CORE-PERIPHERY DYNAMICS IN THE PORTLAND OREGON REGION: 1982 TO 2006

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Acknowledgments

The authors wish to acknowledge the really significant contributions to this paper of our colleague Bruce Sorte at Oregon State University who was deeply involved in the construction of the multi-regional input-output model and provided constructive comments on earlier versions of this paper. The paper also benefited greatly from the comments of two anonymous reviewers who challenged us to think more deeply about the conceptual framework of our study and to improve the clarity of exposition. None of them share responsibility for any shortcomings of the current paper. Support for the research was provided by the Oregon Agricultural Experiment Station Project ORE 817

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ABSTRACT

The relative strength of positive and negative spillovers of urban development is a long-standing and contested issue in regional and development economics, and the search for spread and backwash effects of development in urban core economies goes back at least 50 years. Using data from IMPLAN and the Bureau of Economic Analysis to develop multi-regional input-output models, we developed estimates of core-periphery economic interdependence (sales and purchases of goods and services and commuting of workers between the core and the periphery) of the Portland Oregon region for 1982 and 2006. We explored whether the changing flows of sales and purchases, spillovers and commuting between 1982 and 2006 suggested a dominance of spread effects or backwash effects. We found increased commuting between periphery and core, decreased core-periphery transactions, and smaller core-to periphery spillovers and periphery-to-core spillovers in both goods and services. Our findings do not point to a clear dominance of spread or backwash effects. Results showing smaller core-to-periphery and periphery-to-core multipliers/spillovers suggest that spread effects related to trade in goods and services weakened between 1982 and 2006. Our findings of increased commuting are consistent with enhanced spread effects in labor markets.

Keywords: Regional economic changes, Economic interdependence, Central Place hierarchy, Portland region, Core-Periphery trade and commuting, Multi-regional SAM model, Spread and backwash effects.

JEL Classification: R11, R12, R15

1. INTRODUCTION

Urban cores and their rural peripheries have long been recognized as economically interdependent. Globalization, technological advances and economies of agglomeration have generated strong growth in many urban centers. Whether this growth in the core will create new opportunities in the periphery or draw resources from the periphery, however, is not clear a priori, and the relative strength of positive and negative spillovers of urban development is a long-standing and contested issue in regional and development economics. Myrdal (1957), explaining development in a third-world context, suggested that growth in core economies would tend to produce "backwash" effects in the periphery, drawing labor and capital out of the periphery. Hirschman (1958) argued that backwash effects would fade over time as the positive effects of development in the core "spread" across space, generating new opportunities in the hinterland.

The core-periphery framework has been applied in a developed nation context for analysis of spread and backwash effects between large urban centers and their surrounding peripheries (Richardson, 1976; Gaile, 1980; Hughes and Holland, 1994; Henry et al., 1999; Partridge et al., 2007)). Core-periphery models in the developed nation context are spatial models that draw on the insights of central place theory to understand the spatial organization of economic activity around large urban centers. Richardson (1976, 1979) extended the static central place concepts underlying the core-periphery models to explore the dynamic spread and backwash spillover implications of investments in "growth poles", suggesting that very long time horizons are needed to evaluate the extent of spread and backwash effects. Richardson also suggested that spread and backwash effects could occur simultaneously. Interest in the spatial dimensions of core-periphery growth was sidelined by the emergence of the New Economic

Geography in the early 1990s. With the maturation of the New Economic Geography models, there is a re-emergence of Central Place Theory (Mulligan et al., 2012) and new interest in core-periphery economic interdependence (Hibbard, et al. 2011; Dabson et al., 2012) and the spatial evolution of urban systems.

The impact of urban core growth on the periphery in developed economies has been explored at various geographic scales over the past several decades. Some studies have analyzed core-periphery economic relationships in particular cores and their surrounding peripheries (Henry et al. 1999, Hughes and Holland, 1994). Others have taken advantage of new GIS capabilities and examined population and employment patterns in large urban systems across the U.S. and Canada (Partridge et al. 2007; Partridge et al. 2008). There has been no research to date, however, that has looked in depth at a single core-periphery regional system to see whether changing core-periphery economic relationships over a long time period suggest the dominance of spread effects or backwash effects. We believe this study of the changes in core-periphery economic interdependence in the Portland, Oregon region[1] between 1982 and 2006 represents the first attempt to examine long-term changes in commuting and core-periphery trade spillover patterns for evidence of the relative strength of spread effects and backwash effects.

2. PREVIOUS CORE-PERIPHERY SPREAD AND BACKWASH LITERATURE

The core-periphery model has its roots in what economic geographers have termed "central-place theory" (CPT) (Christaller 1966). CPT suggests that there is an ordering of cities

[1] The term "region" will be used in this paper to refer to the functional economic area comprised of a core and its periphery. The only exception to this is when we are describing the "three-region" approach to estimating trade flows. In this case, the functional economic area, the core and the periphery are all called "regions".

within a region. At the upper end of the ordering are regional cities, primary cities where all goods and services, including higher-order services are available. When people living in smaller (lower-order) towns and villages need some of these services, they must travel to primary cities to obtain them. Of course, many important goods and services (for example, agricultural products) are necessarily produced in the periphery and tend to flow up and through the primary cities to the rest of the world. The basic idea of CPT is that small towns are not just scaled-down primary cities, but must be viewed in relationship to primary cities in their economic area to better understand all the economic forces at play.

Spread or backwash effects from the growing metropolitan core to its periphery depend to some extent on core and periphery economic structure and on distance. Empirical research has found that there is a spread effect for communities in the periphery closer to the core and a backwash effect for communities in the periphery that are farther away (Barkley et al. 1996; Partridge et al. 2007). For example, growth in the nearest core allows periphery residents to access new jobs (spread effects) (Barkley et. al 1996; Renkow 2003; Partridge et al. 2007). Also, core populations can move to the periphery looking for lifestyle and quality of life, while retaining core employment (Hughes and Holland 1994; Barkley et. al 1996; Henry et al. 1997; Khan et al. 2001; Polèse and Shearmur 2006; Partridge et al. 2007; Partridge et al. 2010). This has a significant impact in labor force growth and residential development in periphery counties (Renkow and Hoover 2000), especially if the core or the core fringe has fast population growth and the periphery county provides quality amenities and public services (Henry et al. 1997). Further, core firms may relocate to periphery areas to take advantage of lower cost inputs or may increase purchases of periphery raw materials (Shaffer et al. 2004; Partridge et al. 2007). The growing core population may present an expanding market for periphery goods and services such recreation (Shaffer et al. 2004; Partridge et al. 2007). However, if the distance is too far, then workers may relocate to cores (backwash effect) (Barkley et al. 1996; Partridge et al. 2007).

