Economic Development Impact of Airports: A Cross-Sectional Analysis of Consumer Surplus

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Attributing the entire impact of an airport's operations to economic development would be overestimating the net economic benefits of an airport. A methodology is developed for using consumer surplus as a proxy measure of the net economic development benefits from the construction of a regional airport. This methodology involves partitioning the impact of an airport into two parts: (a) the impact from the purchases of air transportation services; and (b) the consumer surplus from a decline in air transportation prices subsequent to the construction of the facility. Using a combination of input-output analysis and airport-user surveys, a cross-sectional study was conducted on two airports, one in an island economy—with few alternate means of transportation and no other airports—and the other in the Dallas-Fort Worth (DFW) area with an abundant supply of alternate airports and other modes of transportation. The transportation purchase impact was larger in the DFW area than in the island economy ($5.26 billion compared to the island's $3.73 billion—or $1,571 and $612 per capita, respectively). The size of the consumer surplus for the DFW airport was much smaller because of the proliferation of other transportation modes and competing airports ($1.3 billion). In the island economy, the consumer surplus was much larger ($11.03 billion), suggesting the importance of the availability of substitute modes and airports. The study emphasizes the importance of the industry mix, the diversity of the economy, the regional transportation infrastructure, and the full-employment status of the economy in determining the size of the impact. It also provides caveats on using stated preference methods in determining the value to the consumers of products that could be enjoyed as a free rider.

Many economists and policy makers have applauded the benefits of government investments in large-scale public projects on the grounds that such projects generate public benefits over and above the costs of constructing them. The opportunity cost of constructing such projects, the argument goes, would be lower for the public sector than if private-sector cost accounting were used.

A methodology will be outlined for using consumer surplus as a proxy measure of the net economic development benefits from the construction of a regional airport. This measure avoids double counting that would result if the entire upper and lower areas under the demand curve were attributed to the economic development impact. This methodology involves dividing the impact of an airport into two parts: (a) the impact from purchasing air transportation services, and (b) the consumer surplus accruing from a decline in air transportation prices following construction of the facility.

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To identify factors determining the size of the impact, a cross-sectional comparison will be made of the economic impact of two airports, one in an island economy (with few alternative means of transportation and no other airports) and the other in the Dallas-Ft. Worth (DFW) metroplex (with an abundant supply of alternative airports and other modes of transportation).

Although the size of the purchase impact closely relates to diversity of the economy, the size of the consumer surplus is a function of the accessibility of the region, its industrial mix, and the importance consumers attach to continuing operations of the airport. In the DFW metroplex where demand for air transportation was elastic and there were extensive input-output linkages within the economy, there were substantial output multipliers indicating the number of times each dollar spent rolls over within the region. Here, both the absolute and relative sizes of the transportation purchase impact were larger when compared with the island economy ($5.26 billion compared to the island's $3.73 billion for total impact; and $1,571 per capita compared to the island's $612 for per capita impact). In the same economies, because of differences in accessibility and industrial mix characteristics, the relative magnitudes of the consumer surplus were reversed. The DFW region showed a relatively small economic development impact ($1.3 billion, or one-fourth of the purchase impact), whereas the island economy showed a relatively large impact ($11.03 billion) that was three times larger than the purchase impact.

BACKGROUND

Although the idea of using government investment as a tool of promoting economic development by no means started with Keynes, his treatment of the role of government in combating high unemployment gave the notion of benefits from government expenditures vivid urgency that is still present:

> Public works even of doubtful utility may pay for themselves over and over again at a time of severe unemployment, if only from the diminished cost of relief expenditure, provided that we can assume that a smaller proportion of income is saved where unemployment is greater; but they may become a more doubtful proposition as a state of full employment is approached (*1*).

In the postdepression period when high unemployment was prevalent, development benefits from investments in infrastructure projects (e.g., roads, public utilities, and mass trans-

portation) were often used as the rationale for increasing the role of government in the construction of public projects. The first 25 years following World War II was a period of unprecedented federal government involvement in funding public works projects (infrastructure). Several new mass transit systems and the Interstate highway system were the most visible of these commitments.

