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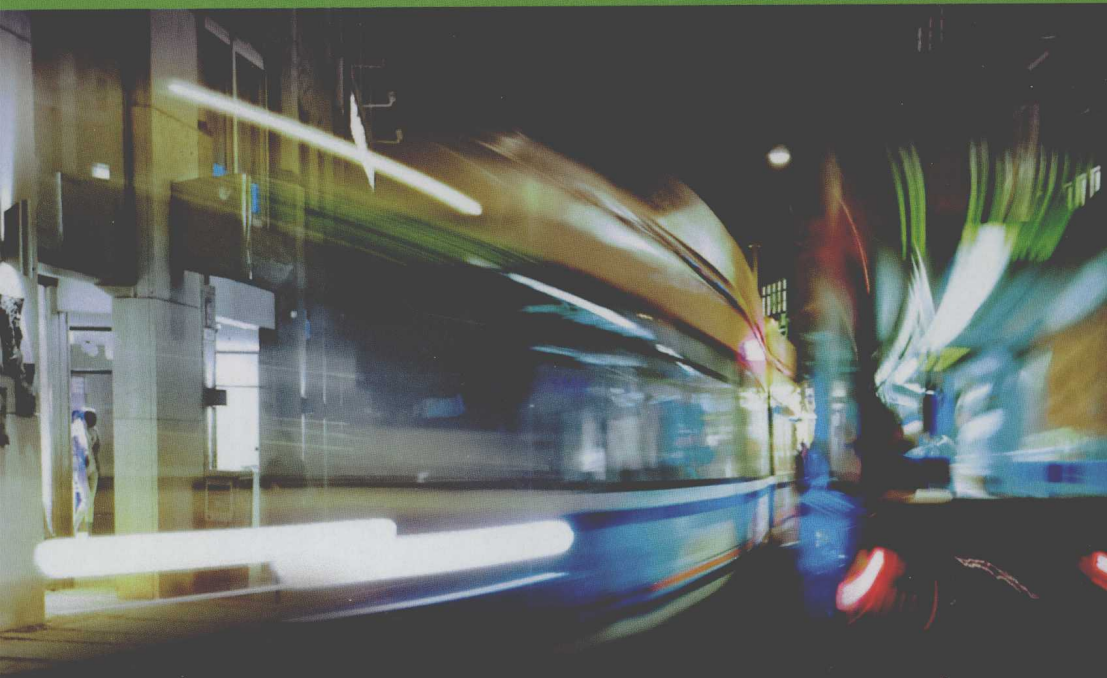

Transportation and Economic Development Challenges

NECTAR Series on Transportation and Communications Networks Research

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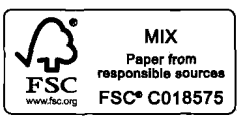

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Preface

This collection of papers stems from a meeting of NECTAR (Network on European Communications and Transport Activities Research) held in Arlington, Virginia in the summer of 2009. As its name suggests, NECTAR is primarily a European-based academic activity, and this was its first transatlantic conference. It is an association with a network culture that has been developed in the framework of a European Science Foundation Network initiated in the late 1980s with the objective of fostering collaboration and exchange of information between experts in the field of transport, communication and mobility. As such, NECTAR is a multidisciplinary, social science oriented activity that brings together a wide range of perspectives on transportation and communication issues and their impacts on society.

NECTAR has numerous thematic seminars and workshops and every two years organizes a major conference. While previous conferences have been in European venues, the 2009 meeting was hosted by George Mason University in Virginia. This collection of papers represents revised contributions to that meeting which focus on the broad theme of transportation and development.

We would like to thank the contributors for the time and effort that has gone into preparing the chapters that make up this volume and hope that readers will find them insightful. Additionally, we would like to acknowledge support for the NECTAR conference from the US Department of Transportation's Research and Innovative Technology Administration through the University Transportation Centers Program, the Free University of Amsterdam, and the University of Las Palmas.