Previous studies of spread and backwash have examined population, income and job impacts of core growth on the periphery, and trade flows between core and periphery. Henry et al. (1999), in a study of cores and peripheries of functional economic regions in the U.S., France and Denmark, examined population and employment effects of core growth. They found that there are statistically significant core growth impacts (spread effects) on both population and employment in their peripheries. They found that the size of spread effects appears to depend on the core growth rates and the size of the labor and population zones. Larger zones have larger spread effects, and backwash effects from core growth tend to occur in periphery places with small labor and population zones. Partridge et al. (2007) examined core spread and backwash effects at a national scale in Canada, in a regression analysis of population change. Specifically, they examined how levels and growth of income and population in cores at various distances affected periphery community population change. They found evidence that distance from a core does matter for periphery communities, but that population and income growth in cores have different spread and backwash effects. Core population growth was found to have spread effects up to a distance of 175 km, but that core income growth produces backwash effects for nearby periphery communities of >1500, and spread effects for more distant ones.

Hughes and Holland (1994), in contrast, sought evidence of spread and backwash effects in an examination of trade flows between Seattle-Tacoma core and the rest of Washington State. Hughes and Holland constructed a single-year multiregional input output model for the Seattle-Tacoma core and the rest of Washington periphery. With this single year model, they looked at backward linkages and spillover effects to see if these relationships were consistent with “growth poles" articulated by Richardson (1979). Where "growth poles" exist, growth in the core stimulates growth in the periphery. Strong and growing backward linkages from core to periphery would provide evidence of a growth pole, as growth in the core would generate large spillover effects in the periphery. Hughes and Holland concluded that, for the Washington State economy during the period they examined, there was little evidence that Seattle-Tacoma acted like a growth pole for the periphery. They conclude that "weak backward linkages from major core industries to the periphery lead to rejection of the growth-pole theory tenet that core growth supports periphery growth." (pp. 364-365).

In this paper, we extend previous studies of core-periphery spread and backwash effects by looking at changes over a quarter century in both dimensions of core-periphery economic interdependence (core-periphery sales and purchases, and core-periphery commuting) in a one growing region. Stronger spillovers from core to periphery would provide evidence of growing "trade spread effects". Growth in periphery-to-core commuting would be evidence of increased economic interdependence and consistent with "commuter spread effects"[2]

3. PORTLAND, OREGON, REGION

The geographic size of each central place's periphery depends on the maximum distance people will travel to purchase specific goods or services at a particular location (Berry and

[2] A perceptive reviewer pointed out that in order to know whether increased periphery-to-core commuting was a spread or a backwash effect, one would need additional information about job trends in core and periphery to know whether increased commuting was the result of workers hired into new core jobs choosing to live in the periphery (and thereby bringing new investments into the periphery) or the result of workers losing periphery jobs because of backwash from the core and needing to commute to the core jobs to maintain their income. Earlier spread-backwash studies cited above did not examine commuting directly, but rather inferred increased commuting from results showing that population and job growth in the core led to population growth in the periphery. Periphery population growth implying increased periphery commuting to the core was interpreted as a spread effect. Our commuting results per se do not allow us to draw strong conclusions about spread effects. The fact that both population and jobs were growing in both core and periphery in the Portland region during the 1986-to-2006 period supports an interpretation of increased periphery-to-core commuting as a spread effect.

Garrison 1958b; Olsson 1966; Parr and Denike 1970, Parr 1973). This distance will depend on individual characteristics and the ease of access (Shepard and Thomas 1980). In addition, since businesses need a minimum market size to yield a normal profit (Berry and Garrison 1958a, 1958b; Olsson 1966, Parr and Denike 1970; Deller and Harris 1993; Shonkwiler and Harris 1996; Wensley and Stabler 1998; Henderson et al 2000), they will choose their location to maximize their demand and reduce their cost. The location optimizing decisions by firms and households define the geographic limit of the market. The Bureau of Economic Analysis of the U.S. Department of Commerce has mapped the United States into regions that they call "economic areas" (U.S. Department of Commerce 1975), groups of counties that constitute functional economic regions according to the central-place perspective. We draw on that mapping for this paper.

The Portland, Oregon, region that we examine in this paper includes all of western Oregon and parts of central Oregon and southwest Washington as defined for 1982 by the Bureau of Economic Analysis of the U.S. Department of Commerce[3]. The region is bounded on the north by the Seattle region, on the west by the Pacific Ocean, on the east by the smaller Boise region, and on the south by California (Figure 1).

[3] The 1975 publication of the BEA "The BEA economic areas: structural changes and growth, 1950-73" outlines the definition of BEA economic areas. BEA continually updates the regions to include new counties based on current economic relationships. We used for our 1982 model the BEA regional trade area definition in effect in 1982. For the metro core of our model we used the 1981 Office of Management and Budget definition of the Portland-Vancouver SMSA in effect in 1982. See http://www.census.gov/population/metro/files/lists/historical/80mfips.txt

