

# Evaluating Local Job Creation

This article introduces economic development planners to a new approach to evaluating local job creation efforts, an approach that explicitly considers the chains of employment vacancies that open up when new jobs are created. This "job chains" model is an analytic framework for assessing the employment impacts associated with economic development programs and the social value of those impacts. The approach focuses on measuring the wage gains to job changers and placing realistic values on jobs for those not previously employed in the area. It explicitly considers both efficiency and distributional effects of job creation. We discuss the simple mechanics of the technique and present an example relating to the establishment of a large auto plant in a major Midwestern city. We conclude with practical ground rules for planners carrying out a job chains analysis of an economic development effort.

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## A "Job Chains" Perspective

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**E**conomic development officials are often called upon to assess the employment effects of local economic development programs. Invariably, jobs are the yardstick used to measure changes in local economic welfare. However, in the absence of any real understanding of the social value of these jobs, evaluations of economic development programs can easily degenerate into a numbers game. Simply counting all the new jobs, income, and taxes associated with a program does not address how much local workers actually benefit.

This article introduces the planning community to a new perspective on the evaluation of job creation programs, a perspective grounded in a "job chains" model. While based in theory, the approach has real implications for practice. It considers the entire chain of job vacancies opened when a job is created in a local labor market. A new job generates a game of musical chairs which provides a number of workers opportunities to improve their welfare through job moves; hence we argue that the aggregate improvement of all workers is the best measure of local welfare gain.

The article begins by surveying current methods for evaluating local job creation and locates the job chains approach within the context of contemporary evaluation practice. We then describe the mechanics of the job chains approach, including the model's assumptions, data requirements, and limitations. We present an example that illustrates the efficiency and distributional effects associated with attracting a foreign-owned auto manufacturing plant to a large urban area in the Midwest, showing how readily the job chains model can be applied to real situations. We conclude with some ground rules for practicing economic development planners grappling with the difficulties of evaluating job creation. These rules underscore the need for more comprehensive economic development evaluations and emphasize the very real limitations on existing efforts.

## Current Practice in the Evaluation of Local Job Creation

Traditionally, practitioners evaluating local job creation have used impact analysis, estimating the change in employment (or income) in a given area that arises from a particular economic stimulus (Davis, 1990). The analyst establishes

a baseline and then measures the gross change due to the introduction of the new project or program, commonly equating new jobs and new income with program benefits (Markely & McNamara, 1995). Such an approach often overlooks who benefits from the program, and just how much better off they are. Understandably, the academic literature has raised doubts about the value of simple job counting (e.g., Courant, 1994; Haveman & Krutilla, 1968).

Cost-benefit analysis may provide the most natural framework for extending impact analysis into a full evaluation of local job generation (Bartik, 2005; Swales, 1997; Willis & Saunders, 1988). While impact analysis typically overstates gains from new employment, cost-benefit runs the risk of underestimating them by exaggerating the alternatives for workers. Often, cost-benefit analyses assume full employment and thus rule out gains from job mobility (Felsenstein & Persky, 1999). In our view, even careful cost-benefit studies tend to underestimate gains to local workers from job chains. As we demonstrate below, such chains can be integrated into the standard logic of cost-benefit analysis.

In recent years, the increased availability of disaggregated micro-level and geo-referenced data, along with greater processing and visualization capabilities, have improved ex post analyses of completed economic development projects and well-established programs. In addition, advances in econometrics and spatial modeling have allowed analysts to take issues of endogeneity, experimental design, spatial dependence, and selection bias into account in their evaluations (Boarnet, 2001; Rogers & Tao, 2004; Sohn & Knaap, 2005).

These advances improve understanding of what the world would be like in the absence of the policy or program being evaluated, a critical element in careful evaluations. While early ex-post evaluations of job creation effectively ignored the counterfactual (Rubin, 1991), many subsequent studies have increasingly incorporated quasi-experimental control methods or econometric controls. For example, in evaluating the employment and income impacts of enterprise zones, analysts match zip codes or counties that contain enterprise zones with areas that have no enterprise zones to control for the extraneous effects of local socio-demographic characteristics and economic structure on the job creation impacts of the zones (Greenbaum & Engberg, 2004; Papke, 1994). One recent study matches individuals employed by enterprise zone companies with similar individuals who are not so employed to estimate income effects attributable to the enterprise zones (Bostic & Prohovsky, 2006). Others use econometric controls to distill the employment effects of enterprise zones and to correct for endogeneity and selection bias<sup>1</sup> (Boarnet 2001; Boarnet &

Bogart, 1996; Rogers & Tao 2004; Sohn & Knaap, 2005). This increasing technical sophistication has resulted in steadily declining employment growth estimates for enterprise zones. Still another approach is to estimate the counterfactual using a revealed-preference control group. Greenstone and Moretti (2003) compare counties that successfully compete for footloose industrial investment to those that are unsuccessful. Thus rather than matching on observed variables or using regression methods to compare winner counties to all others, their control is based on the assumption that near losers closely resemble the winners, thereby adjusting for differences in the pre-existing playing field.