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1. Introduction

Kenneth Button and Aura Reggiani

1.1 INTRODUCTION

Modern, positive economics is generally traced back to Adam Smith's *Wealth of Nations* and, with perhaps less agreement, the normative side to his *Theory of Moral Sentiments*. These books provide a consistent and structured way of looking at both matters of overall economic efficiency and questions concerning the distribution of the gains from this efficiency. In combination, they emphasize that economic efficiency does not automatically correlate with social welfare, although the links are generally strong. The importance of this when considering transportation policies is apparent in many areas, not least of which is the challenge of how to weigh up broader issues of access and mobility with the narrow considerations of increasing more conventionally defined income levels. The focus of the contributions to this edited volume, however, is on the more limited notions of economic development.

Economic development is one of the primary objectives of most democratic governments; dictatorships and despots often have somewhat different goals. But economic development by these governments, whether they are national, state, or local, is not, as we have highlighted, normally seen as simply a matter of maximizing some standard economic index such as gross domestic product (GDP). Certainly there are strong links between trends in GDP and social welfare, if nothing else a fast growing GDP allows governments more flexibility and opportunities in meeting their wider policy agendas. Governments, for example, have clearly been shown to be as much, if not more, concerned over the long term in the distribution of the benefits of economic growth across their populations, even if this has some adverse effects on GDP growth. In a democracy, this is perhaps understandable when there is a need to retain the support of the majority of the population, or at least the median voter, but the longer-term sustainability of more centrally controlled political systems also requires the cultivation of the support of large groups within the populace even if they do not constitute the majority.

In terms of transportation, this has historically meant that road, rail, and other networks have not necessarily linked areas so as to maximize the narrow economic efficient use of resources but have often involved larger objectives of spatial integration and military security. Equally, access to transportation infrastructure is seldom prioritized in terms of maximizing openness to those who would generate the most economic gain from its use, but rather considerations of such things as social equity often dominate. One reason for the direct public involvement in the provision of many major pieces of transportation infrastructure is to increase mobility and enhance social and political cohesion. Nevertheless, the majority of transportation infrastructure involves some degree of public interest in enhancing the economic performance of a country or a region.[1] The public involvement is generally seen as necessitated both by institutional requirements, for example the acquisition of appropriate land to construct the infrastructure, and as an agent to ensure that the economies of optimal connectivity are exploited. The need for a more complete understanding of the role of connectivity and its complex relationship with economic development is, however, required.[2]

In a sense, the underlying issue revolves around how one defines 'development'. Material possessions are relatively easy to quantify and are a standard gauge, although even here there are problems in expressing them in terms of any common unit; certainly using monetary measures such as GDP are far from adequate. The World Bank and United Nations often use measures such as life expectancy, and more recently this has been extended to embrace wider quality of life attributes. While unquestionably having merit, these measures again are influenced by judgments. Development is also sometimes seen as reflected in educational attainments, such as levels of literacy or years of secondary education, on the premise that they reflect the pool of intellectual capital in a society or region. Again deciding on appropriate cut-off points, and the problems of separating out quality from quantity attributes, move the measure away from anything strictly scientific. Perhaps the most tractable approach to defining development is to accept that strict definitions are always likely to be nebulous and to just accept the broad view of such things as expressed in the United States by Justice Potter Stewart, 'I shall not today attempt further to define the kinds of material I understand to be embraced within that shorthand description ["hard-core pornography"]; and perhaps I could never succeed in intelligibly doing so. But I know it when I see it . . .'.

The aim of this Introduction is not to just offer abstracts of the papers in the book but rather to put them into a much broader context, and to spend some time looking at some of the difficulties that exist in trying to relate transportation provision to levels of economic development. While some

of the contributions are mentioned, we try to avoid the contrived nature of many collections and do not try to artificially inject all. The challenges involved in defining transportation strategies that positively stimulate economic growth remain large despite the energies some of the greatest minds have exercised on the topic. This is not very encouraging from an intellectual perspective, and certainly not very helpful in terms of good policy formulation. We begin by looking at what we currently know about the forces influencing economic development.