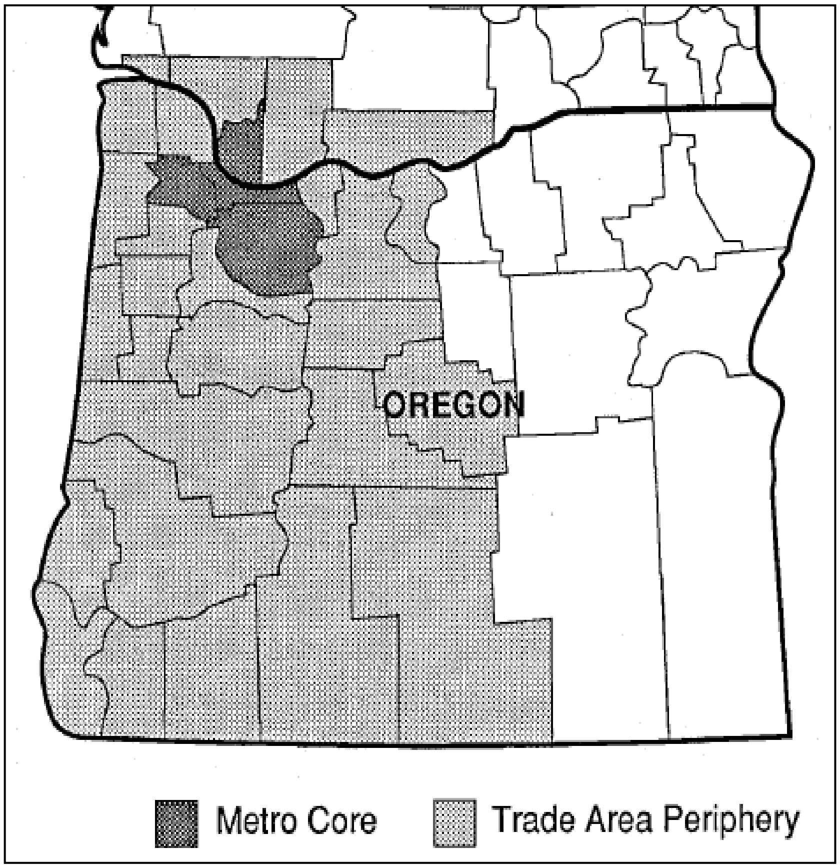

Figure 1. The Portland, Oregon Region: Core and Periphery

The region is relatively large geographically (about 325 miles long and 200 miles wide) and is bisected north-to-south by Interstate 5 (which passes through Portland and through or near four of the Oregon's five other metropolitan areas). The region has as its economic center a relatively populous metropolitan core, which we define as the four counties in the 1982 Portland OR-WA Standard Metropolitan Statistical Area: Multnomah, Washington, and Clackamas counties in Oregon and Clark County in Washington. These core counties are in the northern part of the region. The periphery of the core consists of twenty-three counties in Oregon and four counties in Washington. The periphery area contains the medium-sized cities of Salem, Eugene, Bend, and Medford. Previous studies have shown that the economic relationships between a core and the various cities in the periphery depend in part on the distances between the core and the periphery cities (Barkely, et al. 1996; Partridge et al., 2007). This implies that any spread or backwash effects of core growth are likely to be more powerful in Salem (less than one hour south of Portland), for example, than in Medford (four hours from Portland) or the most distant small towns (up to seven hours away). Our model, however, is not able to incorporate the spatial heterogeneity of the periphery into the analysis, and the relationships estimated in our model represent average values for core and periphery linkages.

The Portland OR region was a $119 billion dollar economy (output in $2006 dollars) in 1982 and output more than doubled during the almost quarter century between 1982 and 2006. The region is relatively self-contained economically, with about two-thirds of its production consumed in the region and one-third exported to the rest of the world.. Table 1 presents some basic statistics on population, personal income, earnings, employment, and output for the Portland region and its core and periphery in 1982 and 2006.

As would be anticipated, the core economy has grown faster than the periphery. Output (sales) in the core economy more than tripled over the 1982-2006 period, whereas in the periphery output only doubled in size. Core and periphery produced about the same amount of output in 1982, but the core economy was half again as large as the periphery in 2006.

Jobs and earnings grew faster than population over the period 1982-2006: jobs increased 51% from 1.1 million to 1.7 million and earnings grew 159% from just under $35 billion to almost $90 billion, while population increased only 43% from 2.8 million to over 4 million. Because other sources of income grew more slowly than earnings, total personal income increased only 115% from 65 billion to 140 billion.

Table 1. Economic Profile of the Portland Region Core and Periphery in 1982 and 2006

	Year	Core	Periphery	Total Region
Population (Thousands)	1982	1,272	1,536	2,808
	2006	1,951	2,073	4,024
	Change (%)	53	35	43
Total Personal Income (Millions of $ 2006)	1982	33,450	31,801	65,251
	2006	76,027	64,244	140,271
	Change (%)	127	102	115
Total Earnings by Place of Residence (Millions of $ 2006)	1982	18,438	15,925	34,363
	2006	51,751	37,296	89,047
	Change (%)	181	134	159
Total Full and Part-time Jobs by Place of Work (Thousands)	1982	586	562	1,148
	2006	918	818	1,736
	Change (%)	57	45	51
Total Output (Sales in Millions of $ 2006)	1982	58,567	60,669	119,236
	2006	187,716	120,022	307,738
	Change (%)	220	98	158

Source: Population and Personal Income: U.S Department of Commerce, Bureau of Labor Statistics; Full- and Part-time Jobs by Place of Work and Earnings by Place of Residence: U.S. Department of Commerce, Bureau of Economic Analysis; Output (sales): IMPLAN.

In 1982, the core had 45% of the total region population, 51% of the personal income, 54% of the earnings, and 51% of the jobs. By 2006, the core shares had increased on all these measures by 2 to 4 percentage points: to 48% of the population, 54% of the personal income, 58% of the earnings and 53% of the jobs.

4. THE MULTIREGIONAL SAM ACCOUNTS

Multiregional input-output models (MRIO) capture core-periphery links as well as the within-core and within-periphery inter-sectoral economic interdependence (Leontief and Ford, 1970; Miller and Blair, 1985). Thus, with an MRIO model, we can trace how an economic shock in one or more sectors in the core, for example, spills over to affect sales in all sectors in the periphery (Miller and Blair, 1985; Holland, Weber, and Waters, 1992).

