac{\Delta e}{\Delta \Omega} \leq \frac{e_B}{\Omega_S}$ so that, according to proposition 1, low self-confidence is defined as $\sigma \leq \alpha_{BB \succ SS}$ and a worker never selects trajectories (B, S) and (S, B) *ex ante* based on her self-assessed ability, but she might still end up following them *ex post* if her initial self-assessment turned out to be wrong. Panels (a) and (b) of figure A.1 describe the only two alternative possibilities.²⁵

Panel (a) of figure A.1 describes location choices under parameter values such that $\frac{\Delta e}{\Delta \Omega} < \frac{e_S}{\Omega_B}$. As before, junior workers locate in S if they have low self-confidence and locate in B if they have high self-confidence, although low self-confidence is now defined by proposition 1 as $\sigma \leq \alpha_{BB \succ SB}$.

²⁵Panel (a) is plotted for $e_B = 0.40$, $e_S = 0.24$, $\Omega_B = 0.95$, $\Omega_S = 0.21$, $\pi_2 = 3.08$, and $\Delta\gamma = 0.30$. Panel (b) is plotted for $e_B = 0.80$, $e_S = 0.70$, $\Omega_B = 0.50$, $\Omega_S = 0.45$, $\pi_2 = 10.80$, and $\Delta\gamma = 0.30$.



Panel (a) $\frac{\Delta e}{\Delta \Omega} < \frac{e_S}{\Omega_B}$



Panel (b) $\frac{e_B}{\Omega_S} < \frac{\Delta e}{\Delta \Omega}$

$(\frac{e_S}{\Omega_B} \leq \frac{\Delta e}{\Delta \Omega} \leq \frac{e_B}{\Omega_S}$ represented in figure 1)

Figure A.1: Alternative equilibrium location choices by self-confidence and ability

When senior, workers locate in S if either they have low ability or they have intermediate ability and did not locate in the big city during their junior period; they locate in B if either they have high ability or they have intermediate ability and located in the big city during their junior period. The main difference is that some junior workers now choose trajectory (S, B) *ex ante*. We can see this from the fact that the diagonal (corresponding to perfectly accurate self-assessment $\sigma = \alpha$) crosses through the area marked SB .

Analogously, panel (b) of figure A.1 depicts the case arising for parameter values $\frac{c_B}{\Omega_S} < \frac{\Delta e}{\Delta \Omega}$. The same general results of proposition 1 hold, although low self-confidence is now defined as $\sigma \leq \alpha_{BS} > \alpha_{SS}$. The main difference is that some junior workers now choose trajectory (B, S) *ex ante*. We can see this from the fact that the diagonal crosses through the area marked BS .

Appendix B. Endogenizing urban structure

We have so far determined individual location choices taking as given that there are big and small cities. However, city sizes result from the combination of the location choices of individuals, and we must make sure there is consistency between individual location choices and city sizes. In other words, we must make sure that the equilibrium we have characterized exists. For this reason, we now endogenize the urban structure and solve for the general equilibrium of our model. We also show that this equilibrium is unique.

Suppose there are two cities, and each is linear and monocentric.²⁶ Land covered by each city is endogenously determined and can be represented by a segment on the positive real line. All workers in a city perform their job at a single point $x = 0$, the Central Business District (CBD).

Workers consume housing and a freely tradable numéraire good. For simplicity, let us assume that all residences have the same size, are built under perfect competition with a constant capital to land ratio, and are owned by absentee landlords.²⁷ Thus, every individual consumes one unit of floorspace built on one unit of land with a fixed amount of capital. The price of capital is constant throughout the economy while the price of land varies. Commuting costs increase linearly with distance to the CBD, so that a worker living at distance x incurs a commuting cost τx . The total urban costs for a worker located in a residence at a distance x from the CBD of city i are the sum of her commuting costs τx and her housing costs $P_i(x)$:

$$\gamma_i(x) = \tau x + P_i(x), \quad i, j \in \{B, S\}. \quad (\text{B.1})$$

As a result, any resident in a city is willing to bid τx more for a house that is x closer to the CBD. Equilibrium house prices are then such that the increase in commuting costs incurred as one relocates towards the CBD is exactly offset by an increase in house prices.