1.2 WHAT DO WE KNOW ABOUT ECONOMIC DEVELOPMENT?

Given the importance in policy formulation of understanding the underlying forces that shape economic development, very little is known about why some countries or regions develop faster than or differently to others. In the distant past when it has been estimated that economies grew at about 0.5 percent per decade, the issue was perhaps more pressing, but given the very limited expectations and aspirations of the populace at the time, much less explored. The change in attitude came in the late eighteenth century with Smith's work that explicitly considered economic development, and in a rather basic way through his trade and transport analysis, the role of spatial interactions in bringing this about.[3]

The modern formalized theories of economic development, while expressed in a general form by Adam Smith, are usually seen as stemming from the neo-classical model developed by Solow (1956) and Swan (1956) with the focus on changes in the factor endowment of a country or region. In these models, the long-run rate of growth is exogenously determined. In other words, it is determined outside of the model resulting in the common prediction that an economy will always converge towards a steady-state rate of growth and that this rate depends on the rate of technological progress and the rate of factor accumulation. A country with a higher saving rate, for example, will experience faster growth.

Critics of this growth theory cite a number of major limitations of the neo-classical model:

- It relies heavily upon notions of technological change to supply growth in per capita income, but has no mechanism for explaining the sources for such change.
- It offers only a very rudimentary framework for assessing the effects of government policy, and while government actions may not be able to raise long-run growth rates, government interventions do

affect behavior and this, in aggregate, affects the growth path (be it positively or negatively) in at least the short term.

- The model has limited capabilities for analyzing trade between regions or countries and the links between such trade and economic growth; a major weakness as globalization forces have expanded.
- A key assumption of the neo-classical economic growth model is that capital is subject to diminishing returns, but there are many industries that enjoy various forms of scale economies at least for significant variations in output.

Refinements to the neo-classical model came as some of these assumptions were gradually relaxed. Kaldor and Mirrlees (1962), for example, posited the existence of a 'technical progress' function with per capita income treated as an increasing function of per capita investment. Thus 'learning' was regarded as a function of the rate of increase in investment and not exogenous. Arrow (1962) took a more nuanced view that the level of the 'learning' coefficient is not associated with the rate of growth in investment but rather with the absolute level of knowledge already accumulated, a stock rather than a flow concept.

The 1980s saw an up-surge of interest in economic development theory partly because major structural shifts were occurring in the service sector and information based industries. Essentially, changes were taking place at both the technical and institutional levels that were seen as potentially affecting economic growth. According to the 'New' or endogenous growth theory that began to emerge at that time, economic growth can be understood as a process of learning-by-doing, within a firm, within an industry, and within a given spatial jurisdiction such as a region or metropolis. While there were the earlier attempts to indigenize technical progress, much of the credit for the modern formulation of endogenous growth theory is attributed to the likes of Romer and Lucas (Romer, 1994).

The practical challenge in policy making has been in deciding whether the largely supply driven, neo-classical or the endogenous theories have greater validity. Empirically testing the validity of the alternative theories, in the absence of easily quantifiable counterfactuals, has frequently involved looking at secondary evidence, and in particular at evidence shedding light on whether there is convergence in the economic growth paths of regions or, at the macro-level, nations.

The empirical question that is explored becomes one of whether there is convergence in regional economic development rates in, generally, per capita income, as is an outcome of the neo-classical model, but only possible with endogenous growth under rather particular circumstances. The body of empirical analysis that has emerged has been assisted by the availability

of improved data sets as well as new modeling frameworks, enhanced econometric techniques, and better understandings of how to measure convergence. In particular, there has been the development of the concept of β-convergence measures (Barro and Sala-i-Martin, 1992) that have allowed a more rigorous analysis of economic convergence than the more traditional *s*-convergence measure that only normally looks at the variances in regional incomes. The estimation of possible β-convergence involves a mean-reversion calculation with β-convergence occurring if there is a negative relationship between the growth rate of income per capita and the level of initial income. More recent work has made use of β-convergence measures, and embrace a number of sub-national studies, and has tended to find little general support for overall convergence. Those using conditional convergence indicators that allow for homogeneity between, for example, the local economies within a country but also diversity between countries, suggest potential differences in steady-state growth rates for the more local areas, offering little support for the exogenous growth idea.[4]

What does this all mean in broad public policy terms? If there are indeed endogenous growth affects, this would seem to provide decision-makers with some opportunity to intervene to stimulate economic development and to combat spatially divergent growth paths. This contrasts to the Solow model where only a change in the savings rate could generate long-run growth in per capita income. Although when in disequilibrium, the neo-classical model does allow for fairly limited public policy interventions that would *de facto* lubricate the system and facilitate a more rapid move to a steady-state growth path this would not produce movement along it or shift it. In the context of migration, for example, this may involve improved information and enhanced transportation services to allow existing resources to move and be used more effectively along Adam Smith's lines of argument of greater divisions of labor.