Beginning in the early 1970s, economic difficulties faced by all levels of government in the United States resulted in rethinking the role of government in the economic development of a region. With the increasing practice of privatization, the question of the economic development impact of infrastructure investment has not lost its relevance, but rather has reemerged with renewed force in the form of benefit fees, assessment districts, and joint ventures.

The common thread running through the postwar activism of the federal government and the privatization trend of the past two decades has been the effort of quantifying the net external benefits that accrue from infrastructure investments. Developing a methodology for estimating net development benefits from these investment projects will gain increasing significance as state and local governments continue to juggle their increasingly scarce funds to complete as many projects as possible.

STUDY OBJECTIVES

The objective is to offer a methodology for dividing the economic impact of an airport so that the entire impact is not attributed to economic development. By dividing the total impact into purchase of air transportation service and consumer surplus, the latter can more appropriately be interpreted as a measure of development impact. Much of the activity generated as part of the purchase impact is a transfer of resources within the economy and would not constitute a net gain to the region.

The rationale behind attributing both development and purchase of service impacts is the notion of external economies. An airport, the argument goes, enhances the accessibility of a region and stimulates further economic development by opening up its consumer and labor markets and improving passenger and goods movement. The forces behind this surge of economic development are the agglomeration (or external) economies that generate cost savings for businesses located in proximity of the airport and also increase their productivity. Local governments, therefore, have an incentive to invest in projects such as airports because they can stimulate economic growth.

Separating the impact of the purchase of air transportation services from the external benefits of the investments would

- Avoid overestimating the development impact by refraining from using a label for an array of resource transfers, and
- Include only incremental benefits to the consumer.

These benefits are measured as the consumers' willingness to pay for the nonmarket benefits of a more accessible region.

Consumer surplus in this context was used instead of the amount business consumers of air transportation would be willing to pay over and above the market rates rather than go without air transportation. In this sense, a measurement was made of the increment to the regional welfare function that is not reflected in the market value of goods and services purchased for airport operations.

A second factor is the derived-demand nature of consumer demand for air transportation. Although the size of the transportation purchase impact is a function of the complexity of the economy and the region's size, the size of the development impact is a function of the derived demand for air transportation in the region and the prevailing level of unemployment. Construction of an airport would lower the price of an input rather than the price of a final product. As the price of air transportation declines, the production levels for firms locating in commuting range of the airport increase and the economy of the region grows because of the following factors:

- More firms substitute the now cheaper air transportation for other modes;
- Firms producing products with a higher income elastic demand grow at a more rapid rate now that the price of one of their inputs has declined; and
- Regions with abundant supplies of labor—either from unemployment or high levels of immigration—and capital, enjoy a further boost in the growth that was earlier fueled by the drop in the price of air transportation.

The interplay of these three factors ultimately determines the size of the development impact of an airport.

THEORETICAL UNDERPINNINGS

Regional economics has assessed the role of transportation improvements in economic development by integrating spatial and gravity models of geographers with the theory of least-cost production. Isard's (*2*) formulations, for instance, maintain that transportation improvements, by removing barriers to the efficient movement of goods and people, maximize the profits for firms and thereby stimulate further growth.

A related and somewhat supply-oriented school of thought, represented by central place theory, focuses on the interrelationships between a firm's location within a system of cities and its production costs. In higher-order cities, the array of services and amenities available to firms reduces production costs, thereby stimulating growth. These cost savings accrue from the establishment of an efficient system of market areas that minimizes transport costs and maximizes profits by providing easy access to inputs, abundant labor supply, and a smooth movement of the final output.

