The Push-Pull Effects of the Information Technology Boom and Bust

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Abstract

This paper examines the inflow and outflow of workers to different industries in Georgia during the Information Technology (IT) boom of the 1990s and the subsequent bust. Workers in the Software and Computer Services industry were much more likely to have been absent from the Georgia workforce prior to the boom, but were no more likely than workers from other industries to have exited Georgia's workforce during the bust. Consequently, Georgia likely experienced a net gain in worker human capital as a result of being an area of concentration of IT-producing activity during the IT boom.

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I. Introduction

The U.S. information technology (IT) sector experienced remarkable growth during the second half of the 1990s, driven by strong business demand for IT goods and services. As shown in Figure 1, the dollar value of output of the IT-producing sector (solid line) grew by more than 10 percent each year between 1996 and 1999. However, IT production declined sharply in 2001 when businesses made deep cuts in IT spending. Since 2003, IT sector production has recovered somewhat, with IT output reaching an annual growth rate of 8.5 percent by 2005.

The boom in IT production during the 1990s led to a dramatic rise in employment in IT-producing industries, and the subsequent contraction in IT production resulted in a large decline in IT-sector employment in the early 2000s. Figure 1 shows that, between 1993 and 2000, the number of workers in IT-producing industries in the U.S. (dashed line) increased by 50 percent, which is almost two and a half times as fast as the employment gains in private sector non-IT industries (dotted line). From 2001 to 2003, employment in IT-producing industries declined by 20 percent from the peak, compared with a two percent decline in non-IT industries. Since 2003, employment in the IT sector has been relatively stable, although at much lower levels than during the boom, while non-IT employment has been expanding.

[Figure 1 here]

Although there was rapid growth in employment in the IT sector during the boom years of the mid to late 1990s, it was not uniformly distributed across the U.S. (Daly and

Valetta, 2004). The concentration of IT employment growth in geographically distinct metropolitan areas such as Washington, D.C., San Francisco, Austin, Boston, Seattle, Phoenix, and Atlanta presents these areas as unique laboratories in which to investigate the impact of extraordinary swings in labor demand on movements of individuals into and out of local labor markets. Moreover, Cortright and Mayer (2001) show that metropolitan areas varied considerably in their areas of specialization within the IT sector. For instance, Atlanta was identified as having a relatively high concentration in software development but a low concentration in IT manufacturing. In contrast, Phoenix was identified as a center for hardware rather than software development. This suggests there was considerable heterogeneity in the types of workers attracted to different IT centers. In turn, the variation in the skill sets of these workers likely impacts their ability to transition into other sectors during industry-specific as well as general economic downturns. For example, Hart (2007) observes that IT-manufacturing industries are often characterized by semi-skilled workers while hardware and software development are characterized by high skilled workers. Thus, following an employment shock, IT-manufacturing workers are expected to act more like workers in other manufacturing industries than workers in IT services such as software and system design.

The purpose of this paper is to investigate whether the flow of individuals into a local workforce in response to a substantial increase in employment opportunities in the IT sector was matched by a comparable outflow when those specific opportunities evaporated. Research has established a fairly stable positive relationship between the skill level of an area's workforce (as measured by educational attainment) and the growth of that area's economy (Gleaser and Saiz, 2003). Thus attracting high-skilled workers has

often been viewed as a goal of local economic development efforts, and local public funds are often used to attract new businesses in particular high-skilled industries. However, if skilled workers exit the local workforce when businesses fail, then the economic gain is only as long-lived as the businesses themselves. If, on the other hand, skilled workers have staying power beyond the original attraction to the local workforce, the economic benefits of a skilled workforce accrue beyond the life of the initial opportunities.

The pull on individuals to geographic areas experiencing positive economic growth and the push of individuals out during economic declines has been referred to as "push-pull" migration, and has been analyzed in a variety of different contexts.[1] For the purposes of this paper, migration will be considered in the context of entry and exit from the workforce in the state of Georgia, with the IT sector's boom providing the pull of individuals with IT skills into Georgia's workforce, and the subsequent decline as the potential push out. Hotchkiss, Pitts, and Robertson (2006) demonstrate that the patterns in IT and non-IT employment in Georgia closely resemble those for the US displayed in Figure 1. Using matched employer-employee payroll data for Georgia over the period 1993-2005, the analysis in this paper finds that workers in the Software and Computer Services industry were disproportionately more likely to be new workforce entrants during the IT boom, but were not any more or less likely to exit the workforce during the IT bust. The implication is that the pull of employment opportunities in the IT-producing sector was much stronger than the push of declining opportunities in that sector during the bust. This asymmetry, which is attributed to the transferability of IT skills to non-IT

producing industries (see DeBacker, Hotchkiss, Pitts, and Robertson, 2005), may bode well for long-term economic benefits of attracting high-skilled workers.

II. Theoretical Framework

The goal of the analysis in this paper is to determine whether the dramatic swings in demand for workers in the IT-producing sector caused individuals to be more likely to enter the state's workforce during the boom and more likely to exit after the boom ended relative to workers in other industries. There are two ways in which workers are observed entering or exiting the Georgia workforce. The first is through physical migration and the second is through changes in residents' decisions to participate in the labor market. While the data do not allow for the distinction between these two sources, the actions are guided by the same utility maximizing framework.