If there is endogeneity in the growth process then the policy options are somewhat wider. Since knowledge is important, then diffusion of ideas and broader national policies for R&D can be deployed to bring lagging regions up to the production frontier enjoyed by the leading regions. To stimulate a nation's growth, Romer, for example, in the case of the US, argues for a reduction in the federal deficit to reduce interest rates that would in turn increase the amount of human capital devoted to R&D, by raising the discounted value of any given stream of future revenues associated with a new design. The Romer framework would also suggest subsidies for R&D because of the currently uncompensated external benefits that it generates; in contrast, the Lucas models suggest that those subsidies aimed at economic development need largely to go to the education and training of workers.

There is also a case for freer trade in that it allows for the more rapid diffusion of knowledge and thus breaks down the monopoly of those regions and countries that current enjoy its 'ownership'.[5] More generally, it releases knowledge workers to invent new designs rather than for those in the lagging regions having to expend energies on catching up and effectively continually having to reinvent the wheel. If one accepts Florida's (2005) line of argument that the creative classes are attracted and retained by the larger environment in which they live and work, then investment in various forms of local social and economic infrastructure become important.

1.3 THE ROLE OF TRANSPORTATION

From a policy perspective, if there were indeed endogenous growth affects this would seem to provide decision-makers with some opportunity to intervene to stimulate growth and to combat spatially divergent growth paths. This contrasts with the neo-classical Solow type of model where only a change in the savings rate could generate long-run growth in per capita. Although when in disequilibrium, the neo-classical model does allow for fairly limited public policy interventions that would *de facto* lubricate the system and facilitate a more rapid move to a steady-state growth path but not movement along it. In the context of migration, for example, this may involved improved information and enhanced transportation services to allow existing resources to migrate and be used more effectively along Adam Smith's lines of argument.

If there is endogeneity in the growth process then the policy options are somewhat wider. Since knowledge is important, then diffusion of ideas and broader national policies for R&D can be deployed to bring lagging regions up to the production frontier enjoyed by the leading regions. The role of air travel in this context has been explored and higher growth areas for high-technology developments are mainly at large hub airports that allow for extensive personal interactions between those in the component industries. Equally, at a more micro level, the role of transportation in shaping urban form and scale has been extensively studied, with no clear consensus on the direction of the forces at work.[6]

One of the major difficulties, is that networks, and interactions between various substitute and complementary networks (e.g. transportation, telecommunications, social, and intergenerational networks), are complicated and their consequential effects on economic development are hard to disentangle. The problem has become more pronounced in practical and institutional terms, as transportation and other networks have both played

a major role in facilitating the globalization of trade that has taken place in recent years, and have themselves been shaped by it. Although short-term disruptions to the transportation system have occurred, for example during the SARS epidemic and after the attacks on the United States in 2001, the efforts to rapidly restore transportation services indicate their social, economic, and political importance.

1.4 THE MICROECONOMIC ANALYSIS

While we have largely focused on the broader issues linking transportation and economic development, there are also very practical matters to consider at the more micro level pertaining to decisions regarding individual projects and policies.[7] The options at this level often revolve around which transportation option from a range available best fulfill predetermined strategic goals. That transportation will achieve some level of economic development is effectively taken as axiomatic, and the question becomes one of selection rather than deciding to put resources into transportation per se. In this situation, there are three broad types of assessment tool available, all with their respective pros and cons.

Subjective quantitative assessment involving surveys to elicit the views of experts on how affected parties, often stakeholders in addition to stockholders, are likely to respond to any change in transportation provision. From this information judgments can be made about the economic development effects of alternative policies. The difficulty is to decide who to question, how to question them, and how much weight to put on each of their replies. The potential for capture by vested interests is large, especially if a significant portion of the costs are to be borne by third parties outside of the area of interest or responsibility. But even if the ability to remove this bias exists, the complex interactions between the various actors, and the ways that they assume others will behave, makes it difficult to frame useful questions. Delphi techniques involving iterations of the responses through several rounds allowing participants to modify their answers, offer a partial but incomplete way of circumventing this problem. The development of experimental economics over the past 20 years or more offers a more rigorous methodology but it has yet to be widely applied.