By and large, these improvements in ex-post evaluations have provided little help in ex-ante evaluation. In principle, the results of ex-post studies can be used to provide key parameter inputs to evaluations done as part of the planning process, prior to actual implementation. In practice, such complementarities have yet to be fully explored. Such ex-ante applications will require a more explicit theoretical model of local labor market processes.

Rather, current practice still relies on impact and cost-benefit analyses for ex-ante evaluations. But such studies have themselves become more sophisticated, increasingly considering demand displacement, opportunity costs (i.e., the value of inputs in their next best alternative use), and distributional effects (see Reese & Fasenfest, 2004).

Both impact analyses and cost-benefit studies consider demand displacement, offering a range of options for assessing how new jobs interact with the existing labor market. These include author assumptions (Willis & Saunders, 1988), survey responses (Lenihan, 1999), location quotients (to measure export activity; Persky, Ranney, & Wiewel, 1993), spatial interaction estimation (Thompson, 1983), and imported parameters such as regional purchase coefficients generated by input-output models (Persky, Felsenstein & Wiewel, 1997).

It is methodologically challenging to incorporate opportunity costs into the evaluation of local job creation, and thus it is done only inconsistently. In impact analyses, opportunity costs of capital are either ignored or proxied by the rate of return on long-term investments (Dewar & Hagenlocker, 1996; Howland, 1990; Willis & Saunders, 1988) while labor opportunity costs are commonly assumed to be zero (Johnson & Thomas, 1990; Mondello & Rishe, 2004). Cost-benefit studies address opportunity costs of capital directly when they specify a social discount rate (Willis & Saunders, 1988), but are less likely to include opportunity costs for labor. When they do, they often use the reservation wage as a proxy (Bartik, 2005; Sridhar, 1996; Swales 1997).

Improving overall welfare and its distribution across society are the much heralded benefits of economic development progress (Courant, 1994; Partridge & Rickman, 2003). However, in practice, whether or not programs actually achieve them has been evaluated in a rather sketchy manner. Change in local income by income class and the redistribution of jobs from low to high unemployment areas are two typical indicators, but neither has been used frequently. Analysts have operationally defined an improvement in local welfare in a wide variety of ways, including a net reduction in unemployment claims (Papke, 1994), a larger share of new jobs going to local residents (Rephann, Dalton, Stair, & Isserman, 1997), growth in taxable property values (Greenstone & Moretti, 2003; Loh 1993), and others. Bostic and Prohofsky (2006) come closer to defining net welfare increase by analyzing a difference-in-difference of incomes between workers hired under the California enterprise zone program and a group of matched non-participants, however they do not consider possible indirect effects on local non-participant workers.

In sum, despite some notable technical advances in ex-post analysis, scholars still view ex-ante economic development evaluation with dissatisfaction. Some criticism revolves around technique and method (Organization for Economic Co-operation and Development, 2004), while other critiques focus on questions of scope and breadth of evaluation (Reese & Fasenfest, 2004). Key to this dissatisfaction is the lack of a disaggregated model of local labor market dynamics. Without such a model it remains unclear whether policies and programs attain even the most basic local economic development goals, such as job creation. The job chains model suggests a theoretical framework consistent with the realities of involuntary unemployment and underemployment.

The evaluation frameworks also fall short in guiding practice. The lack of an evaluation model of the labor market in the literature leaves practitioners ill-equipped to decide between aiming for high wage or low wage jobs, jobs for locals or for commuters, and jobs that reduce local unemployment or increase local purchasing power. Even if an evaluation is able to show local employment growth in the aggregate, the planner is still without a guide as to how this concentration of jobs within the area benefits or harms the various local subpopulations.

## The Job Chains Model in the Context of Current Practice

Economic development projects are expected to create new jobs. This ensures that they will get political support,

since most communities value job creation. But simple job counting is hardly an adequate evaluation technique, and will not ensure that these efforts retain support. An evaluation approach capable of offering socially meaningful insights into the workings of the local labor market would inform practice far more. The job chains model offers such insights.

The job chains model of the local labor market assumes an open economy<sup>2</sup> characterized by slack in the labor market (involuntary unemployment and under-employment). It says that each new job created triggers a chain of job changes as workers move into new positions, leaving behind vacancies to be filled by others. In such a world of job chains and vacancies, the value of the new jobs created can be evaluated by measuring the welfare gains due to movement along a chain.

The job chains model offers practical new insights to supplement existing evaluation approaches. It results in a more precise accounting of gains from job creation and extends some of the evaluation concepts and indicators familiar to practitioners. These insights are far more than simply technical. Job chains supplement and extend current evaluation practice in the following three substantive areas in particular.

First, the job chains approach revisits and reinterprets the concept of the job multiplier. This is a key indicator of economic development evoked in many impact studies. Standard impact analysis focuses exclusively on traditional multipliers, which illustrate how the effects of a program spread as jobs are created among suppliers. The job chains model supplements traditional multiplier analysis by adding a set of vacancy multipliers. These vacancy multipliers illustrate how new jobs create mobility for chains of workers, each moving up to a new position.