A. Migration

Basic migration theory models the decision to migrate as an investment decision (e.g., Schultz, 1961, Becker, 1964, and Mincer and Jovanovic, 1981). The net present value of migrating (NPV_M) is determined by evaluating the difference in the returns to moving and the cost of that move:

$$NPV_M = \sum_t^T \left[\frac{\left(w_B \pi_B - w_A \pi_A \right)}{(1+r)^t} \right] - C . \tag{1}$$

The returns to moving from location A to location B are depicted as the present value of the expected wage in location B, which is equal to the probability of finding employment in B (π_B) times the wage offered in B (w_B), minus the expected wage in location A; r is a

discount factor; T is the amount of time spent in location B; and C represents the cost of the move. There is a vast literature that establishes how the total cost of migration is dependant upon the characteristics of the worker and the amenities of the geographic locations being compared (for example, see Greenwood, 1985, Hunt, 1993, and Gabriel and Schmitz, 1995). For example, the greater the distance between location A and location B the higher the cost of moving, and people with more education apparently experience lower (psychic and informational) costs (see Schwartz, 1973).

For the purposes of this analysis, it is expected that the unprecedented growth in demand for IT workers in Georgia during the IT boom affected migration decisions through π_B, and perhaps through w_B. Certainly, the growth in demand for workers, ceteris paribus, increases the probability of finding employment and may also be large enough, relative to the supply of workers, to bid up wages. So, for any given employment opportunities in the original geographic location (outside of Georgia) and any given costs associated with moving to Georgia, the net present value of migrating to Georgia would be higher during the IT boom than during other periods, increasing the likelihood of migration.

This type of migration is often referred to as "pull-migration," as the economic rewards in location B "pull" workers to that location. As the boom turns into a bust, and industry demand for workers in location B falls, there may be an analogous "push" out of the local workforce. The existing push-pull literature typically finds pull factors are stronger than push factors in affecting migration decisions (e.g., see Boyd, 2002).[2]

B. Labor Force Participation

In addition to physical migration into Georgia, the workforce can grow as a result of residents of Georgia re-assessing their labor force participation decisions. The standard labor/leisure choice model assumes that a person maximizes utility over two goods, income and leisure:

$$\max_{L} U = U(Y, L), \tag{2}$$

with $U(.)$ increasing in both expected income (Y) and leisure (L). There is a tradeoff between income and leisure summarized by the budget constraint:

$$Y = Y_0 + (E - L)w^*, \tag{3}$$

where Y_0 is a person's non-labor income, E is the endowment of time that a person has available to work, and w^* is the person's expected wage and reflects the cost of one hour of leisure. The expected wage, as in equation (1), can be thought of as the product of the value of the person's human capital (the actual market wage for that person, w) and the probability that the person can find a job (π):

$$w^* = w\pi. \tag{4}$$

The well-known optimizing solution to the labor/leisure choice model is that a person will choose to enter the workforce if the expected wage exceeds his/her reservation, which is defined as the marginal rate of substitution (*MRS*) between income and leisure at zero hours of work ($L=E$):

$$L < E \text{ if } w^* > MRS_{L=E}. \tag{5}$$

Just as with the decision to migrate, an increase in demand for workers during the IT boom will increase the probability of employment (π), thus increasing the expected

wage and labor force participation for workers with the needed skills. Here, too, there is a large literature that ties labor force participation decisions to the strength of the labor market (for example, see Long, 1958 and Borrow, 2004).

III. Empirical Framework

Among workers observed to be working in Georgia during the IT boom, the decision to have entered the workforce during the boom or to exit the workforce during the bust is operationalized by assuming that a person's assessment of the costs and benefits of migrating into or out of a labor market can be represented by a linear function of observable factors affecting the entrance and exit decisions:

$$I_i^* = \beta' X_{1i} + \varepsilon_i = \begin{cases} > 0 \text{ if } NPV_{M_{in}} > 0 \text{ or } w^* > MRS_{L=E} \Rightarrow Enter_i = 1 \\ \leq 0 \text{ otherwise} \qquad\qquad\qquad\quad \Rightarrow Enter_i = 0 \end{cases} \qquad (6)$$

$$Y_i^* = \alpha' X_{2i} + \upsilon_i = \begin{cases} > 0 \text{ if } NPV_{M_{out}} > 0 \text{ or } w^* \leq MRS_{L=E} \Rightarrow Exit_i = 1 \\ \leq 0 \text{ otherwise} \qquad\qquad\qquad\quad \Rightarrow Exit_i = 0 \end{cases} \qquad (7)$$

X_{ji} is a vector of observable characteristics, detailed below, that determine individual i's net return to entering or exiting the Georgia workforce. The unobserved random components, ε_i and υ_i, are assumed to be independent and identically distributed according to a standard normal distribution function. Estimates for β and α are obtained via maximum likelihood.

III. The Data and Sample Construction

The data used for the analysis are for private sector workers outside of the natural resource and agriculture industries, and come from two sets of state administrative

records compiled by the Georgia Department of Labor for the purposes of administering the state's Unemployment Insurance (UI) program.   The program provides almost a complete census of employees on non-farm payrolls, with information available on approximately 97 percent of these employees. These data are highly confidential and strictly limited in their distribution.