Econometric studies using statistical analysis looking at the impacts of transportation infrastructure on local economic development are fairly limited. They often focus on some particular aspect of the link between the transportation change and economic development, for example local job creation or enhancement of the tax base. The aim of the approach is often

to apportion things like job changes and income effects in a region between various influencing factors including transportation costs and capacity. It does, however, require considerable data, and specifying the appropriate model can be challenging. The ugly head of causality also resurfaces – does improved transportation quality increase the productivity of a region, or do productive regions have more resources to invest in better transportation? While there are techniques that allow econometric analysis to move towards answering this question, such as Granger causality tests, the methods are not ideal and data is generally not readily available.

A common approach often used by consultants to quantify the regional and local economic implications of transportation investment is to use exogenously determined multipliers. A facility goes through a number of stages from its planning to becoming a fully operational piece of infrastructure, and each generates its own particular type of income and employment multiplier effects. We critique these multipliers in the context of a physical investment but they largely hold for any form of policy change.

Primary effects

The primary multiplier stems from the income associated with the multiplicand inherent in construction of the transportation facility and the rounds of expenditure that emanate as part of that money is recycled through the local economy. Its size is often tempered, if there is a need for significant inflows of labor, raw materials, and equipment to plan and construct the facility. Hence, there is a tendency for primary multipliers to decline with the geographical area being considered and with the resources available locally to construct the infrastructure.

Secondary effects

Once a piece of transportation infrastructure is operational, it pumps money into the local economy through the staff that it employs for maintenance and, where applied, net fees collected from users. This income, in turn has multiplier effects on the regional economy. Some forms of transportation infrastructure, such as airports and seaports, can be major employers but there can be a bimodal distribution in the labor force. While transportation facilities do employ many highly skilled and generally highly paid workers, many jobs are unskilled or semi-skilled and thus generate limited income to re-circulate in the local economy.

Tertiary effects

The tertiary multiplier concerns the amount of economic activity drawn to the region by the existence of the enhanced transportation facilities, and with the subsequent ripple effects that results as this pumps income

into the area. These effects can be substantial. For example Memphis Shelby Airport, the major United States airline hub for FedEx, is surrounded by warehouse and distribution facilities that handle products as varied as just-in-time surgery and orthopedic devices, home decor products, and DVDs. At much smaller facilities, the presence of air services is important to companies not necessarily to move their cargo but often in terms of allowing their employees and customers easy access to facilities and markets. High-technology industry makes extensive use of air transportation, as do tourists.

Perpetuity effects

The perpetuity effect is often associated with the development chunks of transportation infrastructure that shift the regional production function upwards by changing the structure of the economy. For example, many islands in the Caribbean and the Mediterranean have seen their economies moving from fishing and agriculture to tourism with the construction of an airport. Additionally, high-technology corridors have emerged on former farmland or where there was more traditional industry. Within many cities, the arrival of metro systems and freeways has stimulated the development of high-technology and bio-technology centers on their outskirts, that have on occasions led to the emergence of an edge city.

It is easy, however, to overestimate local economic development using multipliers. The concept was initially derived as part of closed economy, demand-side macroeconomics in the 1940s when factor supply constraints were not an issue. Many local areas, however, are not initially well endowed with factors and the need to import can limit the size of multiplier effects. It may also not just be a shortage of transportation capacity that is holding local development back but inadequacies in other types of infrastructure, limitations of the local labor force, institutional land-use planning constraints, etc. may be more important. Most empirical work also tends to just transfer macro-parameters that may not be relevant for the region under consideration.

Multipliers analysis often only considers the gross impacts of transportation changes. The initial injection of resources is, however, often from outside the region, for example, and there are opportunity costs associated with resources drawn-in during successive multiplier rounds. In other words there is an opportunity cost involved for the entire economy – essentially a 'crowding-out effect'. In the case, for example, of a road aimed at opening up a tourist area, this may stimulate more tourism in aggregate, but some of the visitors will be attracted away from alternative destinations. As with any activity that allows trade, transportation investments have both a development generation and a development diversion effect.