Second, job chains force a reconsideration of the "all or nothing" approach characteristic of much impact assessment. As noted earlier, many impact evaluations fail to recognize that most workers at new jobs created by economic development policy would have found alternative employment in the community or outside it. When they overlook this, they presume the welfare gain to the individual worker from a new job will be equal to that worker's wage, though this is not generally true. Rather it will be a much smaller amount, equal to the difference between wages on the new job and the worker's wage in his or her next best alternative. In the extreme case of smooth and perfectly functioning labor markets, these alternative wages will be close to the wage level in the new job, making the welfare gain to the individual employed in the new job very small. Indeed, this is why in a fully employed labor market, wages are not only a private cost to the business, but a social

cost as well. In the full employment case, wages indicate the value of alternative production given up when a worker shifts to a new enterprise. Simply counting additional employment without addressing alternative opportunities for this resource teaches us very little about the efficacy of economic development programs (Courant, 1994).

Cost-benefit analysts, by contrast, often define the opportunity cost of taking a new job as the *reservation wage*, or lowest wage at which the worker would accept employment. Empirical estimates of reservation wages of job seekers are generally quite high. Some claim a figure as high as 90% of wages actually achieved (Bartik, 2005; Jones, 1989). Others suggest lower figures, but still well above zero (Hodge, 1982; Sridhar, 1996). Thus cost benefit analyses using reservation wages often conclude that the actual welfare gains from new local employment are likely to be modest if not negligible.

The job chains approach suggests that one way out of this all or nothing dichotomy lies in recognizing that in real world labor markets, creating a new job begins a chain reaction that will affect many workers in addition to those who actually obtain the newly created jobs. In a less than fully employed economy, a tightening in the labor market allows underemployed workers all along the line to move up. In this respect, the job chains perspective effectively bridges the gulf between the impact analysis and reservation wage approaches. The worker who gains a newly created job may improve his or her condition only marginally, but in turn other workers find their positions improved as they move up a job ladder. Admittedly, the sum of all these gains is still likely to fall short of the total wages the new jobs pay, wages commonly identified as benefits by impact analysis. As so often is the case, the answer lies somewhere in between two extremes.

Third, the job chains model forces a reconsideration of the linkage between the efficiency and distribution outcomes of job creation. A subtle point, lost in many job evaluation efforts, is that efficiency and distributional issues are closely interrelated. A benefit-cost ratio that is greater than 1, commonly taken to indicate efficient use of resources, is specific to a given income distribution. If the income distribution were to change, the value of the benefit-cost ratio would change as well. For example, the poorer and less employed inner-city residents are, the greater the employment benefits from a new inner-city manufacturing plant will be.

The job chains approach begins by disaggregating workers in order to make explicit the differences in opportunity costs associated with different classes of labor. In this way it integrates distributional and efficiency concerns. It adjusts for the fact that high earners have higher oppor-

tunity costs and other alternatives for earning at a similar level, while low-wage workers have few alternative opportunities and therefore a greater share of their new wages represent real gains. While these adjustments reflect distributional considerations, they are central to measuring efficiency.

A job chains approach will not solve all the problems of evaluation. Moreover, like any tool, a job chains model is subject to estimation errors. We return to these limitations on practical applications in our concluding section.

## The Job Chains Model: Assumptions, Data, and Method

A job chain is an analytic device that lets us estimate the amount of movement triggered by a new job and record the traffic in and out of newly created vacancies. Two key assumptions of the job chains approach are the existence of persistent involuntary unemployment and underemployment and a relatively stable wage structure.<sup>3</sup> A new job will generate a chain-like sequence of moves in the local labor market. For example, when worker *A* moves to new job *i*, he or she vacates job *j* for worker *B* who moves in, thereby vacating job *k* for worker *C* and so on. In this approach every new job *i*, whether direct, indirect, or induced, is a starting point for a vacancy chain. Each job chain will continue until it is broken by a worker moving into a new job without creating a local vacancy, as would happen any time a job were taken by an in-migrant to the local area, an unemployed worker, or someone who had not previously been in the labor force.<sup>4</sup>

The chain metaphor has been used to analyze a wide variety of markets involving durable goods such as housing (Forrest & Murie, 1994; Millard-Ball, 2002; White, 1971). Since every house has an address, housing chain research can proceed in a straightforward fashion, charting and mapping who moved into new units and what units they vacated in order to do so. A housing chain ends when the household occupying one unit does not vacate another locally, either because they are new to the area, they are forming a new household, or their previous residence is demolished. In each of these cases, no vacant replacement unit perpetuates the chain. Once researchers identify an average chain for each type of new house in an area, they can begin to quantify who has benefited and how much they gain on average from the new construction. Benefits accrue not only to the households moving into the new homes, but also to those who move up along the chains. A variant in the local economic development literature focuses on such chains in commercial and office real estate

markets, but mainly emphasizes filtering effects (Greenhalgh, Downie, Fisher, & Barke, 2003; Robson, Bradford, & Deas, 1999).