Using N_i to denote the equilibrium population in city i , house prices in city i can then be expressed as

$$P_i(x) = \tau(N_i - x) + \bar{r}, \quad i, j \in \{B, S\}, \quad (\text{B.2})$$

²⁶We develop a highly simplified version of the monocentric city model (Alonso, 1964, Mills, 1967, Muth, 1969). For an exposition of more general versions of the monocentric city model, see Brueckner (1987) and Duranton and Puga (2015).

²⁷Having instead common ownership of the housing stock by local residents yields essentially the same results. One simply gets $\gamma_i = \frac{1}{2}\tau N_i$ instead of $\gamma_i = \tau N_i$ in equation (B.3) below.

where the constant \bar{r} is the sum of the rental cost of the fixed amount of capital used in every residence and the rental price of land in the best non-urban use (e.g., agriculture). A worker living at the edge of a city has to commute a distance equal to the population of the city, thus incurring a commuting cost τN_i , but only pays \bar{r} for housing. A worker living at the CBD has no cost of commuting but pays an additional τN_i for her house. Substituting equation (B.2) into (B.1) yields urban cost in city i :

$$\gamma_i = \tau N_i + \bar{r} . \quad (\text{B.3})$$

In order to allow for the coexistence of junior and senior workers in a city, let us assume that there are overlapping generations of workers. Each generation is made up of a continuum of workers of measure 1 and lives for two periods. Thus, workers coexist when junior with senior workers of the previous generation and coexist when senior with junior workers of the next generation. Since our focus is on the steady state, we avoid using a time subscript for our variables.

The total population of city i , N_i , is the sum of junior and senior workers in the city. Let us denote by n the difference in population between the big and the small city:

$$n \equiv N_B - N_S . \quad (\text{B.4})$$

Note that $0 \leq n \leq 2$ holds since, by definition, the big city has a larger population and since the total population in the economy at any point in time is made up of two living generations with unit population mass each. Combining equations (B.3) and (B.4), we can then express the difference in urban costs between B and S , $\Delta\gamma \equiv \gamma_B - \gamma_S$, as

$$\Delta\gamma = \tau n . \quad (\text{B.5})$$

Taking n as given, each worker can calculate $\Delta\gamma$ as per equation (B.5). She can then substitute this into equations (2), (3), (7), (8) and (9) to calculate, respectively, $\alpha_{BS \succ SS}$, $\alpha_{BB \succ BS}$, $\alpha_{SB \succ SS}$, $\alpha_{BB \succ SB}$ and $\alpha_{BB \succ SS}$. Given all these thresholds, each worker chooses her optimal location as per proposition 1. If we then add up how many workers choose to locate in each city, an equilibrium arises when this yields a difference in population between the two cities equal to n .

Adding $N_B + N_S = 2$ to equation (B.4) and solving for N_B , we can express population in B in terms of n :

$$N_B = 1 + \frac{n}{2} . \quad (\text{B.6})$$

In equilibrium this must equal the total number of junior and senior workers choosing to reside in B , which we will denote by $b(n)$. To obtain an expression for $b(n)$, we must refer back to proposition 1. Let us denote by $f(\sigma, \alpha)$ the probability density function for the bivariate distribution

of ability and self-confidence for workers in the population. Hence, we can write:

$$b(n) = \begin{cases} \int_{\alpha_{BB>SB}(n)}^1 \int_0^1 f(\sigma, \alpha) d\alpha d\sigma + \int_{\alpha_{BB>SB}(n)}^1 \int_{\alpha_{BB>BS}(n)}^{\alpha_{SB>SS}(n)} f(\sigma, \alpha) d\alpha d\sigma + \int_0^1 \int_{\alpha_{SB>SS}(n)}^1 f(\sigma, \alpha) d\alpha d\sigma & \text{if } \frac{\Delta e}{\Delta \Omega} < \frac{e_S}{\Omega_B} \\ \int_{\alpha_{BB>SS}(n)}^1 \int_0^1 f(\sigma, \alpha) d\alpha d\sigma + \int_{\alpha_{BB>SS}(n)}^1 \int_{\alpha_{BB>BS}(n)}^{\alpha_{SB>SS}(n)} f(\sigma, \alpha) d\alpha d\sigma + \int_0^1 \int_{\alpha_{SB>SS}(n)}^1 f(\sigma, \alpha) d\alpha d\sigma & \text{if } \frac{e_S}{\Omega_B} \leq \frac{\Delta e}{\Delta \Omega} \leq \frac{e_B}{\Omega_S} \\ \int_{\alpha_{BS>SS}(n)}^1 \int_0^1 f(\sigma, \alpha) d\alpha d\sigma + \int_{\alpha_{BS>SS}(n)}^1 \int_{\alpha_{BB>BS}(n)}^{\alpha_{SB>SS}(n)} f(\sigma, \alpha) d\alpha d\sigma + \int_0^1 \int_{\alpha_{SB>SS}(n)}^1 f(\sigma, \alpha) d\alpha d\sigma & \text{if } \frac{e_B}{\Omega_S} < \frac{\Delta e}{\Delta \Omega}. \end{cases} \quad (\text{B.7})$$

Equation (B.7) can be readily understood by referring back to proposition 1. For example, the first case (for $\frac{\Delta e}{\Delta \Omega} < \frac{e_S}{\Omega_B}$) has three types of workers choosing to locate in B (each type captured by one of the three double integrals for this first case): junior workers with high self-confidence $\alpha_{BB>SB} < \sigma$; senior workers with intermediate ability $\alpha_{BB>BS} < \alpha \leq \alpha_{SB>SS}$ who in their junior period located in B due to high self-confidence $\alpha_{BB>SB} < \sigma$; and senior workers with high ability $\alpha_{SB>SS} < \alpha$, regardless of their self-confidence.

We can also interpret equation (B.7) in terms of figure 1. Given the unit population mass of each generation of workers, the number of junior workers who decide to reside in B is given by the fraction of them with self-confidence and ability in rectangles BB or BS . The number of senior workers who decide to reside in B is given by the fraction of them with self-confidence and ability in rectangles BB or SB .

Any equilibrium value of n has to satisfy $b(n) = 1 + \frac{n}{2}$ for $0 \leq n \leq 2$. Under the assumption that $f(\sigma, \alpha)$ is continuous and differentiable in $\alpha \in [0, 1]$ and $\sigma \in [0, 1]$, the following result holds.

Proposition 2. There exists a unique equilibrium allocation of population across cities. In equilibrium, both the big and small cities are populated. The difference n in population between the big and small cities decreases with the common commuting cost per unit of distance τ , and increases with the additional opportunities $\Delta \Omega$ and the additional experience Δe provided by the bigger city.

Proof Define the auxiliary function

$$\tilde{b}(n) = 1 + \frac{n}{2} - b(n). \quad (\text{B.8})$$

This is the difference between the population of B , $1 + \frac{n}{2}$, and the number of workers who wish to locate in B given that population, $b(n)$. Existence and uniqueness of the urban equilibrium can be proven by showing that $\tilde{b}(n)$ has a single root in the feasible interval $0 \leq n \leq 2$.

We begin by showing that $b(n)$ is a continuous decreasing function of n over the interval $[0, 2]$. Consider the case where $\frac{\Delta e}{\Delta \Omega} < \frac{e_S}{\Omega_B}$. By the fundamental theorem of calculus, $b(n)$ is a continuous function of $\alpha_{BB>SB}(n)$, $\alpha_{BB>BS}(n)$, and $\alpha_{SB>SS}(n)$, which are in turn continuous functions of n . From equation (B.7), by the fundamental theorem of calculus and the chain rule of derivation, its

derivative with respect to n can be written

$$\begin{aligned}
b'(n) \Big|_{\frac{\Delta e}{\Delta \Omega} < \frac{e_S}{\Omega_B}} = & -\alpha'_{BB>SB}(n) \int_0^1 f(\alpha_{BB>SB}(n), \alpha) d\alpha - \alpha'_{BB>SB}(n) \int_{\alpha_{BB>BS}(n)}^{\alpha_{SB>SS}(n)} f(\alpha_{BB>SB}(n), \alpha) d\alpha \\
& -\alpha'_{BB>BS}(n) \int_{\alpha_{BB>SB}(n)}^1 f(\sigma, \alpha_{BB>BS}(n)) d\sigma - \alpha'_{SB>SS}(n) \int_0^{\alpha_{BB>SB}(n)} f(\sigma, \alpha_{SB>SS}(n)) d\sigma,
\end{aligned} \tag{B.9}$$