The Employer file contains records on all UI-covered firms and includes establishment level information on the number of employees and the wage bill, as well as the NAICS industry classification of each establishment.[3] The Individual Wage file contains information on a worker's total quarterly earnings from an employer.[4] The wage file contains no information about the worker's demographics (e.g., education, gender, race, etc.) or about the worker's job (e.g., hours of work, weeks of work, or occupation). However, the worker's employment experience can be tracked over time using a worker ID number and can be linked to the Employer file via a firm ID number.[5] Because the individual wage file contains a firm, rather than an establishment, identifier, a choice of which NAICS code to assign to each worker who was employed by a multi-establishment firm is required. Following the Department of Labor convention, a 6-digit NAICS code is assigned based on the largest share of the firm's total employment.

A. Time Period Definitions

The data are available from the first quarter of 1993 to the fourth quarter of 2005 (52 quarters). Because the focus is on the differences in behavior of workers across industries during the IT-employment boom and after the boom ended, the sample is split into four time periods; pre-boom, boom, bust, and post-bust, which correspond to the

periods shown in Figure 1. The beginning of the boom period is defined at the point when the growth rate in Georgia's IT-sector employment began to deviate from the growth in the non-IT sector, which occurred in the first quarter of 1996. The peak in Georgia's IT sector employment occurred in the fourth quarter of 2000, signaling the end of the boom period.

Given that the data are available from the first quarter of 1993, the pre-boom period is defined as all quarters from 1993 through 1995. The bust period is the period from the first quarter of 2001 through the fourth quarter of 2002. The post-bust period is defined to be the first quarter of 2003 to the fourth quarter of 2005.

B. Industry Definitions

The IT-producing sector is divided into three components: the manufacturing of IT equipment or components, Software and Computer Services, and Communication Services.[6] The non-IT industries are Construction, non-IT Services (including Transportation and Utilities, Wholesale and Retail Trade, Finance, Insurance, and Real Estate, and Miscellaneous Non-IT Services), and non-IT Manufacturing.

The industry of employment for the worker is determined by the worker's modal industry, i.e. the industry in which the worker spent most of his/her employed quarters during the boom. This concept of modal industry allows for the panel data to be collapsed in a single cross-section which describes an individual's primary activity and characteristics between 1993 and 2005.[7]

C. Full-time Worker Restriction

In defining boom-period employment, the sample is restricted to those who are most likely to be full-time workers with at least one complete quarter of employment in the boom period. With no information on hours of work or number of weeks worked in a quarter, this restriction is accomplished by using only "interior" quarters of earnings to identify employment activity. An interior quarter of earnings is a quarter with real earnings of at least $3000 that is sandwiched between two other quarters of earnings from the same employer.[8] To assign a unique industry characteristic to each worker in the sample the firm ID is assigned based on the employer from which the worker received his/her greatest earnings during that quarter.

D. Defining Entry and Exit

Conditional on having at least one quarter of employment in the boom-period, individuals are considered to have entered the Georgia workforce if they were completely absent from the Georgia Individual Wage Files during all 12 quarters of the pre-boom period. Likewise, individuals are considered to have exited the Georgia workforce if they were absent from the Wage Files during all 12 quarters of the post-bust period.[9] These definitions of entry and exit are used to ensure the "cleanest" entrance and exit possible, relative to the boom period, given the limitations of the data at hand. To require that a worker not have been present for three years prior to the boom and for three years in the post-bust period guards against identifying a *marginally* attached worker as someone whose behavior was systematically affected by the timing of the IT boom. In addition, exits are defined based on the post-bust period so that labor markets will have had time to

adjust to the declines in employment during the bust and so that short-term job losses associated with the IT-bust are not counted as a permanent exit from the local workforce.

A further important consideration for the interpretation of the results is that the data do not allow for the identification of where individuals are coming from upon entry, or where they go when they exit.   An individual may be absent from the Wage File for a number of reasons. A person absent from the Wage File may be living in Georgia, but not working, because they are unemployed or out of the labor force (e.g., retired or in school), or may be living outside of Georgia, either working or not. For this reason, the results do not provide information on the specific geographic migration patterns of individuals. However, research (for example, Greenwood, 1975) has shown that employment opportunity is a major determinant of migration, and so it is expected that the results are generally relevant to considerations of migration.

E. Sample Characteristics

The probability of entry/exit is modeled as a function of observed boom-period individual characteristics: the rate of employer turnover (as an indicator of mobility), modal industry of employment, the individual's average earnings in that industry during the boom, and the individual's average earnings interacted with modal industry. Pre-boom absence is also included as a regressor in probability of exit specification since one might expect that individuals who were new to Georgia's workforce in the boom period may be more mobile and hence may be more willing to exit as well.

The industry of employment during the boom is the regressor of primary interest. Because the data do not contain information on a worker's human capital, and because

others have found that migration and job-changing tendencies vary across human capital characteristics, the worker's average boom period earnings is interacted with the worker's modal industry of employment.[10] Earnings are found to vary systematically across industries, with some of the highest paid workers being found in the IT industries. The interaction of earnings with industry controls for human capital differences in workforce decisions and allows for conclusions specific to industry of employment.[11]   The descriptive statistics for these variables are presented in Table 1.

