Evaluating Local Job Creation: A “Job Chains” Perspective

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Abstract

This paper introduces economic development planners to a new approach for the evaluation of local job creation efforts. The “job chains” model is an analytic framework for assessing the employment impacts associated with economic development programs and their social value. It stresses the vacancy chains that are opened up with new job creation. The approach focuses on the wage gains of job changers and takes a realistic view of the value of jobs to the unemployed in local labor markets. Job chains allow the explicit treatment of both efficiency effects and distributional outcomes resulting from job creation. The simple mechanics of the technique are discussed and a worked example relating to the establishment of a large auto plant in a major Midwest city is presented. The paper concludes with practical ground rules for carrying out a job chains analysis in the context of economic development planning.
1. Introduction

Economic development officials are often called upon to assess the employment effects of local economic development programs. Invariably, jobs are chosen as a yardstick for measuring 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. Simple stock-taking of all new jobs, income and taxes associated with a program can often over-shadow the critical issue of how much local workers actually benefit from these programs.

This paper introduces the planning community to a new perspective on the evaluation of job creation programs grounded in the “job chains” model. While theoretically based, the approach has real implications for practice. It stresses the vacancy chains opened by job creation and the musical-chairs mechanism operating in local labor markets that ensues. With the creation of a new vacancy, many workers have an opportunity to improve their welfare through job moves; hence the aggregate improvement of all workers is the best measure of local welfare gain. The paper starts by surveying current methods for evaluating local job creation and locating the job chains approach within the context of contemporary evaluation practice. The mechanics of the job chain approach are then described including the model’s assumptions, data requirements, and limitations. A worked example is presented that deals with the efficiency and distributional effects associated with a classic economic development project--the attraction of a foreign-owned auto manufacturing plant to a large urban area in the Midwest. This highlights the type of real-world situations in which the job chains model can be readily applied. The paper concludes 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 also emphasize the very real limitations that continue to surround such efforts.

2. Current Practice in the Evaluation of Local Job Creation

Traditionally, standard impact analysis has been the staple approach of practitioners evaluating local job creation. Impact analysis attempts to measure quantitative estimates of employment (or income) change in a given area arising from a particular economic stimulus (Davis 1990). The analyst establishes a current or baseline situation and then measures the gross change arising through the introduction of the new project or program. Much effort is expended in judiciously counting outcomes (new jobs, new incomes) that are immediately equated with program ‘benefits’ (Markely and McNamara 1995). The social valuation of these outcomes i.e. who benefits from program effects and just how much better off they are, is often overlooked. This practice continues despite long standing exhortations in the academic literature raising doubts about the value of job counting (e.g. Haveman and Krutilla, 1968; Courant, 1994).

Cost-benefit analysis provides perhaps the most natural analytic framework for extending impact analysis into a full evaluation of local job generation (Willis and Saunders 1988, Swales 1997, Bartik 2005). Where impact analysis typically overstates gains to producers, cost-benefit runs the risk of under estimating changes in the welfare of producers by exaggerating their employment alternatives. Often, cost-benefit analyses assume full employment and thus rule out gains from job mobility (Felsenstein and Persky 1999). Even careful cost benefit studies tend, in our view, to underestimate gains
to local workers. These gains are closely related to the job chains generated in economic development projects. As we demonstrate below, such chains can be integrated into the standard logic of cost benefit analysis.

In recent years, a number of breakthroughs have been made in ‘ex-post’ analyses, i.e. studies carried out after projects are completed or programs well established. The increased availability of disaggregated data (micro-level and geo-referenced) along with greater processing and visualization capabilities have greatly increased the scope and range of statistical analyses. In addition, substantive analytical advances in the area of econometrics and spatial modeling have allowed consideration of issues such as endogeneity, experimental design, spatial dependence and selection bias in the evaluation of economic development projects (Boarnet, 2001, Rogers and Tao 2004, Sohn and Knaap 2005).

These recent methodological developments address the broad issue of “alternative states of the world” so critical in careful evaluations. Ex-post studies of job creation are more rigorously attempting to define the counter factual “no economic development” situation using either quasi-experimental control methods or econometric controls. Much of this activity has been centered around evaluating the employment and income impacts of enterprise zones. While early evaluations effectively ignored the question of the magnitude of employment and income changes in the absence of zone designation (Rubin 1991), subsequent studies began to incorporate indirect methods for estimating the “but for” situation. Some analysts have used a matched pairs experimental control design, matching zip codes or counties with enterprise zones to those without in order to control for extraneous effects of local socio-demographics and economic structure on the job creation impacts of the zones (Papke 1994, Greenbaum and Enberg 2004). One recent
study matches individuals employed by enterprise zone companies with similar individuals not so employed to estimate income effects attributable to the enterprise zones (Bostic and Prohofsky, 2006). Another method includes the use of econometric controls to distill the employment effects of enterprise zones and to correct for endogeneity and selection bias inherent in zone designation (Boarnet and Bogart 1996, Boarnet 2001, Rogers and Tao 2004, Sohn and Knapp 2005). These arise from pre-existing differences between zone and non-zone areas, the administrative processes by which zones are designated, or self-selection on the part of the qualifying zones. This increasing technical sophistication has resulted in steadily declining employment estimates for enterprise zones. A further approach is to estimate the counterfactual using a revealed preference control group (Greenstone and Moretti 2003). In an evaluation of the bidding wars for footloose industrial investment, these authors compare ‘winner’ and ‘loser’ counties in this arms race. Thus rather than engage in matching based on observed variables or regression methods to compare ‘winner’ counties to all others, their control is based on the assumption that ‘losers’ closely resemble the winners (adjusting for differences in the pre-existing playing field).