Much of these cost savings (or agglomeration economies) are not internal to the firm or its production technology, but rather are external and a result of more efficient movements of input and output between intermediate and end users. Hoover (*3*) distinguished between two types of agglomeration economies: (a) localization economies that depend on the size of an industry that is centralized in a single location; and (b) urbanization economies that depend on the size of the city and the amenities it offers in terms of more efficient input and output linkages. According to Hoover, economic development gains result from the firms' comparative advantage in market access, adequate supply of labor and materials, and

low costs of transportation and production. The interplay of these market and supply forces

- Attracts new firms to the region;
- Increases demand for the products of existing firms; and
- Increases production in general as firms substitute the now cheaper air transportation as an input in their production process and produces more of the now cheaper final product as well.

EMPIRICAL EVIDENCE

Empirical quantification of the relationship between investing in public infrastructure and economic development has been sparse. Eberts (*4*) tried to quantify gains in regional productivity from a given increase in investment by establishing a moderate and positive link between specific infrastructure investments and gains in productivity. Eberts considered public infrastructure an input, together with labor and private capital, in a citywide manufacturing production function and estimated that a doubling of public infrastructure would lead to a 4 percent increase in manufacturing output in a sample of 38 metropolitan areas. This increase translates to an elasticity of 0.04, i.e., for each 1 percent additional investment in infrastructure, regional productivity grows by 0.04 percent. This rise in productivity is analogous to a slight shift in the regional supply curve subsequent to a lowering of the price of an input.

The overwhelming empirical evidence on the size of the development impact relates to the industrial mix of the region. Numerous studies have indicated that the location of high-technology and research and development (R&D) firms shows a strong and positive association with the presence of airports. In a survey of firms' locational decisions, proximity to an airport was cited as one of the top five factors for high-technology firms. A similar panel study found access to air transportation as one of the top six factors in the locational choice of R&D firms (*5*).

Additional evidence of the positive correlation between the presence of an airport and the growth of high-technology firms is provided by a study of biotechnology firms that found proximity to airports and major research centers to be of major significance (*6*). On the other hand, Anjomani et al. (*7*) suggested that although the presence of an airport in a county showed a positive and significant correlation with manufacturing growth for some four-digit Standard Industrial Code (SIC) sectors, airports showed negative and significant relationships with growth in other sectors.

Although the overall relationship between transportation improvements and economic development is not strong, sector-specific relationships are pronounced. For instance, in a study of metropolitan areas with a high level of air service, only when the type of the industry sector is controlled is employment growth positively affected by a high level of air service (*8*). A study of new airports in Ohio similarly illustrated that when all industry sectors were combined and the overall employment growth was observed, no positive correlation was found between the presence of an airport and employment growth (*9*).

In addition to these findings on the influence of industrial mix, a survey of firms in Pennsylvania showed that advanced-technology firms were more likely than other manufacturing firms to cite proximity to an airport as a locational factor (*10*). The survey further showed that an average of 8.5 percent of the products and services of advanced-technology firms were transported by air, whereas only 1.1 percent of the products and services of all other firms were shipped by this mode.

DATA COLLECTION AND METHODOLOGY

Two types of surveys were conducted to ascertain and divide the economic impacts of two regional airports, one the Dallas-Ft. Worth International Airport and the other a major international airport in an island economy. The first type of survey measured the transportation purchase impact of the airports by measuring the final demand impact of the airport generated as a result of the purchase of air transportation services; whereas the second type measured the economic development impact by estimating the consumer surplus of the nonaviation firms in the region.

FINAL DEMAND IMPACT OF AIR TRANSPORTATION PURCHASE

The air transportation purchase impact of the two airports was measured by estimating the final demand—net of intermediate inputs—of the firms directly connected with airport operations. To estimate final demand, data were collected from all on-airport firms and a sample of off-airport firms. On-airport firms included

- Passenger airlines,
- Cargo airlines,
- Airline suppliers,
- Airport concessions, and
- Airport board and government agencies.

Off-airport firms that were sampled and their impact extrapolated included

- Hotels,
- Travel agencies,
- Airline headquarters and ticket offices,
- Car rentals, and
- Ground transportation agencies.