[Table 1 here]

The 26 percent of workers that entered the Georgia workforce during the boom mirrors the U.S. Census (2001) estimate of population growth for the state between 1990 and 2000. The 31 percent of workers who exited after the boom translates into an average annual exit rate of 6.2 percent (this is an upper bound estimate as workers may have exited before the year 2000). Dardia et al. (2005) found similar rates of entry and exit in California during and after the IT boom. While the data used in this paper do not allow us to discern the source of entry and exits, the U.S. Census Bureau (2007) estimates that 2.7 percent of the U.S. population moved from one state to another each year between 2000 and 2005, suggesting that transitions from employment to nonparticipation explains about half of the annual exit rate. Frazis et al. (2005) estimate average *monthly* flows of workers between employment, nonparticipation, and unemployment; the estimation suggests that, on average across all industries, almost three percent of those employed each month flow into nonparticipation.

Workers had an average of 0.3 different employers per quarter observed working. This translates into workers changing employers about every two years, on average.

Workers in construction changed jobs most frequently (every six quarters, on average) and workers in manufacturing stayed with the same employer the longest (approximately 10 ten quarters, on average).[12] The mean of average boom-period earnings was $8,993 per quarter, in 2003 dollars. Most workers were employed in non-IT Service industries during the boom (65.5 percent), followed by non-IT Manufacturing (20.4 percent). About seven percent of Georgia workers worked in one of the three IT-producing industries. The highest paying industry was Software and Computer Services (an average of $15,478 per quarter). Although Construction was the lowest paying industry (an average of $8,356 per quarter), there was relatively very little difference in the mean of average earnings in each of the three non-IT sectors.

The boom-period entry and exit percents show some variation across industries. The Software and Computer Services industry and the Construction industry had the largest share of workers that were absent from the Georgia workforce during the 1993-1995 pre-boom period. In contrast, Manufacturing workers (IT and non-IT) were the least likely to have been absent during the pre-boom period. Construction workers were the most likely to exit the Georgia workforce during the 2003-2005 post-bust period, whereas manufacturing workers and communication service workers were the least likely to have exited.

While the sample means tell us about the raw movement into and out of the workforce by the average worker in each industry, they do not indicate whether differences across workers in different industries are the result of the opportunities that differ across the industries or whether they are the result of differences in the characteristics of workers in the different industries. The results of the probit model

- 13 -

estimation and simulations that follow yield workforce transition probabilities net of observable worker characteristics.

IV. Predicted Probability of Entry and Exit

The probit estimation results for entry and exit are reported in Appendix A. Table 2 contains the average predicted probabilities of entering and exiting the Georgia workforce constructed from the estimated parameter coefficients; the sample entry and exit proportions by industry are also included for comparison purposes. The probability of entry and exit for industry j was calculated for all workers as if they had been employed in industry j during the boom, given their individual characteristics. These individual predicted probabilities were then averaged across the entire sample to yield the average predicted probabilities.[13]

[Table 2 here]

The first thing to notice in Table 2 is that there is more variation in the raw sample averages than in the predicted probabilities. This is because controlling for the observable individual characteristics that impact entry/exit probabilities eliminates some individual specific sources of cross-industry variation.

Focusing on the predicted probability of entry, workers in IT Software and Computer Services have the highest probability (33 percent) of having been absent from the Georgia workforce prior to the IT boom. This entry probability is six percentage points higher than the next highest probability of 27 percent, which is seen for workers in Communication Services, Construction, and non-IT Services.

The high probability of entry into Software and Computer Services, relative to other IT-producing sectors, is not surprising, given the tremendous employment growth in that sector. Between 1993 and 2000, total employment in Software and Computer Services in Georgia increased 92 percent (an increase of more than 56,000 workers) while employment in IT Manufacturing and Communication Services increased by 26 percent (4,000 workers) and 43 percent (20,000 workers), respectively (see Hotchkiss, Pitts and Robertson, 2006). Although the data do not contain information on worker experiences prior to 1993, it is likely that the large growth in demand for Software and Computer Service workers during the boom far outstripped the supply of appropriately skilled workers already in the Georgia workforce. Indeed, the percent of workers employed in Software and Computer Services during the boom who were absent from the Georgia workforce prior to the boom was *greater than* the percent that were employed in Software and Computer Services in Georgia prior to the boom. In contrast, the greatest proportion of workers employed in other industries during the boom was also employed in those industries in Georgia during the pre-boom period.

The closeness of the predicted entry probabilities for IT and non-IT Manufacturing matches the finding of Hotchkiss, Pitts, and Robertson (2006) and Hart (2007) that workers in the IT Manufacturing sector behave more like non-IT Manufacturing workers than like other workers in IT-producing industries. The relatively low probabilities of entry into both the IT and non-IT Manufacturing sectors is consistent with the relatively slower employment growth in these sectors over the boom period.