By and large, these improvements in ex-post evaluations offer little direct assistance in ex-ante evaluations (i.e. those evaluations offered as part of the planning process, prior to actual implementation). In principle, the results of ex post studies can be used to provide key parameter inputs to ex ante studies. 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.
For ex-ante evaluations, current practice still focuses on impact analysis and cost-benefit. But such studies have themselves become more sophisticated. Increasingly, these efforts are expected to address key evaluation issues such as the incorporation of demand displacement, opportunity costs (i.e. the value of inputs in their next best alternative use) and distributional measures (see Reese and Fasenfest, 2004.)

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

The incorporation of opportunity costs in the evaluation of local job creation is a greater methodological challenge and less consistently addressed. In impact analyses, opportunity costs of capital are either ignored or proxied by the rate of return on long-term investments (Willis and Saunders 1988, Howland 1990, Dewar and Hagenlocker 1996) while labor opportunity costs are effectively ignored, i.e. assumed to be zero (Johnson and Thomas 1990, Mondello and Rishe 2004). In cost-benefit studies, opportunity costs of capital are routinely addressed in direct form via the discount rate (Willis and Saunders 1988). Opportunity costs of labor are incorporated less frequently. When addressed, the reservation wage is often used as a proxy (Sridhar 1996, Swales 1997, Bartik 2005).
Welfare improvement and distributional effects are much heralded as the key benefits of economic development progress (Courant 1994, Partridge and Rickman 2003). However in practice, they have been treated in a rather sketchy manner. Change in local income by income-classes and the redistribution of jobs from low to high unemployment areas are two typical indicators, but both have been used only infrequently. ‘Local welfare’ is interpreted in a wide variety of ways ranging from net reduction in unemployment claims (Papke 1994), share of new jobs going to local residents (Rephann, Dalton, Stair and Isserman 1997), growth in taxable property values Loh 1993, Greenstone and Moreti 2003) and so on. Bostic and Prohofsky (2006) come closer to defining a net welfare increase by analyzing a difference-in-difference of incomes between participants in enterprise zones and matched non-participants, however they do not consider possible indirect effects on local non-participants.

In sum, we can observe that despite some notable technical advances in ex-post analysis, it would seem that a “consensus of dissatisfaction” can still be said to characterize the current state of ex-ante economic development evaluation. Some of this is grounded in issues of technique and method (OECD 2004) while other critiques focus on questions of scope and breadth of evaluation (Reese and Fasenfest 2004). Key to this dissatisfaction is the absence of a disaggregated model of local labor market dynamics. Without such a model, even the most perfunctory of local economic development goals such as job creation becomes unclear. The job chains model suggests a theoretical framework consistent with the realities of involuntary unemployment and underemployment.
The absence in the literature of an evaluation model of the labor market also leaves its footprint on practice. The practitioner is left ill-equipped to grapple with the contingencies of job creation: what kind of jobs, high wage or low wage? jobs for whom, locals or commuters? jobs that reduce local unemployment or increase local purchasing power? The evaluation frameworks on offer to the economic development planner often fall short of a guide to practice. Even if an evaluation is able to show an aggregate picture of local employment growth, the planner is still without a guide as to how this concentration of jobs within a given space benefits or harms the various subpopulations in the local area.

3. The Job Chains Model in the Context of Current Practice

An axiom of current economic development efforts is that economic development projects are expected to create new jobs. They will thereby enjoy political support largely because job creation is valued by the community. But, simple job-counting is hardly an adequate evaluation technique in order to retain that support. As evaluation is meant to inform practice, an approach offering some socially meaningful insights into the workings of the local labor market is needed. The job chains model offers such insights.

The job chains model of the local labor market assumes an open economy characterized by a measure of slack in the labor market (involuntary unemployment and under-employment). Each new job triggers off a job-chain and with workers leaving behind vacancies to be filled by others. In such a world of job chains and vacancies, the
evaluation of job creation is based on accounting for the welfare gains made along the various job chains generated by a job creation project.