Expenditures, budgets, revenues, and employment generated in each airport in 1987 were thoroughly inventoried and entered into a data base. Capital budgets were not included in the expenditures to ensure that only the flow of expenditures in the study year were included in the impact.

The transportation purchase impact of an airport can be illustrated as the rectangle under the demand curve that is the product of P (unit price of air transportation service) and Q (quantity of final air transportation-related goods and services produced net of intermediate goods). Figures 1 and 2 show the position of the transportation purchase impact relative to the consumer surplus impact. For the DFW airport, the size of the rectangle was $5.2 billion, whereas for the island economy airport the impact was $3.73 billion. In per

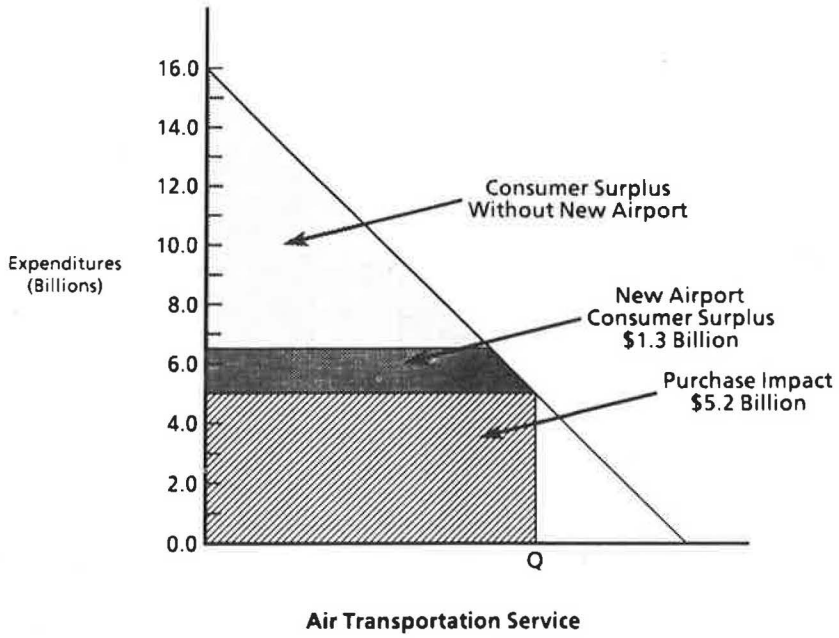

FIGURE 1 Air transportation impact for DFW airport.

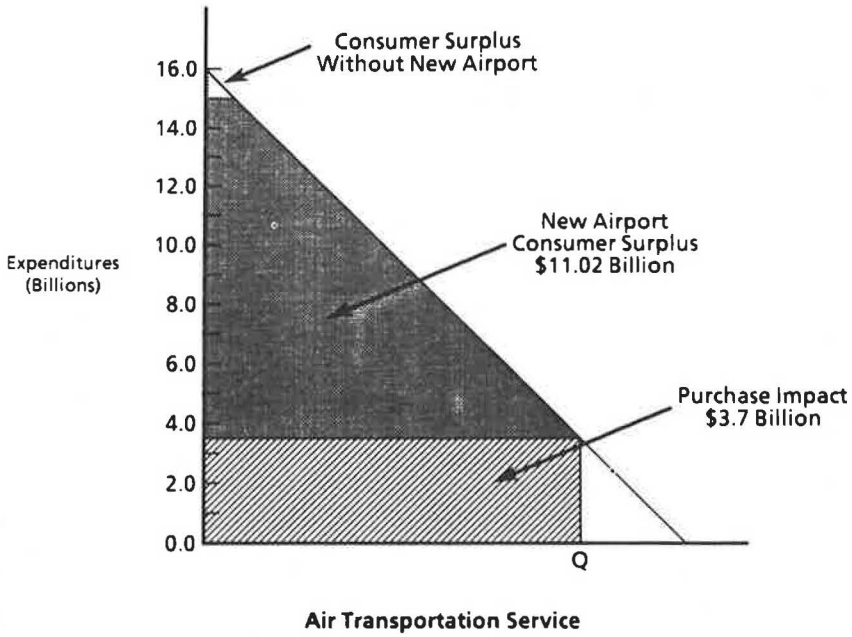

FIGURE 2 Air transportation impact for island airport.