In principle, job chains generated by new employment growth could also be mapped. However, in the case of employment, data that would make this possible are not generally collected. While housing researchers can trace households moving from one address to another, it is extremely difficult to look at who passes through individual jobs as people move up job ladders because data on jobs are not maintained that way. The empirical problem is similar to that encountered in input-output (I-O) research. In these studies, researchers do not go back through the actual market transactions at every stage of production for a given good. They do not actually track the sale of cloth to the apparel firm, preceded by the sale of cotton to the textile firm, preceded by the sale of petroleum to the cotton farmer, and so on. Rather, they estimate an expected set of inputs for each industry, and assume that this set will remain constant whatever the use of the industry's product. Given these assumptions, they can then use Leontief's approach to calculate the total requirements for the production chains needed to supply additional demand, and from these calculate the well known production multipliers.<sup>5</sup>

To accomplish this for job chains, we must define and measure the equivalent of the I-O input set for each new job type. We do this by breaking jobs into groups based on wages (as a measure of quality), and asking what proportion of job vacancies at the highest level (1) are filled by workers currently employed at level 2, level 3 and so on. Such movements are made possible by the existence of substantial underemployment, meaning that some workers at lower levels are fully qualified to take higher level vacancies as they appear. We need to know the types of new jobs and old jobs for only a sample of job changers.<sup>6</sup> Following the I-O model, we now assume that the probability of a given link in a job chain (e.g., the probability that the vacancy at level 3 is filled by a worker previously employed at level 5) depends only on the level of the vacancy to be filled (level 3 in the previous example), and not on any other characteristics of the chain (such as the level of the new job which began the chain). With this key assumption, we need no further information concerning job chains, but can estimate the number of vacancies created at each level, for any new job.

This approach to job chains greatly simplifies the empirical requirements. In recent work (Persky, Felsenstein, & Carlson, 2004), we used data on job moves by household heads and their spouses from the Panel Study of Income Dynamics (PSID) to construct input sets for an average state<sup>7</sup> for five classes of jobs defined by wage level. To

construct the input column for a given job level, we only needed information on job changers, and observations from a representative sample of unrelated links in job chains, not entire job chains. Such data are available from workers' longitudinal job histories. For the period observed (1987–1993), the PSID contains data on roughly 3,600 job moves. This allowed us to estimate all the relevant coefficients of a job recruitment matrix (Table 1), our job-chain equivalent of an I-O input matrix. Not surprisingly, the largest percentage in each column falls along the diagonal, showing that between 30 and 50% of new hires were already employed locally at the same wage level. These people experience very modest wage gains. From the PSID we estimate that within-level job changers improve their wages by only 2% on average. Noteworthy local welfare gains come when workers move up to a higher level, or take a job after being unemployed or out of the labor force, or migrate in to the area.<sup>8</sup> Note that the percentage of gross hires who are in-migrants in Table 1 is considerably less than the ratio of in-migrant workers to net new jobs reported by Bartik (1991), a figure which does not reflect the potential for upward movement through job chains.

Table 1. Job recruitment matrix: Percentages of workers hired into each wage level by previous job status.

Hired from	Hired to				
	Wage level 1	Wage level 2	Wage level 3	Wage level 4	Wage level 5
Wage level 1	41.1%	0.0%	0.0%	0.0%	0.0%
Wage level 2	25.0%	52.9%	0.0%	0.0%	0.0%
Wage level 3	4.8%	22.1%	46.6%	0.0%	0.0%
Wage level 4	2.2%	1.5%	18.5%	47.3%	0.0%
Wage level 5	0.0%	0.3%	2.4%	13.3%	34.5%
Unemployed	2.9%	3.8%	9.7%	15.8%	24.7%
Out of labor force	4.0%	3.8%	7.5%	13.5%	30.5%
In-migrant	20.1%	15.6%	15.4%	10.0%	10.2%
Total	100.0%	100.0%	100.0%	100.0%	100.0%

Notes:

- Wage level 1 is the highest level, and level 5 is the lowest level.
- We set all entries above the diagonal to zero, meaning we allowed no downward job movement. Instead, we distributed the relatively small number of downward movers proportionally across the categories of other job changers.<sup>7</sup>
- Because the source data were from the period 1987 to 1993, this represents an average across the business cycle.

Source: Calculated by the authors from job changes identified in the PSID (see Persky et al., 2004).