In the context of current practice, the job chains model offers some new insights that supplement existing evaluation approaches. It presents a more precise accounting of gains from job creation and extends some of the evaluation concepts and indicators familiar to the practitioner. These insights are far more than simply technical. We can point to three substantive areas in which job chains supplement and extend current evaluation practice.

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. These map the spread effects of a program as jobs are created among suppliers. The job chains model alerts us to the existence of vacancy multipliers, as every new job potentially creates a job chain. Vacancy multipliers chart the job mobility effects initiated by a new job and are created through openings as workers move from one position to another.

Second, job chains force a reconsideration of the “all or nothing” approach to evaluation characteristic of much impact assessment. As noted earlier, many impact evaluations fail to recognize that most workers at new subsidized facilities would have found alternative employment in the community or outside. The welfare gain to the individual worker from a new job will not in general be equal to that worker’s wage. 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 on a new
job. Indeed, this is why, in a fully-employed 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 may not teach us very much about the efficacy of economic development programs (Courant 1994).

At the other end of the evaluation spectrum, cost benefit analysts aware of the need to include opportunity costs often equate them with ‘reservation wages’ i.e. the minimum wage acceptable for entering into employment. Empirical estimates of reservation wages of job seekers are generally quite high. Some claim a figure as high as ninety percent of wages actually achieved (Jones 1989, Bartik 2005). Others suggest lower figures, but still far more than zero (Hodge 1982, Sridhar 1996). These high reservation wages suggest that the actual welfare gains of 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 new job formation 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 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 position improved over their expectations as they move up a job ladder. Admittedly, the sum of all these gains is still likely to fall short of the total new local wages identified as benefits by impact analysis. As so often is the case, the answer lies somewhere in between.
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 do not stand apart from each other. In fact they are closely interrelated. A positive benefit-cost ratio greater than 1, commonly taken as an indicator of efficient use of resources, is specific to a given income distribution. If the income distribution was to change, the value of the benefit-cost ratio would as well. For example, the employment benefits attributable to a new inner city manufacturing plant will be greater, the poorer and less employed, the inner-city residents are.

The job chain approach builds up from a disaggregation of the labor market. It makes explicit the differences in opportunity costs associated with different classes of labor. In this way it integrates distributional and efficiency concerns. The amount of earnings credited to each class of workers is adjusted to account for the fact that high earners have higher opportunity costs and other alternatives for earning at a similar level. While these adjustments reflect on distributional considerations, they are central to measuring efficiency. Low wage workers have few alternative opportunities and therefore a greater share of their new wages represent real gains.

A job chain 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.
4. The Job Chains Model: Assumptions, Data and Method

The “job chain” is an analytic device that lets us estimate the amount of movement triggered off by a new job and to record the traffic in and out of the newly created vacancies. Two key assumptions of the job chains approach are the existence of persistent involuntary unemployment/underemployment and a rigid wage structure. 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 instance, we are not simply observing new job $i$ and estimating how many jobs (indirect and induced) are stimulated by this new position. Rather, we are taking job $i$ as a starting point and attempting to measure the vacancy implications of this job. The job chain will continue until it is broken. This will occur when a worker moves into a new job without creating a local vacancy, for example an in-migrant to the local area, an unemployed worker, or someone entering from out of the labor force.

The chain metaphor has been used to analyze a wide variety of markets involving durable goods such as housing (White 1971, Forrest and Murie 1994, Millard-Ball 2002). Since every house has an address, housing chain research can proceed in a straightforward fashion charting and mapping who moved in to new units and what units they vacated in order to do so. A housing chain ends with either an in-mover to the area, new household formation or stock demolition. In each case no replacement is offered to continue the chain. Once an average chain is identified for each type of new house in an area, researchers 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 of this approach has also been adopted in the local economic development literature although mainly concerned with the filtering effect of chain movements in commercial and office real estate markets (Robson, Bradford and Deas 1999, Greenhalgh, Downie, Fisher and Barke 2003).

In principle, the chain mapping approach can be applied to job chains generated by new employment growth. However, in the case of employment, data is not generally collected on positions as individual entities. Where housing researchers can trace back from one “address” to another, it is extremely difficult to look at the traffic through a “job address” as people move up job ladders. Data on jobs are just not maintained that way. The empirical problem is similar to that facing input-output (I-O) research. In these studies, researchers do not go back through actual market transactions at every stage of production for a given good. They do not actually log the sale of cloth to the apparel firm, then the sale of cotton to the textile firm, the sale of petroleum to the farmer and so on. Rather, they estimate an expected set of inputs for each industry, assume that set to remain constant whatever the use of the industry's product, and then use Leontief’s approach to infer the necessary total requirements of the production chains generated by new sales. The resulting total requirements give the well known production multipliers of input output analysis.