capita terms, this amounted to $1,570 for each resident of the DFW region and $612 for each resident of the island. The overall purchase impact consisted of the primary (direct, first round of air transportation-related expenditures) and secondary (induced-multiplier effect) impacts as follows:

1. Primary Impact. The primary final demand impact for each airport was estimated using the method of National Income Accounting. All airport-related (direct on-airport and off-airport) expenditure flows (net of intermediate purchases) were measured as the primary impact in the sense that they included only the first round of expenditures attributed to the airport (Figure 3 shows the two economies in their primary impact).

2. Secondary Impact. Input-output multipliers (using the RIMS II model generated by the Bureau of Economic Analysis) were used to estimate the induced and indirect impacts. Induced impacts result from the rippling effect through the economy of the first round of expenditures (multiplier effect), whereas indirect impacts result from increased expenditures in all other nonaviation sectors of the economy (Figure 3 shows the sizes of the secondary impact in the two economies).

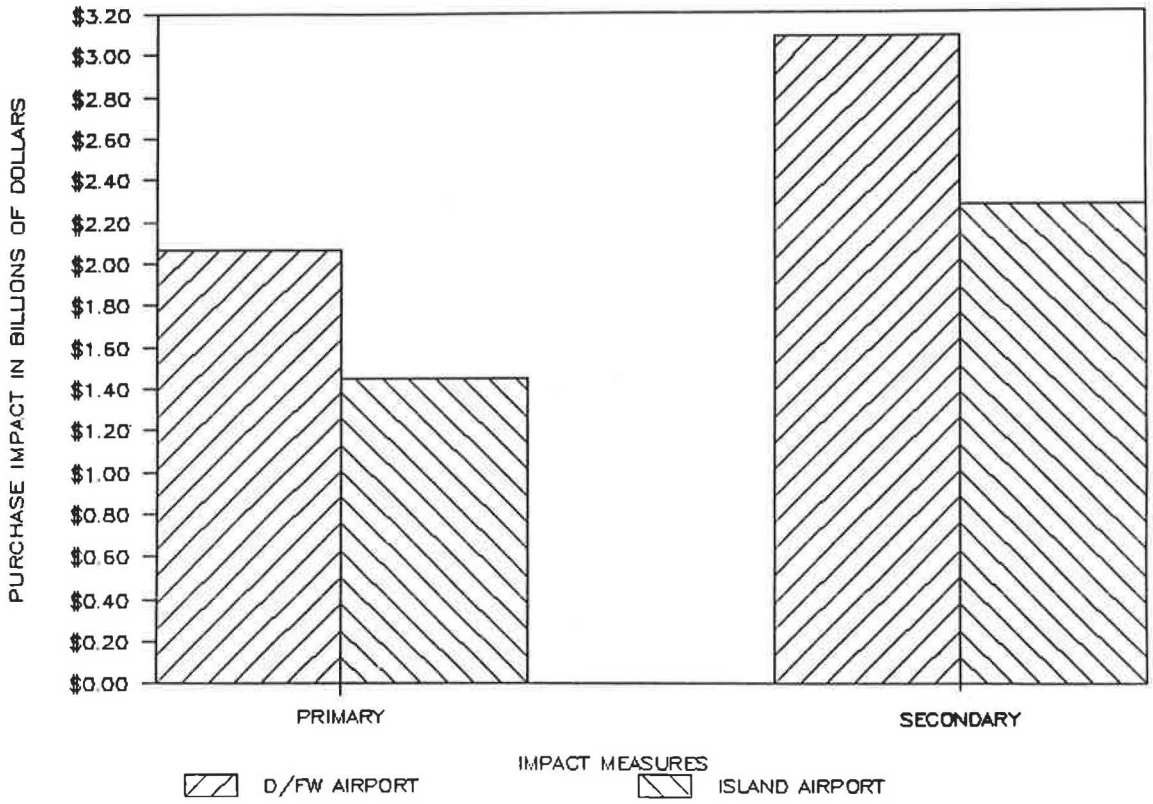

FIGURE 3 Transportation purchase impact: primary and secondary impacts.