We construct our MRIO model on the Social Accounting Matrices (SAM) framework. In addition to showing interindustry linkages, the SAM accounts identify the economic linkages between household income and household expenditures, between government revenues and government spending, and between saving and investment (Holland and Wyeth, 1993).[4]

The resulting MRIO model based on SAM accounting identifies linkages across the core and periphery according to industry, factor of production, and household income class (Table 2).

Table 2: Schematic of Major Blocks of the MRIO Model

CORE-CORE ACCOUNTS	PERIPHERY-CORE ACCOUNTS
CORE-PERIPHERY ACCOUNTS	PERIPHERY - PERIPHERY ACCOUNTS

5. BUILDING THE MRIO MODEL

To construct the core-periphery MRIO model of the Portland region, core and periphery labor services flows were combined with estimates of commodity trade flows and information from the IMPLAN[5] regional modeling system.

In creating the model, we treated household income and expenditures in the core and periphery as "endogenous," meaning that the spending of this income has the effect of increasing demand and output in the part of the region (core or periphery) where it is spent. We identified

[4] For further discussion of these accounts see Holland and Wyeth (1993)

[5] IMPLAN is a commercially available database and software that can be used to construct input-output models for any county or combination of counties in the United States. IMPLAN uses secondary data on employment by sector in combination with Leontief type production functions to estimate industry output and value added for any county or multi-county economic region. Regional estimates of other input-output accounts are provided as well. The weakness of the IMPLAN system is the lack of primary data on many economic aspects or regional economies that are estimated by the IMPLAN system by appeal to secondary data and the assumption of Leontief production technology. The strength of IMPLAN is that it provides a balanced regional social accounting matrix (SAM) that assures that all SAM accounts, such as regional commodity supply and regional commodity demand, are balanced at the regional level.

nine distinct household income classes for the Portland core and periphery from IMPLAN data. The model identifies linkages across core and periphery according to industry, factor of production, and household expenditures by household income class. Thus the model is able to show how a shock to the periphery economy affects economy wide industry output and household income in the periphery, and in the core.

The model assumes that consumption for each household income class is a function of the personal income received by that household group: households spend, save and pay taxes on what they earn. Personal income is the sum of employee compensation, proprietors' income, government transfers, and property income. Employee compensation and proprietors' income as measured in IMPLAN was assumed to flow between core and periphery in proportion to core-periphery flows of earnings, as described below. All "other property income" generated in the core and periphery was assumed to be paid to capital owners in each of the respective component of the functional economic area or distributed to capital owners outside the combined functional economic area. Core-periphery flows were assumed zero. Payments of interest, dividends, and rent to households and government transfers in the core and periphery were treated as exogenous and were derived from the IMPLAN Social Accounting Matrix (SAM) constructed for core and periphery. As is conventional in SAM-type models, employee compensation and proprietors' income are assumed to be distributed in fixed but different proportions across the size distribution of households in the core and periphery.

5.1 Labor and Earnings Flows Estimation

We calculated labor flows using the information published by the US Census Bureau in the "United Stated Census 2000, County-To-County Worker Flow Files". Then, we constructed earnings flows using data from the Bureau of Economic Analysis, Regional Economics

Accounts, in "CA04 — Personal income and employment summary"[6] table for the year 2006. Finally, we used the RAS technique[7] to modify slightly each estimated flow to ensure that the sum of earnings flows by place of work and by place of residence match their respective totals obtained from the data set[8].

5.2 Estimating Commodity Trade Flows Between Core and Periphery

The nature of trade in and between regions was categorized according to a Central Place Model as modified and developed by Parr (1987). In this model the central place system contains a number of hierarchical levels of settlement with lower level communities depending on supply of central place goods from higher-level places extending up to primary cities. The primary cities are important suppliers of higher order services and goods to secondary places in the functional economic area.

In addition, Parr identifies what he calls specialized goods. These goods will have the advantages of low cost of transportation or advantages of climate or a special amenity that give such goods the ability to trade in national and international markets. Trade in specialized goods can flow across the hierarchy of places as well as up the hierarchy to national and international primary cities.

Goods and services trade between core and periphery in the Portland region was estimated using the information produced by the IMPLAN Commodity Trade Report and the Commodity Summary Report (Hughes and Holland, 1994) and (Holland and Pirinque, 2000). Three approaches were developed to estimate possible trade between core and periphery:

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6 http://www.bea.gov/regional/reis/default.cfm?catable=CA04

7 RAS is an iterative procedure for adjusting a matrix in which elements of a matrix are adjusted proportionally to sum to preassigned row and column totals. This technique is well described in Miller, R. and Blair, P. 1985. *Input-Output Analysis, Foundations and Extensions*, page 276.

8 For further details about labor and earning flows estimation, please see Holland et al. 2009.

Maximum Possible Trade Approach, the Supply-Demand Pool Approach and the "Three Region" Approach. Each approach uses the IMPLAN regional purchase coefficient (RPC) estimates for each commodity in each model (core, periphery, and entire Portland region) and IMPLAN estimates of commodity imports and domestic and foreign exports by commodity to generate estimates of trade between core and periphery.

Maximum Possible Trade Approach: For each commodity, this approach identifies the maximum possible trade that could occur between the core and periphery. Maximum sales from the core to the periphery are equal to the lesser of core sales and periphery purchases of a particular commodity. Likewise, maximum periphery sales to the core are defined as the lesser of periphery sales of the commodity and core purchases.

The Supply-Demand Pool Approach: The approach assumes trade will only take place in the functional economic area when the core or the periphery is in excess supply and the other is in excess demand of a particular commodity. Excess supply is defined as net commodity supply being larger than gross regional commodity demand. Excess demand is defined as gross commodity demand exceeding net commodity supply.

The Supply-Demand Pool Approach determines only the levels of sales and does not allow for transshipments between the core and periphery for a given commodity. If the core has an excess demand for natural resource commodities and the periphery and excess supply of those commodities, then the expected trade would be from the periphery to the core. Likewise, if the periphery has an excess demand for higher ordered commodities and the core has excess supply, then the expected trade flow would be from the core to the periphery.