Turning to the estimated exit probabilities, the most striking result is for workers in the Software and Computer Service sector. Whereas the disproportionate growth in

Software and Computer Services industry employment during the IT-boom pulled individuals into the Georgia work force at a faster rate than other sectors, the probability of still being in the workforce 3-5 years after the IT-boom ended is similar to workers in sectors that did not experience dramatic employment declines.

One reason these workers stayed in Georgia was that the IT-bust was a national phenomenon, and so comparable employment opportunities in other IT centers weren't pulling workers away from Georgia. Another reason is that IT workers, and especially those in the Software and Computer Service industries, are likely to have greater flexibility in applying their skills across industries than workers with lower levels of skills. Interestingly, almost one-third of the boom-period IT workers who left the IT sector during the bust period transitioned into Professional and Business Services Industries, possibly reflecting a transition to staffing and temporary employment agencies. Nationally, it has been observed that there was a substantial increase in IT occupations at firms that provide staffing services (Bureau of Labor Statistics, 2007). Nineteen percent of the IT Manufacturing workers went into non-IT Manufacturing, reflecting the similarity of skills across the two sectors. Almost 16 percent of the Software and Computer workers went into Financial industries, and 13 percent of Communication Services workers went into the Retail Trade sector. A detailed table of post-bust industry distribution of IT workers is provided in Appendix B.

Another possible explanation for the lower rates of exit among those drawn to Georgia during the IT boom could be the amenities the workers discovered once they arrived. The main IT center in Georgia is the city of Atlanta, which boasts significant

attractive attributes which add to the marginal cost of a decision to exit after the boom (see Nucci, Tolbert and Irwin, 2002).

V. Post-bust Entry: The Importance of Pull Factors

  The disproportionate entry of new workers into Georgia's Software and Computer Services industry during the IT boom suggests that individuals entered the state's workforce to take advantage of the increased employment and earnings opportunities in the IT-sector. The absence of a disproportionately large exit of these workers when IT-sector employment declined sharply during the IT bust indicates that the higher entry probability was not merely the result of a higher pattern of mobility among workers in the Software and Computer Services sector. Thus, there was something unique about the opportunity for these workers that motivated persistent movement into the state's workforce.

  A test of the validity of this conclusion was performed by looking at entry into the Georgia workforce during the post-bust period across industries. A probit estimation identical to that described by equation (1) was estimated but with the sample conditioned on being employed in Georgia during the post-bust period and entry being defined as having been absent from the Georgia wage files prior to the post-bust period. If, indeed, workers in the Software and Computer Services industry were motivated to enter the Georgia workforce because of the employment and earnings opportunities available during the IT boom, it is not expected that these workers should be entering the workforce at any greater rate than workers in other industries during the post-bust period,

since opportunities for IT workers were lower during the post-bust. Table 3 presents the results from this probit estimation.

[Table 3 here]

The predicted probabilities in Table 3 indicate that IT workers (including those in Software and Computer Services) were not any more likely to enter the Georgia workforce during the post-bust period than workers in other industries.[14] This is further evidence that boom-period entrants into IT-industries were responding to the unique economic opportunities of the time period.

VI. Conclusions and Implications

The IT boom pulled workers into Georgia's IT sector, specifically the Software and Computer Services industry, at higher rates than seen in other industries. However, the decline of employment in the IT sector did not result in an analogous disproportionately large push of those individuals out of the Georgia workforce. Given that workers in the Software and Computer Services industry are among the highest paid and most skilled in the workforce, the large inflow followed by the much smaller outflow suggests that the IT boom in Georgia resulted in a net gain of skilled individuals in the workforce. Thus, the IT boom resulted in Georgia's workforce becoming more highly concentrated with high-skilled workers.

An interpretation of this finding is that the inter-industry transferability of skills for these workers allowed them to remain in the local workforce during economic downturns. This is especially relevant in the case of workers at IT-service providing firms, as the dramatic employment decline in that sector likely overstates the actual

decline in demand for workers with IT skills. Businesses outside of the IT sector brought more IT services in-house during the IT bust, and this generated demand and employment opportunities for IT workers leaving the IT sector. This is supported by the result that nearly one third of workers who left the IT sector during the bust period transitioned into non-IT Professional and Business Services Industries.

The results in this paper imply that economic development strategies that encourage the growth of a highly educated workforce with skills that are transferable across industries will result in a more resilient workforce. In other words, those regions that focused on developing IT industries with larger concentrations of semi-skilled and/or low-skilled workers, such as certain types of IT manufacturing, likely fared relatively worse after the end of the IT-boom.[15] In addition, there is some evidence that the presence of high skilled (educated) workers helps a local economy to mitigate the effects of negative economic shocks (Glaeser and Saiz, 2003). Furthermore, Giannetti (2001) found that once a workforce has a large enough concentration of high-skilled workers, the workers themselves benefit from the rents generated by skill complimentarity, thus attracting more high-skilled workers. Thus, the results in this paper suggest that development efforts to attract high skilled workers (or industries that employ skilled workers) can have benefits that last beyond the life of the initial attraction.