CONSUMER SURPLUS MEASURE OF ECONOMIC DEVELOPMENT IMPACT

As a proxy for the economic development impact, a measure of consumer surplus was estimated. A combination of survey methods and econometric modeling was used to measure the value that nonaviation firms in the region received from each airport net of the value generated from the production of air transportation services.

In the sample survey of nonaviation firms (with sampling ratios ranging between 12 and 17 percent), the firms were asked to estimate the percentage of their airport dependency (i.e., revenues that would be foregone without the airport in question). In order to ascertain the magnitude of the dependency, a composite dependency index was developed that consisted of the following responses to hypothetical questions about what the firms would do in the event the airport ceased to exist:

- Whether or not the firm would relocate;
- Whether or not the firm's operating costs would increase; and
- Whether or not any percentage of the firm's revenues would be lost.

Figure 4 shows the percentage distribution of the responses of the firms in the two economies for these questions. The magnitude of the development impact and the firms' degree of airport dependency were estimated by using regression models. The models estimated final demand and the extent of airport dependency by assuming a linear or logarithmic relationship between the dependent variables and responses to such explanatory variables as employment size, the firm's industry category, the firm's product mix, and the probabilities of relocation or financial losses.

Figures 1 and 2 show the size of development impact for the two airports under study. For the DFW region, the development impact was estimated at $1.3 billion, approximately one-fourth the size of the purchase impact. For the island economy, the development impact was $11.03 billion, or three times as large as the purchase impact. In per capita terms, each resident of the DFW region was willing to pay an additional $371 rather than go without the airport. In the island, each resident was willing to pay as much as $1,807 rather than go without the airport.

ANALYSIS AND CONCLUSION

To summarize, the findings of the two surveys corroborated the hypotheses as follows:

- The size of the consumer surplus for the DFW airport was small relative to the overall economic impact, whereas for the island economy the economic development impact was three times as large as the overall impact. Transportation supply characteristics thus strongly influenced the degree of airport dependency of firms, suggesting that the greater the