The "Three Region" Approach: This approach uses the trade information from the core, periphery, and the functional economic area to estimate trade between the core and periphery. The functional economic area is simply the aggregate of core and periphery. A separate model is estimated in IMPLAN for the functional economic area. The approach is based on the idea that if the exports from the core, periphery, and functional economic area are known, the sales between the core and periphery can be estimated as a residual after exports out of the functional economic area have been estimated. This approach assumes that trade will only take place between core and periphery when one of them is in excess supply and the other is in excess demand of a particular commodity.

If the exports from the functional economic area are less than the sum of exports from the core and periphery, this implies that there must have been trade between core and periphery to account for the additional exports associated with the core and periphery total. These core-periphery sales must be accounted for by core sales to the periphery plus periphery sales to the core. If the exports from the functional economic area are equal to the sum of the exports from the core plus the periphery, this implies that all the exports from the core and periphery were shipped outside the functional economic area.

The final step was to identify every commodity for which we had IMPLAN data as a specialized good, as a central place good or as a low value-high weight good where little trade outside the functional economic area would be expected. We used the "three-region" approach to estimate trade for specialized goods (commodities) that would be expected to trade nationally and internationally because this approach makes no presumption of one-way interregional trade[9]. For central-place-type goods and services where considerable one way trade across the Central Place hierarchy was expected; for example: furniture and home furnishings stores, selected

[9] When the "three-region" approach presented inconsistency problems for a given commodity (i.e. when exports from the functional economic area were greater than the sum of exports from the core plus the periphery), we used the supply-demand pool approach. See Holland and Pernique (2000) for a more extended discussion of the complications involved in using these different approaches to trade estimation.

medical care services, etc. we used the supply-demand pool approach which emphasizes one way trade-- from excess supply to excess demand. Finally, we used the maximum trade approach for high-weight and low-value commodities, such as concrete blocks and ready mix concrete. These goods would be expected to be traded mainly between core and periphery and only minimally exported from the functional economic area.

6. THE PORTLAND OREGON CORE-PERIPHERY SAM MODEL[10]

Using procedures and protocols described in the previous section, multiregional core-periphery input-output (with SAM accounting) models of the Portland, Oregon, region (functional economic area) were created for both 1982 and 2006. This section of the paper compares both models to examine how the economic interdependence of the core and its periphery changed between1982 to 2006.

6.1 Commuting Between Periphery and Core

Estimates of labor and earnings flows for 1982 are shown in table 3, with earnings reported in inflation-adjusted 2006 dollars. Each earnings flow appears below the corresponding labor flow. Reading across the rows, we can see, for example, how many of the 568,916 workers who lived in the core in 1980 worked in the core (555,857), how many worked in the periphery (8,434), and how many worked outside the functional economic area (4,625). Reading down the column, we note that for the 586,074 people who worked in the core, only 555,857 lived in the core, with 15,917 commuting into the core from the periphery and 14,300 commuting in from elsewhere i.e. outside the functional economic area.

[10] This section of the paper draws heavily on Holland et al. (2011)

Table 3: Labor and Earnings Flows between the Core and Periphery 1982

Place of Residence (P.o.R)	Flows	Place of Work (P.o.W)			Total Full- and Part-time Workers by P.o.R	Total Earnings by P.o.R ($000 of 2006 dollars)
		Core	Periphery	Elsewhere		
Core	Labor	555,857	**8,434**	4,625	568,916	
	Earnings ($000)	17,921,323	**345,977**	171,109		18,438,409
Periphery	Labor	**15,917**	547,431	33,013	596,361	
	Earnings ($000)	**340,857**	14,915,804	668,417		15,925,078
Elsewhere	Labor	14,300	5,949			
	Earnings ($000)	403,884	213,782			
Total Full- and Part-time Jobs by P.o.W		586,074	561,814			
Total Earnings by P.o.W ($000 of 2006 dollars)		18,666,064	15,475,562			

Source: Holland et al (1993). U.S Department of Commerce, Bureau of Census (1980); U.S. Department of Commerce, Bureau Economic Analysis (1988)
Note: Labor statistics are for 1980 and earnings statistics are for 1982. Gross Earnings by P.o.R are inclusive of Social Security Insurance by P.o.W. Jobs include full- and part-time jobs.

Estimates of labor and earnings flows between core and periphery for 2006 are shown in table 4. The number of periphery-to-core commuters roughly tripled from 1982 to 2006; the number of core-to-periphery commuters also increased over this period, though not nearly so much.

Table 4: Labor and Earnings Flows between the Core and Periphery, 2006 ($000)

Place of Residence (P.o.R)	Flows	Place of Work (P.o.W)			Total Full- and Part-time Workers by P.o.R	Total Earnings by P.o.R ($000 of 2006 dollars)
		Core	Periphery	Elsewhere		
Core	Labor	866,761	**18,575**	7,839	893,175	
	Earnings ($000)	50,287,477	**888,001**	575,514		51,750,992
Periphery	Labor	**44,932**	793,472	9,166	847,570	
	Earnings ($000)	**2,368,396**	34,463,113	464,318		37,295,827
Elsewhere	Labor	6,151	5,949			
	Earnings ($000)	281,640	224,448			
Total Full- and Part-time Jobs by P.oW.		917,844	817,996			
Total Earnings by P.o.W ($000 of 2006 dollars)		52,937,512	35,575,563			

Source: U.S. Department of Commerce, Bureau of Economic Analysis, Regional Economic Accounts; U.S. Census Bureau, United State Census 2000, County-to-county worker flow files. Note: Labor statistics are for 2000 and earnings statistics are for 2006. Gross Earnings by P.o.R are inclusive of Social Security Insurance by P.o.W. Jobs include full- and part-time jobs.