With the aid of this input matrix it is relatively straightforward to estimate the expected number of vacancies creating a job at a given level will open at each wage level. These simulations are exactly analogous to the calculation of multipliers in I-O analysis; thus we call them job chains multipliers. For example, a newly created job at level 3 is associated with an average chain of 2.73 vacancies, including 1.87 vacancies at level 3 itself, 0.66 vacancies at level 4, and 0.20 vacancies at level 5 (Table 2). The average chain of a new level-3 job is terminated by the hiring of an unemployed worker, someone from outside the labor force, or someone moving into the area. Perhaps not surprisingly, high-wage jobs (level 1) give rise to longer chains than low-wage jobs (level 5). But a chain's value derives not from its length, but from the welfare gains it produces.<sup>9</sup>

We calculate the average welfare gain to those who move to new jobs at each wage level from other local employment simply by calculating the difference between their old and new wages, using PSID data. It is more difficult to value the gains to those taking new jobs after being unemployed, outside the labor force, or outside the region. To understand welfare gains to these groups we must evaluate the alternatives available for such workers. Using national data, we first estimate the influence of individual worker attributes (including sex, age, age squared, and education) on wages. We then use these results to predict what wages the unemployed would get if they were working, based on their characteristics. This allows us to calculate an unemployment rate for each wage group (Perksy et al., 2004). Based on these unemployment rates,

we assign opportunity costs of the next best alternative to working. These range from 25% of the wage for the lowest level workers to 75% of the wage for the highest level workers.<sup>10</sup> We use these assumptions about opportunity costs to discount the welfare gains to the unemployed, new entrants to the labor force, and in-migrants taking jobs at each level.

Using our estimates of the average total welfare gain and numbers of job chain vacancies at each level resulting from creating one initial job at a given wage, we construct estimates of total welfare gain associated with a new job at each level. These are expressed in Table 3 as shares of the average wage for jobs at each level. Hence they can be used to discount the results of a standard impact analysis, which would count all wages of new jobs as local welfare gains. We estimate that new jobs at the highest levels (1 and 2) generate welfare gains equal to about 43 cents per dollar of wages. At the lowest levels (4 and 5), these benefits rise to more than 60 cents per dollar of wages. On average a job is worth about 50 cents per dollar of wages. Thus the common practice of counting all new wages as net benefits considerably overstates welfare gains, exaggerating gains from high-wage jobs more than for low-wage jobs.

## A Worked Example

The job chains model provides a useful extension of the more traditional forms of impact analysis currently used by economic development planners. To clarify this and to illustrate how the model works in practice, we present an extended example.

The client in our example is a Chicago economic development authority, charged with evaluating the impact of a proposed 1,500-worker automobile plant to be located in the city.<sup>11</sup> While wooing an auto assembly plant sounds a lot like smoke-stack chasing, this form of economic development strategy continues to rank high on the agenda of many regional and local economic development agencies (Greenstone & Moretti, 2003; Hanson, 1993). As noted earlier, agencies are likely to evaluate such efforts using impact analysis to obtain multipliers and predict fiscal effects (University of South Carolina, 2002), or cost-benefit analysis (Marvel & Shkurti, 1993). Because of the stakes involved, such evaluations are also sometimes manipulated to obtain desired results (Connaughton & Madsen, 2001).

A full evaluation of a project of this scope would normally include estimation of a broad range of benefits and costs: employment and earnings effects, tax revenue enhancement at the state and local level, and fiscal impacts including infrastructure requirements. Here we focus only

Table 2. Job chains multipliers, by wage level.

Job chain vacancies created in	New jobs created at				
	Wage level 1	Wage level 2	Wage level 3	Wage level 4	Wage level 5
Wage level 1	1.70				
Wage level 2	0.90	2.12			
Wage level 3	0.52	0.88	1.87		
Wage level 4	0.28	0.37	0.66	1.90	
Wage level 5	0.08	0.12	0.20	0.39	1.53
Total job chain multiplier	3.48	3.48	2.73	2.28	1.53

### Notes:

a. Wage level 1 is the highest level, and level 5 is the lowest level.

Source: Derived from Table 1. See Persky et al., 2004.

on the employment and earnings effects, since these are where job chains analysis can improve the estimates. By choosing the example of a new automobile plant we have avoided the need to address jobs lost when pre-existing local firms are displaced, since an auto plant is unlikely to compete with existing firms in the region for local markets.

For this exercise the job chains model is linked to a Chicago economic development cost-benefit evaluation model.<sup>12</sup> To use the job chains estimates we described in the last section we need a local model that predicts new jobs for the same five wage levels, both for the expected jobs in the new plant (direct jobs) and those created through the multiplier process (indirect and induced jobs). The Chicago cost-benefit model does this for both employment and earnings. The city, of course, is concerned with jobs and wages for city residents although many new jobs will be taken by commuters. Of the 1,500 basic jobs in the motor vehicle plant, the model estimates that 915 will go to city residents. In addition it predicts that city residents will obtain 832 new jobs generated in the indirect and induced sectors, reflecting a jobs multiplier of 1.91. The earnings multiplier is somewhat lower at 1.56 because of the lower wages in many of the induced service activities. Table 4 shows how the model distributes these jobs across wage categories based on census data for earnings in the automotive industry in the first row and also including all industries with indirect and induced jobs in the second row.