To use such a synthetic approach for job chains we need to define and measure the equivalent of the I-O input set for each new job type. If we break jobs down into discreet groups based on wages or some other general measure of quality, we simply ask what proportion of vacancies in jobs at the highest paying level (level 1) are filled by
workers currently employed at the next highest level (level 2 jobs), workers employed in level 3 jobs, etc. Such movements are made possible by the existences of substantial underemployment in the labor force. In terms of the job chain model this means that at least some workers at lower levels are fully qualified to take higher level vacancies as they appear. To fill in the elements of such a list we need information only on a sample of job changers—the types of their new jobs and the types of their old jobs. 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 opened at level 3 is filled by a worker currently employed in level 5) depends only on the level of the vacancy being filled (e.g. level 3), and not on any other characteristics of the chain (e.g. the chain began with a new job at level 1). With this key assumption we need no further information concerning job chains. In effect, once we are armed with these input lists we can synthesize the “total requirements,” i.e. the number of vacancies created at each level, by any given new job type.

This approach to job chains greatly simplifies the empirical requirements. In recent work (Persky, Felsenstein and 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 for five classes of jobs defined by wage level. To construct the input column for a given job level, we only need information on job changers. For the period observed (1987-1993), the PSID contains data on roughly 3,600 moves. We do not need observations on entire chains, but only a representative sample of unrelated chain links. Such data are available from workers’ longitudinal job histories. Without ever creating a sample of realized job chains, we can now estimate all the
relevant coefficients of the input or job recruitment matrix (Table 1). Not surprisingly, the largest entry in each column falls along the diagonal. Depending on the wage level, anywhere from 30 to 50 percent of hires in jobs come from workers already employed at that same level. These hires add only modestly to wage gains despite the size of the wage groups. From the PSID we estimate that within-group movers improve their wages by only 2.0% on average. Gains must come from workers moving up to a higher job from a lower one or from non-employment (i.e. unemployment, not in the labor force or in-migration). It should be noted here that the in-migrant share of hires refers to gross hires. This number is considerably less than the ratio of in-migrant workers to new jobs as reported by Bartik (1991). The latter is a net figure that makes no allowance for local upward movement through job chains.

[Table 1 about here.]

With the aid of this input matrix, the estimation of the expected number of vacancies opened in each wage group as the result of an initial job at a given level, is relatively straightforward. These simulations are exactly analogous to the calculation of multipliers in I-O analysis and yield job chain multipliers. For example, a newly-created job at level 3 is associated with an average chain of 2.7 vacancies, including 1.87 vacancies at level 3 itself, 0.66 vacancies at level 4 and 0.2 vacancies at level 5 (Table 2). The average chain is terminated by the hiring of an unemployed worker, someone from out of the labor force or someone moving into the area. Perhaps not surprisingly, high-wage jobs such as those at level 1 give rise to longer chains than the low-wage jobs at
level 5. But the length of the chain is not in itself a measure of the chain's value. To assess the worth of a job we need to know the welfare gains made along the chain.⁷

Using the PSID data we can calculate average welfare gain of successful job applicants for each type of vacancy. We simply count the actual increase in wages of similar job movers in the PSID. More difficult are the gains attributed to those moving from unemployment, out of the labor force or outside the region. The welfare gains of these groups require an evaluation of the available alternatives for such workers. For each wage group we first estimate a wage equation based on national worker characteristics, i.e. sex, age, age squared, education. This equation then is used to predict wage levels of the unemployed and hence makes possible the calculation of unemployment rates for each wage group (Perksy et al., 2004). Using those predicted unemployment rates we assign opportunity costs between 25% (lowest wage group) and 75% (highest wage group).⁸ The resulting opportunity costs are applied to the unemployed, new entrants and in-migrants taking jobs in each group.

Using these estimates of average welfare gains at each level, along with the number of each kind of vacancy opened by a given chain, we construct estimates of total welfare gain associated with each kind of new job. These are expressed in Table 3 as a share of the average wage of jobs at each level. Hence they indicate the discount from a standard impact analysis which would count all wages of new jobs. We estimate that new jobs at the highest levels (1 and 2) generate welfare benefits equal to little more then 40
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 normal economic development evaluation practice of counting up all
new wages will considerably overstate welfare gains. On average, the over-statement of
welfare will be higher for high wage jobs than for low wage jobs.

[Table 3 about here.]

5. A Worked Example

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

The “client” is a Chicago economic development authority, charged with
evaluating the impact of a proposed 1500-worker automobile plant to be located in the
city. While wooing auto assembly plants can be construed as a latter-day version of
smoke-stack chasing, this form of economic development strategy continues to rank high
on the agenda of many regional and local economic development agencies (Hanson 1993,
Greenstone and Moretti 2003). The tools for evaluating these efforts are invariably those
of impact analysis with a stress on multipliers and fiscal effects (University of South
Carolina 2002) or cost-benefit analysis (Marvel and Shkurti 1993). Because of the stakes
involved, evaluations in this area have not been free of manipulation (Connaughton and
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 on the employment and earnings effects, since these are the elements modified by the job chain analysis. We also note that the choice of an automobile plant reduces any major problem with displacement since such an investment is not likely to directly compete with existing firms in the region for local markets.