There are several important considerations in trying to apply the experience identified for Georgia to economic development planning and policy in other locales. First is that Atlanta (the primary IT center of Georgia) enjoyed some unique natural advantages in attracting skilled workers during the IT boom. One advantage was the relative geographic isolation of its industrial development efforts; the next closest

significant IT center in the nineties was Washington, D.C. That means that there was very little competition in attracting high-skilled workers over a significant geographic area. Other advantages include community and social characteristics that come together to define a location's "quality of place" (see Florida, 2007 and Nucci et al., 2002) as well as human capital, financial, and economic characteristics that define a location's "knowledge competitiveness" (see Huggins and Izushi, 2007 and Partridge, 1993).

The second consideration is that the rapid growth of the IT sector in Georgia during the 1990s was not a random event, but was associated with a concerted, diverse effort by state and local governments, often in partnership with private enterprises, to position the region as a major IT center. The primary example of these initiatives is the Advanced Technology Development Center (ATDC) at the Georgia Institute of Technology, which was created in 1980 to help establish links between research institutions and the IT businesses.[16] This very early effort of the ATDC created an environment and made resources available to establish a critical mass of activity that attracted skilled workers to the state, and was likely the reason why the IT specialization in Atlanta became IT services, as opposed to IT hardware development (see Cortright and Mayer, 2001).

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Table 1. Sample means.

	Mean (std. dev.)
Percent of workers absent from Georgia workforce pre-boom	26%
Workers in IT Manufacturing during boom	21%
Workers in Software and Computer Services during boom	34%
Workers in Communication Services during boom	23%
Workers in Construction during boom	31%
Workers in Non-IT Services during boom	27%
Workers in Non-IT Manufacturing during boom	21%
Percent of workers absent from Georgia workforce post-bust	31%
Workers in IT Manufacturing during boom	27%
Workers in Software and Computer Services during boom	31%
Workers in Communication Services during boom	28%
Workers in Construction during boom	37%
Workers in Non-IT Services during boom	31%
Workers in Non-IT Manufacturing during boom	28%
Percent of workers employed during the boom:	
In IT Manufacturing	0.8%
In Software and Computer Services	3.5%
In Communication Services	2.3%
In Construction	7.6%
In Non-IT Services	65.5%
In Non-IT Manufacturing	20.4%
Total number of quarters during the boom with Interior Earnings	9.73 (6.52)
Job change rate	0.3045 (0.2987)
Average quarterly earnings during the boom	$8,993 (6,798)
IT Manufacturing	$11,666 (7,879)
Software and Computer Services	$15,478 (9,310)
Communication Services	$14,109 (7,470)
Construction	$8,356 (4,927)
Non-IT Services	$8,619 (6,820)
Non-IT Manufacturing	$8,632 (5,794)
Sample size = 3,150,731	

Note: Standard deviations of continuous variables are in parentheses. The "pre-boom" time period covers 1993-1995; the "boom" is 1996-2000, and the "post-bust" covers 2003-2005.

Table 2. Predicted probability of entering and exiting Georgia's workforce by boom period industry.

| Boom Period Industry	Probability of Entry		Probability of Exit	
	Sample Average	Predicted Probability	Sample Average	Predicted Probability
IT Manufacturing	21%	22%	27%	28%
Software and Computer Services	34%	33%	31%	30%
Communication Services	23%	27%	28%	27%
Construction	31%	27%	37%	34%
Non-IT Service	27%	27%	31%	30%
Non-IT Manufacturing	21%	23%	28%	31%

Note: The "pre-boom" time period covers 1993-1995; the "boom" is 1996-2000, and the "post-bust" covers 2003-2005. Entry means that the worker was absent from the Georgia work force for all of the pre-boom time period. Exit means that the worker was absent from the work force for all of the 3-year post-bust period. Predicted probabilities are the averages across the sample of individual predicted probabilities (using parameter coefficients from Table 2) holding everything about that person constant except the industry in which he/she worked during the boom.

Table 3. Predicted probability of entering Georgia's workforce during the post-bust period by post-bust period industry.

Post-bust Period Industry	Probability of Entry into Workforce Post-bust	
	Sample Average	Predicted Probability
IT Manufacturing	13%	14%
Software and Computer Services	21%	24%
Communication Services	13%	18%
Construction	27%	25%
Non-IT Service	23%	23%
Non-IT Manufacturing	19%	21%

Note: The "pre-boom" time period covers 1993-1995; the "boom" is 1996-2000, and the "post-bust" covers 2003-2005. Entry means that the worker was absent from the Georgia work force during the boom time period, but working in Georgia during the 3-year post-bust period. Coefficient estimates from the estimated probit model are available from the authors upon request.