Perhaps not surprisingly, jobs in the automobile plant are more concentrated in wage levels 2, 3, and 4 than are the indirect and induced jobs. The distribution of earnings in Table 5 shows the same thing. Just as Table 4 shows the total new jobs the project causes, Table 5 includes a figure for the present value (in 2006 dollars) of the total new wages to city residents as a result of the project. Dividing the latter by the former gives per-worker wages for the auto plant workers averaging a bit below \$40,000 per year, and for indirect and induced workers a bit below \$25,000 per year.

Up to this point, the analysis has been fairly standard. As often done in impact studies, every dollar of these new wages has been counted as a benefit. However, such calculations fail to take account of the opportunity cost of workers and the vacancy chains generated by new jobs. A job chains analysis addresses both these issues, and can be connected to a standard cost-benefit approach like the one in this example simply by using the forecast of new jobs as a starting point for calculating the effects of job chains. Based on the wage levels paid in the new auto plant, and using the job chains multipliers in Table 2, we see that each new direct job creates about 1.5 additional vacancies

Table 3. Total local welfare gain as a percentage of the wage of the initial job, by wage level.

	New jobs created at				
	Wage level 1	Wage level 2	Wage level 3	Wage level 4	Wage level 5
Total welfare gain as % of wage	43%	42%	56%	62%	69%

Notes:

a. Wage level 1 is the highest level, and level 5 is the lowest level.

Source: Persky et al., 2004.

Table 4. Distribution of new jobs<sup>a</sup> by wage level.

		New jobs created at				
		Wage level 1	Wage level 2	Wage level 3	Wage level 4	Wage level 5
Direct	915	3.7%	11.9%	29.5%	39.7%	15.2%
Total	1747	5.0%	10.7%	29.3%	36.1%	18.9%

Notes:

a. These are the jobs forecasted by the conventional model and do not include job chains.

b. Wage level 1 is the highest level, and level 5 is the lowest level.

Source: From a simulation using the Chicago Cost-Benefit Model.

Table 5. Distribution of earnings from new jobs<sup>a</sup> by wage level.

		New jobs created at				
New job earnings		Wage level 1	Wage level 2	Wage level 3	Wage level 4	Wage level 5
Direct	\$239.5 million	9.3%	14.1%	38.0%	34.8%	3.7%
Total	\$374.3 million	14.6%	14.1%	35.3%	30.0%	6.0%

Notes:

a. These are the jobs forecasted by the conventional model and do not include job chains.

b. Wage level 1 is the highest level, and level 5 is the lowest level.

Source: From a simulation using the Chicago Cost-Benefit Model.

on average. Thus the 915 new auto jobs for Chicago residents initiate a set of vacancy chains resulting in an estimated 1,361 additional openings available to Chicago residents.<sup>13</sup> Since indirect and induced jobs also generate vacancy chains, the 1,747 total new positions the project creates generate a total of 4,295 vacancies. The job chains multipliers allow us to break these down into vacancies by wage level as shown in the next to the last line of Table 6. While only 15.2% of the auto plant jobs were at the lowest wage level (Table 4), 20.5% of the 4,295 total vacancies are opened at this level.

Using our basic job recruitment matrix (Table 1), we easily disaggregate these vacancies further into cells showing the number of workers expected to move from any wage level or non-local employment status to any wage level among the new job vacancies created by the project or the resulting job-chain-created vacancies. Each cell in Table 6 is computed by multiplying the column sum by the corresponding entry in Table 1. Thus the entry listed in the column "Vacancies created at: Wage level 3" for the row "Previous employment status: Employed at wage level 4" (216) should be interpreted as the job chains model's prediction that 216 workers living in the city will move from jobs paid at level 4 to jobs paid at level 3 as a result of the new auto plant locating in the city. Some of these job movers will work at the plant, some for plant suppliers, and some for businesses that lost workers to better opportunities in the chains. Thus the analysis includes all changes to the city labor market we expect to result from the establishment of the auto plant. These estimates pro-

vide considerable information on the likely labor market consequences of the plant location. For example, local employment agencies can use them to plan labor placement activities if the plant locates in Chicago.

These predictions also allow us to go on to estimate the economic value of the new vacancies to Chicago residents. The welfare gain for each cell in Table 6 can be estimated as the product of the number of job changers (the cell value in Table 6) and the difference between the wages of the new job and the opportunity costs to those filling the vacancy. Adding these values for all of the cells, Table 7 shows that we estimate the \$374 million increase in direct and indirect earnings the project will generate over 7 years (the standard time frame for discounting in cost-benefit analyses) will result in a welfare gain less than half as great, at just \$162 million. Of this, \$85 million will be generated by chains beginning with new direct jobs, with the remainder from chains connecting to indirect and induced jobs.

Table 7 uses the previous table to calculate how these gains are distributed. It shows a modest increase over Table 5 in the share of welfare gains going to low wage workers. Table 8, breaks down the same gains shown in Table 7 according to wage levels at which those filling the vacancies were previously employed. This result is a much clearer estimate of the distributional effects of job creation through the city's labor market. Workers starting at the lowest wage level before the project receive nearly one fourth of all the gains, and together with the next higher level of workers, account for over 60% of all the gains.<sup>14</sup>

Table 6. Total vacancies created by the project and resulting job chains, by destination wage level and previous employment status.