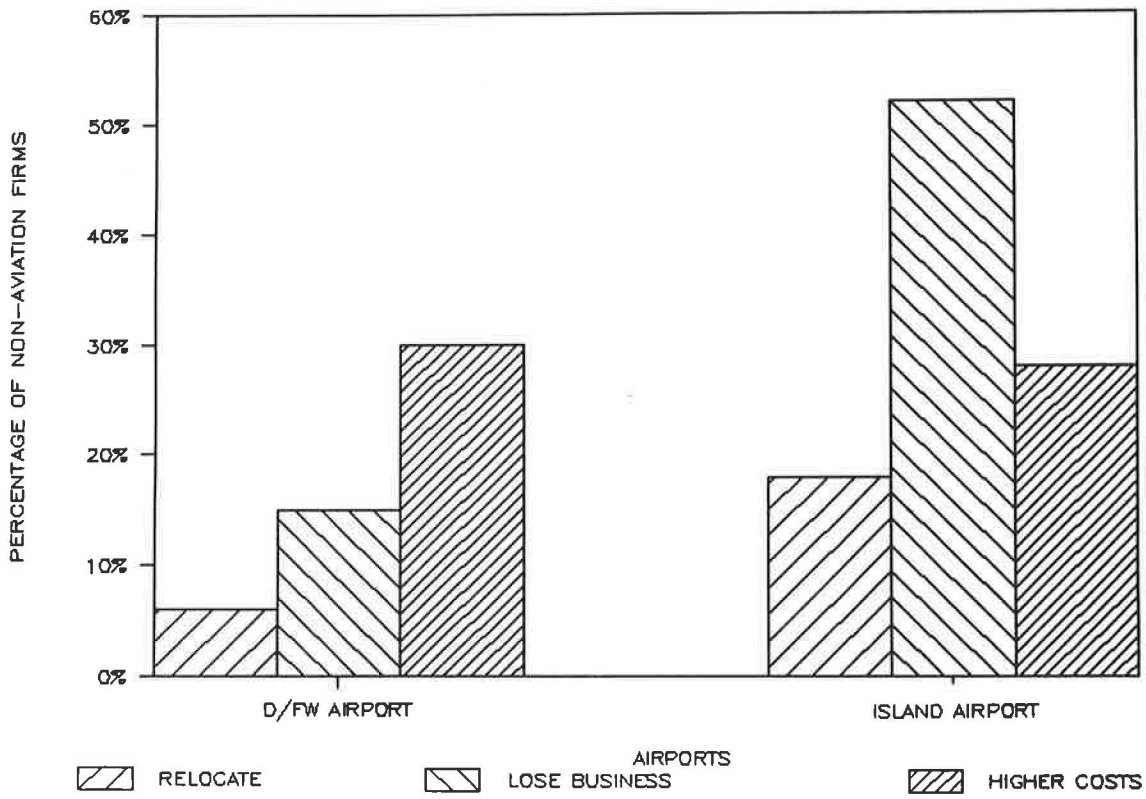

FIGURE 4 Consumer surplus impact: DFW and island airport comparisons.

threat of supply constraints (as in the case of the island) the larger the degree of airport dependency and consumer benefit.

- Substitution of air transportation as an input in production function was done freely by a large number of firms in both study areas. In both regions, the operations of the airport contributed to the overall economic growth.
- Availability of substitute transportation modes and competing airports both emerged as a significant factor in the degree of airport dependency and therefore the size of the consumer surplus. The size of the consumer surplus for the DFW airport, both in absolute terms and relative to the size of the transportation purchase impact, was small because of the proliferation of other transportation modes (especially trucking and rail) and competing airports.
- The size of the consumer surplus for the island airport was larger both in absolute terms and relative to the purchase impact. The strong $11.03 billion impact resulted from the dearth of surface and rail transportation facilities, as well as the monopolistic control of air transportation services by the single airport on the island.
- Firms producing products with a large price elasticity of demand (e.g., high value-added, advanced technology products, or financing and professional services) were more likely to expand production in response to a decline in the price of air transportation. Both in DFW and on the island, firms in these business categories expressed the highest degree of dependency on the airport.
- Elastic supplies of labor, capital, and other inputs allowed the expansion of production prompted by the lowering of prices.
- Transportation supply constraints contributed to the degree of airport dependency and the size of the consumer surplus. For the island, where prospects of capacity constraints were greater, the consumer surplus was proportionately larger.
- The net benefit measure of the consumer surplus should be interpreted as an incremental value rather than a total. In this sense, the larger the range of transportation services available in the region, the less the incremental benefits that consumers perceive. Furthermore, including only the incremental gains in the consumer surplus rather than the total triangle avoids inflating the benefits attributed to the airport.
- The relatively small size of the consumer surplus for Dallas is consistent with the public goods nature of the project and the free rider dilemma. For the island economy, however, the fears of capacity constraint prompted many firms surveyed to move toward the upper bounds of their estimated dependency.

A multitude of factors influence the size of net external benefits from an airport. A naive view, which attributes the entire impact to economic development, ignores that much of the impact often consists of transferred resources, and that such an attribution is justified only in the presence of high unemployment rates. The consumer surplus measurement shows that this component of the impact is rather small partly because of the flaws in the method of stated preferences used in consumer surveys. Consumers tend not to reveal their true preferences because they have the option to be a free rider and enjoy the external benefits of an airport without attaching a dollar value to it. More important, however, the small size of the impact for the DFW area resulted from the saturation

of metropolitan economies with transportation services and the near full-employment status of many urban labor markets in the past decade.

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