Figure 1: U.S. IT-Sector Output and Employment
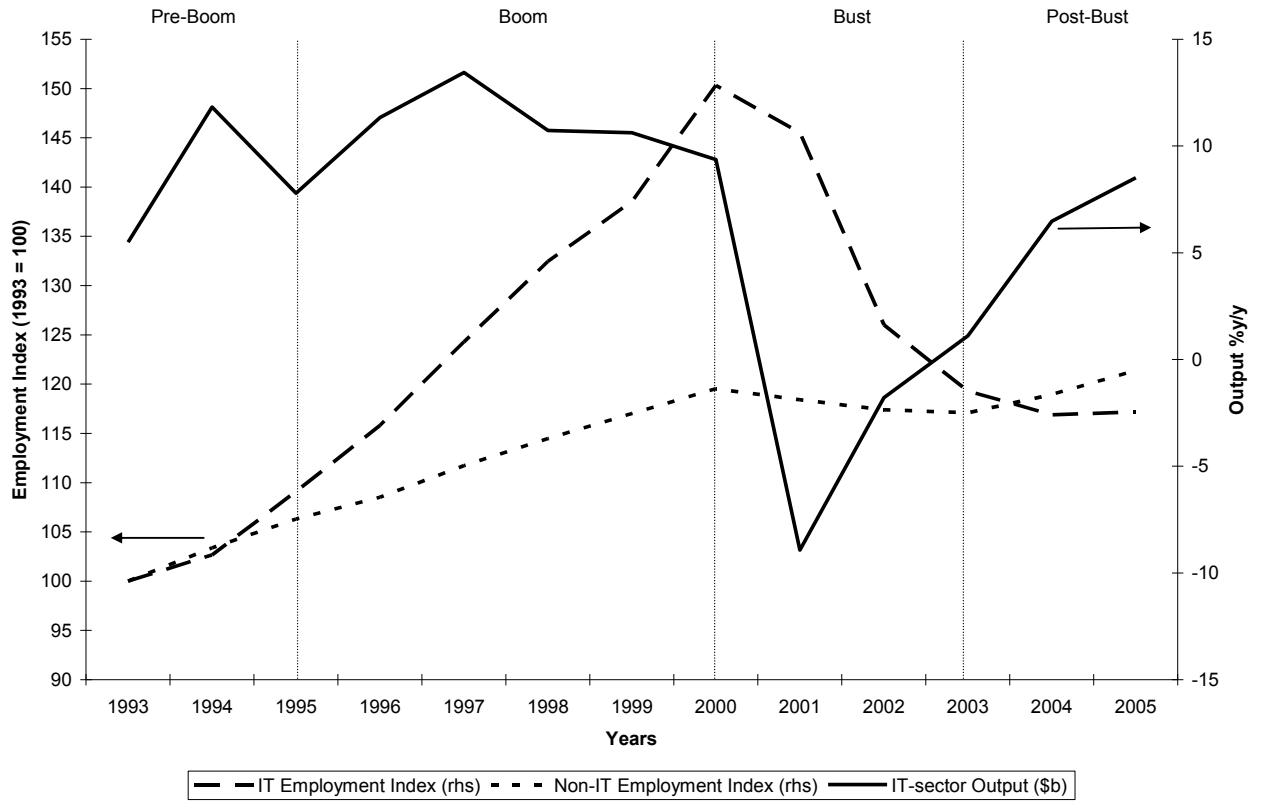
Appendix A: Probit Estimation of Entering and Exiting the Georgia Workforce

	Prob(Entering)	Prob(Exiting)
	Coef (std. error)	**Coef (std. error)**
Absent from Georgia Workforce Pre-Boom = 1	--	0.2611 (0.0017)
Job change rate	1.4030 (0.0027) [0.4150]	0.9591 (0.0027) [0.3169]
Log Average Quarterly Earnings during the boom	0.0626 (0.0035) [0.0185]	0.0631 (0.0033) [0.0209]
Boom Industry		
IT Manufacturing = 1	-2.7459 (0.1523)	-1.2700 (0.1437)
Software and Computer Services = 1	-0.5274 (0.0726)	-0.0984ns (0.0719)
Communication Services = 1	1.3689 (0.1019)	-1.6319 (0.0979)
Construction = 1	0.4434 (0.0615)	0.9587 (0.0589)
Non-IT Services = 1	-0.2387 (0.0344)	-0.5698 (0.0323)
Interaction Terms		
Log Ave. boom Earnings * IT Manufacturing	0.3030 (0.0165) [0.1082]	0.1338 (0.0156) [0.0651]
Log Ave. boom Earnings * Software and Computer Services	0.0936 (0.0077) [0.0462]	0.0075ns (0.0076) [0.0233]
Log Ave. boom Earnings * Communication Services	-0.1387 (0.0109) [-0.0225]	0.1694 (0.0104) [0.0768]
Log Ave. boom Earnings * Construction	-0.0336 (0.0069) [0.0086]	-0.00989 (0.0066) [-0.0118]
Log Ave. boom Earnings * Non-IT Services	0.0406 (0.0039) [0.0305]	0.0614 (0.0036) [0.0411]
Constant	-1.7671 (0.0315)	-1.4416 (0.0293)
Sample size = 3,150,731		

Notes: The "pre-boom" time period covers 1993-1995; the "boom" is 1996-2000, and the "post-bust" covers 2003-2005. All coefficients are significant at the 99 percent confidence level, except as indicated by "ns." Sample includes all workers with earnings during the boom period. Manufacturing (non-IT) is the excluded sector category. Entry means that the worker was absent from the Georgia work force for all of the pre-boom time period. Exit means that the worker was absent from the work force for all of the 3-year post-bust period. Marginal effects of a percentage change in quarterly earnings on each probability is in the brackets under the interaction term coefficients; the impact of earnings on the entry and exit decision of non-IT manufacturing workers is in the brackets under the coefficient for the non-interacted earnings regressor.