which is negative given that $\alpha'_{BB>SB}(n) > 0$, $\alpha'_{BB>BS}(n) > 0$ and $\alpha'_{SB>SS}(n) > 0$. It can be shown analogously that $b(n)$ is a continuous decreasing function of n over the interval $[0, 2]$ when $\frac{e_S}{\Omega_B} \leq \frac{\Delta e}{\Delta \Omega} \leq \frac{e_B}{\Omega_S}$ and when $\frac{e_B}{\Omega_S} < \frac{\Delta e}{\Delta \Omega}$.

Since $1 + \frac{n}{2}$ is a continuous increasing function of n and $b(n)$ is a continuous decreasing function of n over the interval $[0, 2]$, it follows that $\tilde{b}(n) = 1 + \frac{n}{2} - b(n)$ is a continuous increasing function of n over this interval.

By equation (B.5), $n = 0$ implies $\Delta\gamma = 0$; which in turn, by equations (2), (3), (7), (8), and (9), implies $\alpha_{BS>SS} = \alpha_{BB>BS} = \alpha_{SB>SS} = \alpha_{BB>SB} = \alpha_{BB>SS} = 0$; and substituting these into equation (B.7) yields $b(0) = 2$; which, by equation (B.8), implies $\tilde{b}(0) = -1$. Moreover, since $1 + \frac{n}{2}$ takes value 2 for $n = 2$, and since $b(n)$ is decreasing in n over the interval $[0, 2]$ starting from the value $b(0) = 2$, it follows that $\tilde{b}(2) > 0$.

Since $\tilde{b}(n)$ is a continuous function of n over the interval $[0, 2]$, $\tilde{b}(0) < 0$, and $\tilde{b}(2) > 0$, by Bolzano's Theorem there exists at least one value of $n \in (0, 2)$ such that $\tilde{b}(n) = 0$. This proves that an urban equilibrium exists. In addition, both the big and small cities are populated in equilibrium (i.e., the equilibrium value of n satisfies $0 < n < 2$ with strict inequality). The urban equilibrium is also unique. Suppose on the contrary that there were two or more values of n in $(0, 2)$ such that $\tilde{b}(n) = 0$. Then, by Rolle's Theorem there would have to be some n in this interval such that $\tilde{b}'(n) = 0$, which contradicts our previous result that $\tilde{b}'(n) > 0$ over the interval $[0, 2]$.

Turning to comparative statics, totally differentiating the equilibrium condition $\tilde{b}(n) = 1 + \frac{n}{2} - b(n) = 0$ and solving for $\frac{dn}{d\tau}$ yields

$$\frac{dn}{d\tau} = \frac{\frac{db(n)}{d\tau}}{\tilde{b}'(n)}. \tag{B.10}$$

Since τ and n always enter $b(n)$ together as a product (because $\Delta\gamma$ enters every threshold level of α and, by equation B.5, $\Delta\gamma = \tau n$), it follows that $\frac{db(n)}{d\tau} = b'(n)$, and we have already shown that $b'(n) < 0$. We have also shown that $\tilde{b}'(n) > 0$. Hence, we can sign equation (B.10): $\frac{dn}{d\tau} < 0$. The comparative statics $\frac{dn}{d\Delta\Omega} > 0$ and $\frac{dn}{d\Delta e} > 0$ can be proven analogously. \square

When deciding whether to locate in B , junior workers trade off the greater experience they will acquire by locating there against the higher urban costs they need to incur. Senior workers trade off the greater opportunities B provides to use their previously-acquired experience against its higher urban costs. In equilibrium, some workers strictly prefer to locate in B and others strictly prefer to locate in S . Individual choices depend on self-confidence and ability, on common parameters capturing the magnitude of the advantages and disadvantages of locating in the big city, and on the choices of all other workers.