Table 5: Percentage of Core and Periphery Jobs and Earnings Going to Residents of Each Region, 1982 and 2006

Place of Residence	Flows	Place of Work			
		1982		2006	
		Core	Periphery	Core	Periphery
Core	Labor	94.8	**1.5**	94.4	**2.3**
	Earnings ($)	96.0	**2.2**	95.0	**2.5**
Periphery	Labor	**2.7**	97.4	**4.9**	97.0
	Earnings ($)	**1.8**	96.4	**4.5**	96.9
Elsewhere	Labor	2.4	1.1	0.7	0.7
	Earnings ($)	)2.2	1.4	0.5	0.6
Total Jobs by P.o.W		100	100	100	100
Total Earnings by P.o.W		100	100	100	100

Commuting linkages between core and periphery have grown stronger as the core has grown, both in numbers of commuters and also relative to the size of the respective labor forces.

Although both core and periphery represent relatively self-contained labor markets (about 95% of core and 97% of periphery workers are residents of their respective areas in both 1980 and 2000), the commuting ties between core and periphery have greatly strengthened over the decades since the 1980s. In 1980, only 1.5% of the periphery labor force originated in the core, while roughly 2.7% of the core labor force originated in the periphery. By 2000, 2.3% of the periphery workforce commuted from the core, and 4.9% of the core workforce commuted from the periphery.

6.2 Trade Between Core and Periphery

In 1982, the economies of the core and the periphery were roughly equal in terms of size, as measured by total sales (table 6). The core economy exported 37% of its production—a sign that its economy was relatively open to both its periphery and the rest of the world. There was significant trade with the surrounding region: 20% of core's sales went to its periphery communities and consumers. The core imported slightly more goods and services than it exported, but the net trade balance between core and its periphery was positive and large, with the value of core's sales of goods and services to its periphery ($2.4 billion) more than twice the value of its purchases from the periphery ($1.0 billion).

The economy of the periphery was similar, exporting 38% of production and importing 44% of the periphery's purchases of goods and services. Only 8% of the periphery's sales, however, went to the core. More than $2.4 billion flowed from the periphery to core on the trade account, most of it in the service sector (table 6).

Table 6: Core-Periphery Goods and Services Trade (1982, $millions)

From		**To**			
		Core	**Periphery**	**Elsewhere**	**TOTAL SALES**
Core	Total	19,619	**2,400**	9,408	31,427
	Goods	4,017	**709**	5,630	10,356
	Services	15,602	**1,691**	3,778	21,071
Periphery	Total	**1,039**	20,029	11,487	32,555
	Goods	**749**	5,848	10,197	16,794
	Services	**290**	14,181	1,290	15,761
Elsewhere	Total	11,313	13,447		
	Goods	7,650	8,958		
	Services	3,663	4,489		
TOTAL PURCHASES	Total	31,971	35,876		
	Goods	12,416	15,515		
	Services	19,555	20,361		

Source: Holland et al, 1993. Using IMPLAN data.

Between 1982 and 2006, output grew in both core and periphery, but the core's growth was much faster. Because of these changes, the core's overall (goods and services) trade surplus with the periphery was more than $5 billion in 2006. Most of the trade surplus was generated in the service sectors, with service sales from core to periphery of $5.53 billion and sales of services from the periphery to the core of $855 million (table 7).

Table 7: Core - Periphery Goods and Services Trade (2006, $millions)

From		**To**			
		Core	**Periphery**	**Elsewhere**	**TOTAL SALES**
Core	Total	115,271	**7,402**	65,044	187,716
	Goods	19,610	**1,869**	40,667	62,146
	Services	95,661	**5,533**	24,377	125,570
Periphery	Total	**1,816**	81,874	36,331	120,022
	Goods	**961**	14,372	25,379	40,712
	Services	**855**	67,503	10,952	79,310
Elsewhere	Total	61,712	46,900		
	Goods	36,191	31,116		
	Services	25,521	15,784		
TOTAL PURCHASES	Total	178,799	136,176		
	Goods	56,762	47,357		
	Services	122,037	88,820		

Source: Holland et al, 2011 and 2006 IMPLAN data.

Core-periphery linkages have declined over time in relative terms. In 1982 the core was selling roughly 8% of its output to the periphery. By 2006, sales to the periphery represented only 4% of its output. The relative importance of core-periphery trade declined in part because, over the same interval, the core's exports to the rest of the world grew dramatically: the proportion of goods and services production that is exported from the core to the rest of the world increased from 30% to 35%.

Table 8: Goods and Services Trade 1982 and 2006 (Percentage of sales)

		1982				2006			
From		To				To			
		Core	Periphery	Elsewhere	Total	Core	Periphery	Elsewhere	Total
Core	Total	62	**8**	30	100	61	**4**	35	100
	Goods	39	**7**	54	100	32	**3**	65	100
	Services	74	**8**	18	100	76	**4**	19	100
Periphery	Total	**3**	62	35	100	**2**	68	30	100
	Goods	**4**	35	61	100	**2**	35	62	100
	Services	**2**	90	8	100	**1**	85	14	100

Source: Tables 5 and 6

Periphery-core trade also declined in relative terms, in part because periphery inter-industry linkages grew rapidly. In 1982 the periphery was selling 3% of its goods and services to the core; by 2006, the figure was 2%. As economic activity has diversified and become more geographically dispersed in the last quarter-century, some specialized goods and services that were once available only in the core, such as specialized medical and business services, have become available in some cities in the periphery. The result has been a relative weakening in the trade linkages between the core and its periphery as the periphery has become more self-sufficient. Goods and services both produced and consumed in the periphery increased from 62% of output in 1982 to 68% of output in 2006.

6.3 Trade with Rest of the World

A comparison of tables 6 and 7 shows that the core's rate of economic growth was much faster than that of the periphery. This growth was led by the expansion of goods exports from the core to the rest of the world and coincides with the emergence of both microprocessors and sports apparel as signature core industries.

Goods exports from the core to the rest of the world were growing at several times the rate of goods exports from the periphery. By 2006, the core had transformed itself into an export-driven economy with a positive trade balance, something that was not the case in 1982. The periphery, on the other hand, with its mix of resource-based goods, was less successful in expanding its exports and continued to have a negative trade balance (tables 6 and 7).