For this exercise the job chain model is linked to a Chicago economic development cost-benefit evaluation model. The key requirement is that the local model must generate, for both the expected jobs in the new plant (direct jobs) and those created through the multiplier process (indirect and induced jobs), the number of jobs created by wage categories. To use the job chain estimates described in the last section, we need our estimates of new jobs to be broken down into five wage levels: (1) high wage, (2) high mid-wage, (3) mid wage, (4) low mid-wage, and (5) low wage. The Chicago cost-benefit model generates the required breakdowns for both employment and earnings. The city, of course, is concerned with jobs and wages for city residents. From the start, many new jobs will be taken by commuters. Of the 1500 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 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. Based on Census data for earnings in the automotive industry, the model estimates a distribution of these jobs across wage categories as reported in the first row of Table 4. Extending this
disaggregation to the indirect and induced industries yields the distribution for total new jobs shown in the second row of the same table.

[Table 4 about here.]

Perhaps not surprisingly jobs in the automobile plant are more concentrated in mid level wage groups 2, 3 and 4 than the indirect and induced jobs which would be created by the location. The same pattern is seen in the distribution of earnings on new jobs reported in Table 5. The figures at the end of each row are the present values (in 2006 dollars) of the city resident wage bill. The per worker wage for the auto plant workers is a bit less than $40,000 per year, while those of indirect and induced workers are a bit less than $25,000 per year.

[Table 5 about here.]

Up to this point we have been conducting a fairly standard analysis. 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 chain analysis addresses both these issues. We link the chain model to the cost-benefit model by simply taking the data on new jobs as a starting point for running chains. Based on the wage levels paid in the new auto plant, and using the job chain multipliers (from Table 2), on average each new direct job opens about 1.3 additional vacancies. Thus the 915 new auto jobs for Chicago residents initiate a set of vacancy chains resulting in an estimated 1361 additional openings.
available to Chicago residents. Of course indirect and induced jobs also generate vacancy chains. All told the 1747 new positions generate a total of 4295 vacancies. The job chain multipliers allow us to break this figure down into vacancies by wage class as reported in the next to the last line of Table 6. While only 15% of the auto plant jobs were in the lowest wage class, about 20% of the 4300 total vacancies are opened at this level.

Using our basic job recruitment matrix (Table 1) we can easily disaggregate these vacancies further into origin-destination pairs, i.e. the number of workers expected to move from any origin group to any destination vacancy group. (Each origin-destination entry in Table 6 is just the column sum times the corresponding entry in Table 1.) Thus the entry listed under Origin Group 4 and Destination Group 3 (216) should be interpreted in the following manner: “the job chain model predicts that as a result of the location of the new auto plant in the city, some 216 city resident workers will move from jobs at level 4 to jobs at level 3.” Some of these moves will directly involve the plant, some will involve plant suppliers, and some will involve businesses unconnected directly to the auto industry but responding to workers’ consumer purchases. Overall, we have estimated moves resulting from all the flows in the city labor market expected to follow on the establishment of the auto plant. These estimates are of interest in themselves, since they provide considerable information on the likely labor market consequences of the plant location. In particular, they can be used by local employment agencies in planning various labor placement activities in response to the plant location.

[Table 6 about here.]
The predicted labor market flows allow us to go on to estimate the economic value of the new vacancies to Chicago residents. For any given flow (cell in Table 6) this estimate is based on the difference between the wages associated with the vacancy and the opportunity costs of the origin group filling the vacancy. In practice an estimate is available for the gain associated with each flow. Aggregating across all flows, we estimate that the total real welfare gain from the $374 million earnings increase (direct and indirect) over seven years will be less than half this amount, just $162 million (Table 7). Of this, $85 million will be generated from chains connecting to new direct jobs, with the remainder from chains connecting to indirect and induced jobs.

[Table 7 about here.]

Table 7 uses the chain matrix to calculate the breakdown of these gains by destination group. The most striking change here is the higher share of welfare gains going to the lowest destination wage group, again reflecting a modest amount of “trickle down” development. This effect is accentuated if we break down the gains not by destinations, i.e. where vacancies occur, but rather by origins, i.e. who is expected to fill the vacancies. The chain approach allows us to make such estimates because in effect it simulates all the job moves in the chain. Table 8 presents a breakdown of the same gains recorded in Table 7, but now based on the origin wage groups of those filling vacancies.12

[Table 8 about here.]
The result is a much clearer estimate of the distributional effects of job creation through the city’s labor market. Workers starting in the lowest wage category account for about a fourth of all the gains. Workers starting in the two lowest categories account for over 60% of all the gains.¹³

A new auto plant would bring new jobs to Chicago residents. Some of these are in the plant itself, some with its suppliers. These are new payrolls for the city. The job chain calculations have allowed us to extend our understanding of how these payrolls impact on Chicago workers, not only those who get the newly created jobs, but also those who follow along the generated job chains to better positions than they previously held. The result is an integrated picture of the gains from the new facility as distributed through the various vacancy chains it sets in motion.