In equilibrium, the difference in population n between B and S is such that the difference between the mass of workers who prefer to locate in B and the mass of workers who prefer to locate in S aggregates up to precisely n . Off-equilibrium, the mass of workers who given n prefer B to S may aggregate up to more than n , but then as more workers locate in B and fewer in S commuting and housing costs increase in B relative to S until an equilibrium is restored. And conversely, the reverse adjustment occurs if the mass of workers who given n prefer B to S aggregates up to less than n .

The comparative statics for equilibrium differences in city sizes are fairly intuitive. A higher cost of commuting per unit of distance (τ) implies a larger gap in urban costs for any given difference in population between B and S , and so results in a smaller equilibrium difference in population sizes (n). The greater the additional opportunities ($\Delta\Omega$) and the additional experience (Δe) provided by B , the more attractive is B relative to S , so a higher difference in population (n) is needed to balance things out in equilibrium.

Appendix C. Additional results

Table C.1: Determinants of location in big and small cities with risk aversion

| | In a small city upon completing education | | In a big city upon completing education | |
|------------------------------------|--|------------------------------------|---|---------------------------------------|
| | moved to another small city 10 years later | moved to a big city 10 years later | moved to a smaller city 10 years later | moved to a bigger city 10 years later |
| | (1a) | (1b) | (2a) | (2b) |
| Self confidence percentile | 1.000 (0.002) | 1.000 (0.003) | 1.000 (0.003) | 0.998 (0.005) |
| Cognitive ability percentile | 1.003 (0.003) | 1.008 (0.004)** | 1.000 (0.004) | 1.004 (0.005) |
| Risk aversion percentile | 0.997 (0.002)* | 0.992 (0.003)** | 0.995 (0.002)** | 0.997 (0.004) |
| Male | 1.150 (0.146) | 1.068 (0.162) | 1.045 (0.172) | 0.999 (0.253) |
| Hispanic | 0.726 (0.303) | 1.247 (0.637) | 0.596 (0.237) | 1.331 (0.745) |
| Black | 0.696 (0.164) | 1.024 (0.400) | 0.562 (0.174)* | 0.513 (0.335) |
| High school graduate | 0.950 (0.223) | 0.782 (0.237) | 0.821 (0.221) | 0.861 (0.558) |
| Some college | 1.228 (0.318) | 1.662 (0.564) | 1.178 (0.321) | 1.307 (1.059) |
| College graduate | 1.185 (0.335) | 1.755 (0.589)* | 1.276 (0.402) | 1.759 (1.212) |
| Never married | 0.621 (0.116)** | 0.887 (0.210) | 0.622 (0.136)** | 1.216 (0.461) |
| One or more children | 0.836 (0.113) | 0.710 (0.128)* | 0.695 (0.135)* | 0.863 (0.370) |
| Full time working spouse | 0.822 (0.106) | 1.147 (0.187) | 0.847 (0.128) | 1.244 (0.379) |
| % weeks out of work | 1.006 (0.002)** | 1.007 (0.003)** | 1.011 (0.003)** | 0.995 (0.008) |
| Same city when junior as at age 14 | 0.205 (0.036)*** | 0.314 (0.058)*** | 0.329 (0.091)*** | 0.271 (0.113)*** |
| N | | 2,183 | | 1,308 |
| Pseudo R^2 | | 0.103 | | 0.084 |

Notes: All specifications include a constant and birth year indicators. All columns report relative risk ratios (exponentiated coefficients) from multinomial logit estimations, where coefficients above one indicate a positive effect and coefficients below one a negative effect. Standard errors in parentheses are clustered at the metropolitan area level. ***, **, and * indicate significance at the 1, 5, and 10 percent levels. In columns (1a) and (1b) the sample includes individuals who lived in a small city one year after completing education and the dependent variable takes value one if the individual moved to another small city and value two if she moved to a big city ten years later. In columns (2a) and (2b) the sample includes individuals who lived in a big city one year after completing education and the dependent variable takes value one if the individual moved to a smaller city and value two if she moved to a bigger city ten years later. White, female, ever married and high school dropouts are the omitted categories. Risk aversion percentile takes higher values when individuals have a lower willingness to take risks. A 'big city' is defined as a Core Based Statistical Area (CBSA) with population greater than 2,000,000 in 2010.