Previous employment status	Vacancies created at					Total	%
	Wage level 1	Wage level 2	Wage level 3	Wage level 4	Wage level 5		
Employed at wage level 1	61	0	0	0	0	61	1.4%
Employed at wage level 2	37	251	0	0	0	288	6.7%
Employed at wage level 3	7	105	544	0	0	656	15.3%
Employed at wage level 4	3	7	216	768	0	994	23.1%
Employed at wage level 5	0	2	27	216	304	550	12.8%
Unemployed	4	18	113	257	218	610	14.2%
Outside labor force	6	18	88	220	269	600	14.0%
In-migrants	30	74	180	163	90	537	12.5%
Total	148	475	1,168	1,624	881	4,295	
%	3.4%	11.1%	27.2%	37.8%	20.5%		

Note:

Wage level 1 is the highest level, and level 5 is the lowest level.

Table 7. Percent distribution of welfare gains from jobs created by the project and resulting job chains, by wage level of destination jobs.

Welfare gains due to		New jobs created at				
		Wage level 1	Wage level 2	Wage level 3	Wage level 4	Wage level 5
Direct employment at the auto plant	\$85.0 million	8.3%	15.9%	33.9%	33.2%	8.7%
Total jobs	\$162.3 million	11.1%	14.3%	33.7%	30.2%	10.8%

Note:

Wage level 1 is the highest level, and level 5 is the lowest level.

The job chains calculations allow us to understand not only who gets the newly created jobs, but also who moves up to better positions through job chains generated by these new jobs. The result is a more accurate picture of the total gains from the project, as well as a simple system for understanding their distribution.

## Conclusions: Ground Rules for Practicing Economic Development Planners

As noted above, it is appropriate to use the job chains approach as a supplement to, rather than a replacement for, the existing ex-ante approaches to evaluating economic development proposals (including impact analysis, cost-benefit analysis, and cost-effectiveness analysis). To operationalize a job chains model, use a tool such as a local input-output model to predict jobs expected from an economic development project and categorize them into wage classes. The job recruitment matrix (Table 1) determines the lengths of job chains shown in Table 2. Use the job recruitment matrix to determine the share of the predicted vacancies likely to be filled by local workers at

each wage level or others, including new entrants to the labor force, the unemployed, or in-migrants. Although these two tables are small, they distill a substantial amount of information from the PSID and are critical to the results. Thus we caution against making local adjustments without a thorough understanding of our methods and a dataset of equal or better accuracy and completeness. Finally, estimate total welfare gains using a simple spreadsheet-based accounting procedure. At this stage it may be valuable to consider local unemployment rates in making assumptions about workers' opportunity costs.

## Caveats

Appending the job-chains model to a standard impact analysis does not raise any particular technical challenges. However, economic development planners should be aware of the limits of the model and its potential for misuse. We note several cautions in particular.

**Treatment of opportunity costs.** We handled this issue quite informally. Though we estimated the job recruitment matrix empirically, and it seems robust to regional and cyclical variation (Persky et al., 2004), we derived estimates of opportunity costs deductively, from an admittedly simple model of involuntary unemployment. While we

Table 8. Percent distribution of welfare gains from jobs created by the project and resulting job chains, by wage level of new hires before they changed jobs.

Welfare gains due to		Wage level of new hires before changing jobs				
		Wage level 1	Wage level 2	Wage level 3	Wage level 4	Wage level 5
Direct employment at the auto plant	\$85.0 million	2.2%	7.3%	27.8%	39.0%	23.7%
Total jobs	\$162.3 million	3.0%	7.7%	27.6%	36.8%	24.9%

Note:

New hires not previously employed in the area are classified with the wage group they eventually join. Wage level 1 is the highest level, and level 5 is the lowest level.

have conducted initial sensitivity analyses of these estimates, there is still considerable room for a more formal approach to estimating opportunity costs, perhaps using quasi-experiments.

**Localization of the recruitment matrix.** At present, the recruitment matrix (Table 1) is based on national average probabilities for workers grouped by wage level. It would be desirable to have a local variant of this table, but this would require a much larger sample of job movers that could be disaggregated by geography and wage groups. In most cases, we believe that locally specific data would not improve analysis based on the national recruitment matrix sufficiently to justify the cost of obtaining it. However, it is conceivable that local surveys of employers making job hires could be used to rescale the local share of gross placements of in-migrants to the area in the recruitment table, improving local accuracy of the results.

**The absence of ex-post validation.** While the job chains approach primarily serves ex-ante evaluation, a natural extension would be to ex-post analysis. This would allow validation of the model and more transparency in the evaluation process.