6. Conclusions: Ground Rules for Practicing Economic Development Planners

Having illustrated the job chains model in practice, we now proceed to discuss how economic development planners can operationalize this approach. In so doing, we alert practitioners to the very real limitations of the model and to the need for transparency in economic development evaluation, a planning objective that the model helps promote.

As noted above, the job chains approach supplements the tool box of ex ante evaluation. Rather than replace the existing arsenal of evaluation approaches (impact analysis, cost benefit, cost effectiveness and so on), it extends them. In the first instance, the job chains model calls on inputs from one of these other tools, such as a local input-output model, to generate expected jobs from an economic development project and
categorize them into wage classes. This is a required input that the job chain model then processes. The second stage of operationalization involves using the job recruitment matrix (Table 1) that dictates the probabilities of vacancies originating in different wage classes, being filled by these classes or by ‘outsiders’ such as new entrants, the unemployed or in-migrants. This core matrix dictates estimated vacancy chain lengths (Table 2) and cannot be readily changed by the practitioner. For a given new job, Table 2 informs the planner of the expected vacancies and Table 1 predicts the job moves for filling each vacancy. These calculations give predictions of every expected local job move generated by the new jobs. Finally, a welfare estimate can be made based on these job moves and the opportunity costs of those moving. This estimate does not call for any sophisticated modeling approach and can be carried out using a simple spreadsheet-based accounting procedure. At this stage, locally calibrated parameters can be accommodated in the form of changes to the local unemployment rates that govern the estimation of workers’ opportunity costs. Appending the job-chains model to a standard impact analysis does not raise any particular technical challenges. However, the economic development planner does need to be cognizant of the limits of the model and the potential for its misuse. In this respect, the following can be noted:

_Treatment of opportunity costs:_ of all the evaluation issues that the model addresses, this is probably subject to the least formal derivation. The core recruitment matrix is empirically estimated and seems robust to regional and cyclical variation (Persky et al 2004). However, the estimates of opportunity costs are deductively derived from an admittedly simple model of involuntary unemployment. While we have conducted initial sensitivity analyses of these estimates there is still considerable room
for a more formal approach to estimating opportunity costs perhaps using the results of ex-post quasi-experiments.

Localization of the recruitment matrix: at present, this core table is based on national average probabilities for different wage classes. A more locally sensitive model should really allow for a local variant of this table. In practical terms this means drawing on a much larger sample of job movers sufficiently disaggregated by geography and wage groups. Conceivably, local surveys of employers making job hires could be used to rescale the local share of gross placements of “outsiders” (e.g. in-migrants) in the core table.

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. The job chains model, however, 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 can be an anathema to those trained in economics. In defense of the job chains model, we note that most economic developments are not of the scale to substantially change the prices of labor in a metropolitan area.

Political misrepresentation: in contrast to ex post evaluations which can easily generate public criticisms, 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 accumulated vacancies derived from new employment. Planners should be careful not to allow the confusion of vacancies with new jobs. At the same time the job chains model emphasizes that welfare gains are typically much more modest than total generated new wage bills. Again, planners should be careful to emphasize this distinction and not allow selective misinterpretations. Also it is critical that practitioners not avoid the perennial “but-for” question. The job chain model in itself does not directly address this issue. Only job chains initiated by genuinely new employment should be included in the analysis. Often there will be political temptations to overstate project related employment growth.
Bibliography


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University of Southern Carolina (2002) *The Economic Impact of BMW on Southern Carolina*, Division of Research, Moore School of Business, University of Southern Carolina, [http://moreschool.sc.edu](http://moreschool.sc.edu)