6.4 Multipliers and Spillovers in the Core-Periphery SAM Model

Over the past quarter-century, the functional economic area has grown rapidly and has experienced significant changes in industrial structure and in the relationship between its core economy and that of the periphery. In the period between our two studies, decreasing transportation costs and improved communication technology have enabled both the core and periphery economies to expand export sales to more-distant markets. Likewise, imports from more-distant places have become increasingly available and have expanded.

At the same time, these forces have encouraged the decentralization of some parts of the marketing and service sector; some firms or functions that were once at home only in the core have migrated into the periphery. Regional centers in the periphery have taken over medical procedures as well as retail and wholesale functions that formerly were conducted in the core. The result has been a weakening of the central-place hierarchy as a description of economic organization over the economic area investigated here.

Output Multipliers

Household-endogenous output multipliers are derived from the Leontief inverse matrix of the multiregional transactions tables as well as sections of the SAM showing household income and expenditure linkage. The within-core and within-periphery output multipliers are the column sums of inter-industry coefficients in the diagonal blocks of this matrix (table 2). The core-to-periphery and periphery-to-core multipliers are the column sums of inter-industry coefficients in the off-diagonal blocks of the inverse matrix. They show, respectively, the output change in the periphery for a one-unit change in the exogenous demand in the core, and the output change in the core for a one-unit change in the exogenous demand in the periphery.

These output multipliers for the core and periphery are shown in table 9. The within-periphery effect in 2006 of a $1 increase in crop exports in the periphery, for example, is a $1.59 increase in total output in the periphery economy. Simultaneously, because the periphery-to-core multiplier for the core is 0.12, this periphery crop export would result in a $0.12 increase in total output in the core. The sum of the within-periphery and periphery-to-core effects yields the periphery total effect, i.e., the total effect of the increase in periphery exports on the entire functional economic area. Thus, in our example, a $1 increase in periphery crop exports would generate a $1.71 increase in output in the entire functional economic area.

Within-core multipliers, as expected, are larger than within-periphery multipliers. The unweighted average within-core multiplier in 1982 was 1.71, compared with a within-periphery multiplier of 1.60. These averages mask a lot of heterogeneity: within-core multipliers for 1982 range from 1.42 for insurance to 2.12 for wood products.

Except for some major natural resource industries (crops and wood products) for which within-core multipliers and within-periphery multipliers declined from 1982 to 2006, most within-core and within-periphery multipliers increased over this time period. The average within-core multiplier increased from 1.70 to 1.77, and the average within-periphery multiplier increased even more, from 1.60 to 1.74 indicating increased sectoral interdependence within core and periphery. This was especially true for the periphery's service industries, for which virtually all multipliers increased over the time period (table 9). This indicates import substitution on the part of many periphery industries, as formerly imported goods and services have been replaced by those produced by firms in the periphery.

Core-to-periphery and periphery-to-core multipliers, as expected, show a different pattern, with the latter being considerably larger than the former. The core-to-periphery output multipliers for 1982 range from 0.03 (for insurance and real estate) to 0.25 (for woods products manufacturing) (table 9). The magnitude of these output multipliers is a rough indication of a particular core industry's backward linkage to (input purchases from) the periphery.

Table 9: Core and Periphery output multipliers for Portland Oregon Region, 1982 and 2006

Sector	**1982**						**2006**					
	Core			**Periphery**			**Core**			**Periphery**		
	Within Core	**Core-to-Periphery**	**Core Total**	**Within Periphery**	**Perhphery-to-Core**	**Periphery Total**	**Within Core**	**Core-to-Periphery**	**Core Total**	**Within Periphery**	**Periphery-to-Core**	**Periphery Total**
Crops	1.82	**0.13**	1.95	1.63	**0.18**	1.81	1.57	**0.04**	1.61	1.59	**0.12**	1.71
Livestock	1.65	**0.13**	1.78	1.77	**0.18**	1.95	1.65	**0.09**	1.75	1.90	**0.17**	2.07
Forest Products & Logging	1.78	**0.18**	1.96	1.84	**0.14**	1.98	1.78	**0.03**	1.80	1.91	**0.20**	2.11
Commercial Fishing	1.53	**0.06**	1.59	1.37	**0.13**	1.50	1.81	**0.04**	1.85	1.89	**0.18**	2.07
Landscaping & Ag. Services	1.75	**0.11**	1.86	1.60	**0.18**	1.78	1.81	**0.06**	1.87	1.79	**0.15**	1.94
Mining	1.58	**0.08**	1.66	1.48	**0.14**	1.62	2.04	**0.06**	2.09	1.58	**0.17**	1.75
Construction	1.80	**0.08**	1.88	1.60	**0.20**	1.80	1.76	**0.06**	1.82	1.70	**0.14**	1.83
Other Manufacturing	1.60	**0.08**	1.68	1.50	**0.19**	1.69	1.78	**0.09**	1.87	1.86	**0.22**	2.08
Food Processing	1.69	**0.19**	1.88	1.79	**0.25**	2.04	1.71	**0.04**	1.75	1.56	**0.15**	1.71
Wood Products	2.12	**0.25**	2.37	2.18	**0.21**	2.39	1.88	**0.06**	1.94	1.87	**0.19**	2.06
Pulp & Paper	1.69	**0.13**	1.82	1.66	**0.19**	1.85	1.65	**0.04**	1.69	1.68	**0.19**	1.87
Electronics & Instruments	1.68	**0.07**	1.75	1.55	**0.20**	1.75	2.01	**0.05**	2.06	1.75	**0.21**	1.97
Transportation	1.94	**0.07**	2.01	1.58	**0.18**	1.76	1.76	**0.05**	1.81	1.74	**0.14**	1.88
Communications	1.46	**0.05**	1.51	1.41	**0.12**	1.53	1.78	**0.04**	1.82	1.73	**0.14**	1.88
Utilities	1.61	**0.21**	1.82	1.32	**0.08**	1.40	1.72	**0.04**	1.76	1.51	**0.17**	1.68
Wholesale Trade	1.72	**0.08**	1.80	1.59	**0.19**	1.78	1.69	**0.05**	1.74	1.67	**0.14**	1.81
Retail Trade	1.67	**0.07**	1.74	1.57	**0.17**	1.74	1.71	**0.05**	1.76	1.70	**0.13**	1.83
Financial	1.80	**0.07**	1.87	1.61	**0.19**	1.80	1.78	**0.05**	1.83	1.76	**0.12**	1.89
Insurance & Real Estate	1.42	**0.03**	1.45	1.23	**0.06**	1.29	1.67	**0.04**	1.71	1.62	**0.11**	1.73
Eating, Drinking & Lodging	1.79	**0.11**	1.90	1.63	**0.22**	1.85	1.73	**0.07**	1.79	1.75	**0.16**	1.92
Other Services	1.67	**0.07**	1.74	1.54	**0.16**	1.70	1.82	**0.05**	1.87	1.79	**0.15**	1.94
Business Services	1.72	**0.07**	1.79	1.60	**0.18**	1.78	1.84	**0.06**	1.90	1.83	**0.16**	1.99
Health Services	1.84	**0.08**	1.92	1.69	**0.19**	1.88	1.78	**0.06**	1.84	1.76	**0.14**	1.91
Govt. Industry & Enterprise	1.74	**0.09**	1.83	1.64	**0.18**	1.82	1.74	**0.07**	1.81	1.75	**0.14**	1.89
Household Industry & Other	1.05	**0.01**	1.06	1.05	**0.01**	1.06	1.37	**0.02**	1.38	1.42	**0.07**	1.48
Unweighted Average	1.71	**0.10**	1.82	1.60	**0.17**	1.77	1.77	**0.05**	1.82	1.74	**0.16**	1.90