Finally, multipliers and their disaggregated counterparts, input–output analyses, must be taken in context, and in particular it should be remembered that they were developed to look at the effects of changes in inputs on outputs, and not as tools for assessing the importance of a capital stock. In other words, they are designed for flow analysis and the implications of, say, adding capacity on income or employment. While there may be reasons for using them for looking at changes over time, they were not originally conceived as tools for examining the implications of a stock of inputs on the economic performance of a region. In particular, they assume constant scale effects and a common technology across systems when comparisons are made.

1.5 THE NUMBERS GAME

To assess the impact of any transportation policy on economic development requires reasonable forecasts of the transportation implications themselves – traffic flows, congestion levels, numbers of tons moved, etc. – before any relationship with local income or employment can be established. The empirical evidence, however, is that predicting the internal transportation effects of new infrastructure or a change in regulatory regime is remarkably difficult. This is partly due to inadequate knowledge of causal linkages, but also often reflects a lack of appropriate dynamic data.

Transportation forecasting, as we now understand it, is relatively new, going back to the urban master plans for United States metropolitan areas developed in the 1960s. The early forecasts were largely driven by the prevailing philosophy of the time that urban revitalization would require road capacity to cope with growing automobile traffic and freight deliveries. At the inter-urban level freeways were seen as important to allow trade between cities and for strategic reasons. But the performance of the models used transpired to be uniformly poor. A study in the late 1980s of 41 road schemes in the United Kingdom concluded from a comparison of actual and projected flows that only in 22 cases were the actual flows within 20 percent of the original forecast. Of the remainder, flows ranged from 50 percent below to 105 percent above the original estimate. The forecasts for the M25 London orbital road, for instance, were that on 21 of the 26 three-lane sections the traffic flow would be between 50,000 and 79,000 vehicles a day in the fifteenth year whereas the flow within a very short time was between 81,400 and 129,000.

The later focus on enhancing local public modes of transportation, and in particular transit systems, did not show any demonstrable improvement

in forecasts. The traditional method for transit demand forecasting is to use a conventional gravity model. An oft cited example relates to the *ex ante* Bar Area Rapid Transit (BART) impact study that relied on aggregate gravity model and forecast a 15 percent modal share for BART after its opening. What is of particular note about this, is that the economist, McFadden (2001) applied a disaggregate random utility model to generate an alternative forecast of a 6.3 percent mode shift; the actuality was 6.2 percent. Perhaps more disquieting from a policy perspective, is that despite this, BART did not subsequently adopt disaggregate modeling in its policy analysis. McFadden, of course, went on to win the Nobel Prize in economics, which highlights some of the institutional issues involved.

The recent and larger findings in Flyvbjerg et al. (2002, 2006) look more broadly at forecasting issues across a range of countries and modes of transportation and covering projects of traffic flows and costs. The work provides confirmation of the poor performance of forecasting models. There has in particular been a tendency for over-prediction of capacity utilization and under-prediction of the outcome costs of investments – for example for ten rail projects examined from a variety of countries, the passenger forecasts overestimated traffic by 106 percent, whereas for road projects a tendency is found for the forecasts to be wrong by about 20 percent but the errors were spread equally around the ultimate flows. In terms of costs, an examination of 58 rail projects indicates overruns averaging nearly 45 percent, and for 167 road investments, overruns of 20.4 percent; overall for 258 transportation infrastructure projects examined (including rail, fixed-link and roads) costs are found to be generally underestimated and to be systematically misleading.

Why this happens is not a topic dealt with in any detail here, although it is clear from the studies of Flyvbjerg and others, that much of the problem is not technical, but rather lies in the capture of the forecasting processes by politicians and others with vested interests in producing particular predictions. Here we offer some general comments germane to how positive movements could come about. What is clear, however, is if transportation policy is going to be used properly as an input into economic development initiatives, then reasonably accurate forecasts are important.[8] What also seems to be the case is that many of the past errors in forecasting could have been less if state of the art methodologies had been adopted. The continued reliance on essentially engineering models, rather than accepting that travel decisions are made by individuals who exhibit complex socio-economic behavioral patterns is a persistent short-fall in much policy formulation. One example of this given by Dan McFadden (2001) in his Nobel speech is with regard to transit demand forecasting in San Francisco. The conventional aggregate gravity model forecast a 15 percent modal share