### Tables

**Table 1: Basic Wage Group Transition Matrix**

<table>
<thead>
<tr>
<th>Origin Wage Group</th>
<th>Destination Wage Group</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group 1</td>
<td></td>
<td>41.1%</td>
<td>0.0%</td>
<td>0.0%</td>
<td>0.0%</td>
<td>0.0%</td>
</tr>
<tr>
<td>Group 2</td>
<td></td>
<td>25.0%</td>
<td>52.9%</td>
<td>0.0%</td>
<td>0.0%</td>
<td>0.0%</td>
</tr>
<tr>
<td>Group 3</td>
<td></td>
<td>4.8%</td>
<td>22.1%</td>
<td>46.6%</td>
<td>0.0%</td>
<td>0.0%</td>
</tr>
<tr>
<td>Group 4</td>
<td></td>
<td>2.2%</td>
<td>1.5%</td>
<td>18.5%</td>
<td>47.3%</td>
<td>0.0%</td>
</tr>
<tr>
<td>Group 5</td>
<td></td>
<td>0.0%</td>
<td>0.3%</td>
<td>2.4%</td>
<td>13.3%</td>
<td>34.5%</td>
</tr>
<tr>
<td>Unemployed</td>
<td></td>
<td>2.9%</td>
<td>3.8%</td>
<td>9.7%</td>
<td>15.8%</td>
<td>24.7%</td>
</tr>
<tr>
<td>Out of Labor</td>
<td></td>
<td>4.0%</td>
<td>3.8%</td>
<td>7.5%</td>
<td>13.5%</td>
<td>30.5%</td>
</tr>
<tr>
<td>In-Migrant</td>
<td></td>
<td>20.1%</td>
<td>15.6%</td>
<td>15.4%</td>
<td>10.0%</td>
<td>10.2%</td>
</tr>
<tr>
<td>Column Sum</td>
<td></td>
<td>100.0%</td>
<td>100.0%</td>
<td>100.0%</td>
<td>100.0%</td>
<td>100.0%</td>
</tr>
</tbody>
</table>

Data Source: Calculated by the authors from job changes identified in the Panel Study of Income Dynamics, See Persky et al. 2004.

**Table 2: Job Chain Multiplier Matrix**

<table>
<thead>
<tr>
<th>Initial New Job Wage Group</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vacancies Created in Group 1</td>
<td>1.70</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vacancies Created in Group 2</td>
<td>0.90</td>
<td>2.12</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vacancies Created in Group 3</td>
<td>0.52</td>
<td>0.88</td>
<td>1.87</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vacancies Created in Group 4</td>
<td>0.28</td>
<td>0.37</td>
<td>0.66</td>
<td>1.90</td>
<td></td>
</tr>
<tr>
<td>Vacancies Created in Group 5</td>
<td>0.08</td>
<td>0.12</td>
<td>0.20</td>
<td>0.39</td>
<td>1.53</td>
</tr>
<tr>
<td>Total Job Multiplier</td>
<td>3.48</td>
<td>3.48</td>
<td>2.73</td>
<td>2.28</td>
<td>1.53</td>
</tr>
</tbody>
</table>

Data Source: Derived from Table 1, See Persky et al. 2004.
Table 3: Welfare and Distributional Gains by Initial New Job

<table>
<thead>
<tr>
<th>Initial New Job Wage Group</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>All Welfare gains as share of wage</td>
<td>0.43</td>
<td>0.42</td>
<td>0.56</td>
<td>0.62</td>
<td>0.69</td>
</tr>
</tbody>
</table>


Table 4: Distribution of New Jobs by Wage Group

<table>
<thead>
<tr>
<th>Wage Group</th>
<th>1 Highest</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5 Lowest</th>
<th>Number of Jobs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Direct</td>
<td>3.7%</td>
<td>11.9%</td>
<td>29.5%</td>
<td>39.7%</td>
<td>15.2%</td>
<td>915</td>
</tr>
<tr>
<td>Total</td>
<td>4.7%</td>
<td>11.0%</td>
<td>29.4%</td>
<td>37.0%</td>
<td>18.0%</td>
<td>1747</td>
</tr>
</tbody>
</table>

Data Source: Simulation of new auto plant using the Chicago Cost-Benefit Model.

Table 5: Distribution of Earnings on New Jobs by Wage Group

<table>
<thead>
<tr>
<th>Wage Group</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>SUM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Direct</td>
<td>9.3%</td>
<td>14.1%</td>
<td>38.0%</td>
<td>34.8%</td>
<td>3.7%</td>
<td>$239.5 million</td>
</tr>
<tr>
<td>Total</td>
<td>14.6%</td>
<td>14.1%</td>
<td>35.3%</td>
<td>30.0%</td>
<td>6.0%</td>
<td>$374.3 million</td>
</tr>
</tbody>
</table>

Data Source: Simulation of new auto plant using the Chicago Cost-Benefit Model.
Table 6: Origin-Destination Table