**The absence of a pricing mechanism.** Economic theory predicts that changes in demand for labor will affect its price. However, the job chains model assumes sticky prices, with producers willing to increase production for fixed mark-ups or rents. Thus the chain model lacks the formal maximizing behavior of firms and individuals so characteristic of labor market models. This may intuitively appeal to economic development planners, but the lack of any model closure or market-clearing mechanism is likely to provoke criticism from those trained in economics. In defense of the job chains model, we note that most economic development efforts are not of a scale to substantially change the prices of labor in a metropolitan area.

**Political misrepresentation.** In contrast to ex-post evaluations, whose results often generate public criticism of the project or program being evaluated, politicians are generally partial to ex-ante analyses. Job chains multipliers tend to be larger than standard impact analysis multipliers, as they account for all the vacancies derived from new employment, and planners should be careful to distinguish job chain vacancies from net new jobs. At the same time, the job chains model emphasizes that local welfare gains are typically much less than the total of all wages from net new employment. Again, planners should be careful to emphasize the difference and correct selective misinterpretations. Finally, the job chains model itself does not address the critical question of what the future state of the world would be without the project or program being evaluated. Opponents have reason to minimize the estimates of

genuinely new employment caused by the economic development initiative, while supporters may succumb to political temptations to overstate project-related employment growth. The job chains model cannot correct such initial errors, and will be most accurate if it includes all and only the genuinely new employment.

Economic development planners can readily put the job chains approach to work, but need to understand the very real limitations of the model. Transparency is important in economic development evaluation, and is a planning objective the model can promote if properly applied.

## Notes

1. Endogeneity and selection bias arise from pre-existing differences between areas inside and outside the zones, the administrative processes by which zones are designated, or self-selection among qualifying zones.
2. Strictly speaking, the model allows only for in-migration of workers and assumes that out-migration is exogenous, a common assumption in urban and regional studies (Lowry, 1966).
3. A further assumption is that worker quality is constant within each wage group. Thus fluctuations in labor market conditions will not afford employers any gains or losses.
4. The possibility exists that an in-migrant may not end a chain. This will occur when an in-migrant would have moved to the region and taken a job even if no new jobs had been created by the policy or program being evaluated. To the degree that this happens and is overlooked, analysts will undercount the length of job chains. It is also possible that an out-migrant might end a chain. This could happen if a worker who otherwise would have left the area decides to stay as a result of a new position. Overlooking such cases will cause the analyst to overstate the length of the job chain. We hope these errors offset each other, as we cannot measure either type.
5. More formally, given the matrix of input coefficients  $A$ , the total requirements generated by any vector of final sales  $X$ , is the vector  $Y = (I - A)^{-1}X$ .
6. We had originally hoped to identify jobs by a range of characteristics in addition to wage level. Workers are interested in fringe benefits, working conditions, and job quality as they make decisions about job moves. The present study considers only wages, because we were unable to obtain detailed characteristics of current and previous jobs for a large sample of job changers. We hope to explore these questions in future research.
7. These are national data, but the in-migration category covers anyone who changes their state of residence or moves between metropolitan and non-metropolitan areas.
8. Note that all entries above the diagonal in Table 1 have been set to zero, i.e. we allow no downward job movement. This is not to say that downward movements do not occur, but rather that they are not caused by the creation of a new job. A new level-3 job does not create a level-2 vacancy. Rather, most such moves are involuntary, raising the question of where the person losing the level-2 job would have landed in the absence of the level-3 job.
9. The formal calculation of the gross number of vacancies  $C$ , created by any set of new jobs  $N$ , is exactly analogous to the calculation of total requirements using the Leontief approach:  $C = (I - Q)^{-1}N$  where  $Q$  is the job recruitment matrix.

10. This range of opportunity costs reflects the low unemployment rate of highest wage group (estimated at 2.5%) and the very high unemployment rate (estimated at 19.5%) of the lowest wage group. The former have considerably more attractive alternatives than the latter. While this range is not precisely estimated, sensitivity analyses suggest the results we obtained from it are highly robust (see Persky et al., 2004).

11. Recently, Honda announced a search for a new site for a 1,500-worker plant in the Midwest. This example is stimulated by that search. The example presented here was not done for the city economic development agency and is not meant to be a full evaluation of any specific proposal.

12. An early discussion of this tool can be found in Persky, Wiewel, and Felsenstein (1997). Alternatively, a locally calibrated input-output model could be an appropriate first stage for this exercise. In either case, care must be taken to exclude new employment (in the new plant or elsewhere) that would have come to the area in the absence of the project (Lenihan, 1999).

13. We assume throughout that Chicago resident chains and suburban chains are separate although there is undoubtedly movement back and forth between these chains in the real world. The more defensible assumption is that such movements largely cancel one another out. Ideally, the chain recruitment matrix could be expanded to trace the role of commuting and reverse commuting in filling vacancies. The data source for the present matrix (the PSID) does not allow for such geographic detail.

14. Note that these results would probably not be replicated in the case of a service sector facility that would either create more high-level jobs (such as an R&D center) or low-level jobs (such as a financial services back-office facility).

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