Appendix B: Percent of Workers That Did Not Exit Georgia and Were Not Employed in Their IT Boom Sector

Post-bust Industry	Boom Period Employment		
	Software and Computer Services	IT Manufacturing	Communication Services
Construction	3.11	2.73	4.77
Manufacturing	6.45	**19.05**	7.82
Transportation & Utilities	3.31	3.52	3.27
Wholesale Trade	10.57	11.00	8.53
Retail Trade	8.42	10.08	**13.47**
Financial	**15.65**	3.83	9.06
Information	9.64	7.42	9.65
Professional & Business Services	*31.01*	*31.25*	*30.43*
Education and Health Services	6.99	6.30	7.17
Leisure & Hospitality	3.22	2.93	3.62
Public Administration	0	0	0
Other Services	1.63	1.89	2.21

Source: Authors' calculations from data used for analysis.

Endnotes

[1] One of the earliest treatments was Thornthwaite (1934). Also see Blevins (1969), Zimmermann (1996), Boyd (2002), and Kyriakoudes (2003).

[2] An exception among the rural poor is found in Schafft (2005).

[3] White et al. (1990) provide an extensive discussion about the use of these employment data, commonly referred to as the ES202 file. These are the UI data being used by the BLS to construct the Business Employment Dynamics data file introduced at a BLS briefing 30 September 2003 (Bureau of Labor Statistics 2003). These data are also now referred to as the Quarterly Census of Employment and Wages by the BLS (see www.bls.gov/cew).

[4] Included in wages are pay for vacation and other paid leave, bonuses, stock options, tips, the cash value of meals and lodging, and in some states, contributions to deferred compensation plans (such as 401(k) plans). Covered employer contributions for old-age, survivors, and disability insurance (OASDI), health insurance, unemployment insurance, workers' compensation, and private pension and welfare funds are not reported as wages. Employee contributions for the same purposes, however, as well as money withheld for income taxes, union dues, and so forth, are reported even though they are deducted from the worker's gross pay.

[5] See Haltiwanger et al. (1999) for a collection of studies using these and other employer-employee matched data sets. These state administrative data have also been used to investigate employment and earnings among IT workers in California (Dardia et al. 2005) and North Carolina (Bowles 2004). Also see Perrins (2004).

[6] The classifications are based on those used in the Department of Commerce Report: *Digital Economy 2003*, with two modifications: Computer Training Schools are added to the Software and Computer Services category, and Computer Software Wholesalers and Retailers are included in Software and Computer Services instead of Computer Hardware.

[7] Collapsing the long panel into a cross-section of observations is primarily done to allow identification of a worker's industry during the boom period. There are other strategies to do this. For example, one could be identified as an IT worker during the boom if employed in that sector for at least one quarter or in that sector for all quarters during the time period. These options are clearly the extremes, and don't solve the problem of what to do with someone employed in multiple industries across the period. The construction of a worker's modal activity and model industry provides a reasonable approach to identifying the industry that best describes a workers' industry association during the IT boom period.

[8] This cut-off value was used in a study of Californian IT employment (Dardia et al. 2005). To also maintain the focus on a more "typical" IT worker, any worker whose earnings were top-coded at $100,000 per quarter was also eliminated. The earnings of 99 percent of workers fell well below this cap in every year.

[9] The "full-time" restriction applied in the boom time period is not enforced for identifying workers who were employed during the pre-boom and post-boom time periods.

[10] To the extent that physical migration is less costly for workers with more education (e.g., they have greater access to information), then more educated workers will exhibit greater tendency to migrate. For example, see Feliciano (2005) and Chiquiar and Hanson (2005).

[11] The use of observed earnings to control for unobserved human capital characteristics is referred to as taking a value-added approach to measuring human capital (Todd and Wolpin 2003). See Zoghi et al. (2004) for another labor market application of this methodology.

[12] These rates of turnover are consistent with those found in the literature. Abraham and Farber (1987) found that professional workers stay with the same employer for three years on average and blue-collar workers stay an average of two years; Light (2005) found that the average young worker changes employers about every two years, and Fallick and Fleischman (2001) also found the highest job change rate among construction workers and the lowest rate in manufacturing.

[13] Alternative, less stringent, definitions of entry and exit were investigated, with no appreciable difference in the conclusions presented here.

[14] The magnitudes of the percentages in Table 3 are not directly comparable to those in Table 2, since these two analyses are conditioning on employment and defining entry over periods of time of different lengths. However, comparing relative differences across industries is valid.

[15] A test of that specific implication is beyond the scope of this paper, but matched employer-employee data of the type used in the current analysis would be well suited to addressing that question.

[16] More information about the ATDC can be found at < http://www.atdc.org/> (accessed 10 December 2007). A failed development effort--the Yamacraw Cluster, launched in 1999--arrived relatively late in the IT boom and likely suffered its fate as a result of being more reactionary than visionary in its initiation. More information about

the Georgia Research Alliance, which coordinated the development of the Yamacraw Cluster, can be found at < http://www.gra.org/homepage.asp> (accessed 10 December 2007).