<table>
<thead>
<tr>
<th>Destination Wage Group</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>Row Sum by Origin Group</th>
<th>Shares by Origin Group</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Origin Wage Group</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Group 1</td>
<td>61</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>61</td>
<td>1.4%</td>
</tr>
<tr>
<td>Group 2</td>
<td>37</td>
<td>251</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>288</td>
<td>6.7%</td>
</tr>
<tr>
<td>Group 3</td>
<td>7</td>
<td>105</td>
<td>544</td>
<td>0</td>
<td>0</td>
<td>656</td>
<td>15.3%</td>
</tr>
<tr>
<td>Group 4</td>
<td>3</td>
<td>7</td>
<td>216</td>
<td>768</td>
<td>0</td>
<td>994</td>
<td>23.1%</td>
</tr>
<tr>
<td>Group 5</td>
<td>0</td>
<td>2</td>
<td>27</td>
<td>216</td>
<td>304</td>
<td>550</td>
<td>12.8%</td>
</tr>
<tr>
<td>Unemployed</td>
<td>4</td>
<td>18</td>
<td>113</td>
<td>257</td>
<td>218</td>
<td>610</td>
<td>14.2%</td>
</tr>
<tr>
<td>Out of Labor Force</td>
<td>6</td>
<td>18</td>
<td>88</td>
<td>220</td>
<td>269</td>
<td>600</td>
<td>14.0%</td>
</tr>
<tr>
<td>In-Migrant</td>
<td>30</td>
<td>74</td>
<td>180</td>
<td>163</td>
<td>90</td>
<td>537</td>
<td>12.5%</td>
</tr>
<tr>
<td><strong>Column Sum by Destination Group</strong></td>
<td>148</td>
<td>475</td>
<td>1168</td>
<td>1624</td>
<td>881</td>
<td>4295</td>
<td></td>
</tr>
<tr>
<td><strong>Shares by Destination Group</strong></td>
<td><strong>3.4%</strong></td>
<td><strong>11.1%</strong></td>
<td><strong>27.2%</strong></td>
<td><strong>37.8%</strong></td>
<td><strong>20.5%</strong></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Source: Calculations by the authors.

Table 7: Real Welfare Gains by Destination Group

<table>
<thead>
<tr>
<th>Destination Wage Group</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>SUM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Direct</td>
<td>8.3%</td>
<td>15.9%</td>
<td>33.9%</td>
<td>33.2%</td>
<td>8.7%</td>
<td>$85.0 million</td>
</tr>
<tr>
<td>Total</td>
<td>11.1%</td>
<td>14.3%</td>
<td>33.7%</td>
<td>30.2%</td>
<td>10.8%</td>
<td>$162.3 million</td>
</tr>
</tbody>
</table>

Source: Calculations by the authors.
Table 8: Real Welfare Gains by Origin Group

<table>
<thead>
<tr>
<th>Origin Wage Group</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>SUM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Direct</td>
<td>2.2%</td>
<td>7.3%</td>
<td>27.8%</td>
<td>39.0%</td>
<td>23.7%</td>
<td>$85.0 million</td>
</tr>
<tr>
<td>Total</td>
<td>3.0%</td>
<td>7.7%</td>
<td>27.6%</td>
<td>36.8%</td>
<td>24.9%</td>
<td>$162.3 million</td>
</tr>
</tbody>
</table>

Source: Calculations by the authors.
Endnotes

1 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)

2 A further assumption is that worker quality is constant within each wage group. Thus fluctuations in labor market conditions will not afford any gains or losses to employers. Our basic recruitment matrix represents an average across the business cycle.

3 The possibility exists that in-migrants may not end a chain. This will occur when an in-migrant would have moved to the region in the absence of the new chain and taken a separate position. This phenomenon would lead to under-counting of chain length. In contrast, we can posit a case whereby out-migrants end a chain. This could happen when a committed out-migrant decides to stay as a result of a new position. In this case chain length will be over-estimated. Hopefully, these are off-setting errors.

4 More formally, given the matrix of input coefficients $A$, the total requirements generated by any vector, $X$, of final sales is the vector $Y = (I - A)^{-1}X$.

5 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 in moving from job to job. The present study considers only wages, because we were unable to obtain a large sample of job changers along with detailed characteristics of their current and previous jobs. We hope to explore these questions in future research.

6 Notice 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 such movements do not occur, but rather that they are not set off by a new job. A new type three job doesn’t create a type
two vacancy. Rather, such a move is likely involuntary and the question becomes one of determining where the type two job loser would have “landed” in the absence of the type three job. In practice we distribute the relatively small number of downward movers proportionally across the categories of other job changers.

7 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.

8 The choice of the range from 25% to 75% reflects the considerably more attractive alternatives for high wage group workers in the labor market. While this range is not precisely estimated, sensitivity analyses suggest the results obtained using it are highly robust. (See Perksy et al., 2004.)

9 Recently Honda announced a search for a new site for a 1500 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.

10 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 appropriately allow for the portion of the new employment (whether in the new firm or in existing firms) that would have come to the area in the absence of the project, i.e. the “but-for” problem (Lenihan, 1999).

11 Throughout we assume that Chicago resident chains and suburban chains are separate. In the real world undoubtedly there is movement back and forth between these chains.
The more defensible assumption is that such movement is largely canceling. 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.

12 Notice that for these calculations those not coming from a city job are classified with the destination wage group they eventually join.

13 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 service back office facility).