The periphery-to-core multipliers, and thus the backward economic linkages from the periphery to the core, are stronger than the core-to-periphery linkages for 1982 (table 9). The average periphery-to-core multiplier is .17, more than half again as large as the average core-to-periphery multiplier. These output multipliers range between 0.06 (for insurance and real estate) and 0.25 (for other manufacturing). Many periphery-to-core output multipliers are two or more times larger than the corresponding core-to-periphery multipliers.

The core-to-periphery multipliers were almost all considerably smaller in 2006 than they were in 1982 (table 9). This reflects a general weakening of core purchases from the periphery relative to the size of the core economy. The unweighted average of the core-to-periphery multipliers decreased from .10 to .05 over this period. The value of core-to-periphery output multipliers for 2006 (excluding household industry) ranged between 0.03 (for forest products and logging) and 0.09 (for livestock, and other manufacturing).

On the other hand, the periphery-to-core multipliers did not change much between 1982 and 2006. The average periphery-to-core multiplier decreased only slightly, from .17 to .16 over the period. For some industries, such as forest products and other manufacturing, the multipliers are larger in 2006 than they were in 1982.

Export Spillover Impacts as a share of Core and Periphery Output

Core-to-periphery multipliers declined between 1982 and 2006. However, given that the core economy grew more rapidly than the periphery economy, the spillover effect of core export growth on the periphery economy could conceivably have increased over time. In order to assess this, we multiplied the 1982 and 2006 values of core exports to the rest of the world by an average core-to-periphery multiplier for both 1982 and 2006. Dividing this product by total periphery output in both periods yielded the percent impact of core export sales on total sales of the periphery in both years. The results are reported in Table 10.

Table 10. Portland Core and Periphery Spillover Impacts (Percentage)

	1982	**2006**
Core Export Spillovers to the Periphery as a Share of Periphery Output	2.9	2.8
Periphery Export Spillovers to the Core as a Share of Core Output	6.0	3.0

The spillover impact on periphery output of exports from the core to the rest of the world decreased as a share of total periphery output between 1982 and 2006. For 1982, this share was 2.9%; in 2006 the share was 2.8%. Even though the core grew faster than the periphery, core spillovers were a smaller share of total periphery output. The periphery-to-core spillovers also became much less important for the core. For 1982, this share of core output from periphery export spillovers was 6.0%; in 2006 the share was 3.0%. The periphery grew more slowly and bought less from the core than previously. And the spillover coefficients declined, so the core was less sensitive to changes in periphery exports than in 1982.

7. CORE-PERIPHERY DYNAMICS IN THE PORTLAND REGIONAL ECONOMY: FINDINGS AND IMPLICATIONS

In this paper, we have examined the changing commuting and trade relationships between the Portland region's core and its periphery over the 1982-2006 period, and sought evidence about two dimensions of core-to-periphery spread effects in the Portland over the period. Specifically, we argued that stronger core-to-periphery multipliers/spillovers would be evidence of stronger "trade spread effects" and larger shares of the core workforce commuting from the periphery would be consistent with enhanced "commuting spread effects".

Our findings suggest that “trade spread effects” have become weaker and “commuting spread effects” have become stronger:

- Core-periphery trade weakened as a mechanism for spread effects. Core-periphery trade flows diminished as a share of output as the core expanded trade to the rest of the world and as the periphery became more self-contained.
- Core-to-periphery multipliers declined. Export growth in the core did not exert as powerful an economic impulse to the periphery as in previous decades.
- The spillover impact of exports from the core (to the rest of the world) on periphery output decreased as a share of total periphery output between 1982 and 2006.
- Commuting linkages grew stronger as the core has grown, both in numbers of commuters and also relative to the size of the respective labor forces.

These results provide some support for the hypothesis recently offered by Mulligan et al. (2012) that the critical transmission linkages across localities in the central place hierarchy have changed from those envisioned by the original central place theorists: “rather than input-output linkages between and among firms and households [in a central place hierarchy], contemporary regional linkages are arguably more commonly established via commuting patterns” (p. 421).

Our results suggest that urban-centered regions evolve over time, and that while the core-periphery spread-backwash framework can provide useful insights into the evolution and development of functional economic areas, this framework cannot capture the diversity and complexity of large regions. The periphery of the Portland OR region examined here, for example, included three metropolitan areas in 1982 (Eugene, Salem and Medford in Oregon). By 2006, three new metropolitan areas had emerged in the periphery (Bend and Corvallis in Oregon and Longview in Washington) and two counties in the periphery had been added to the Portland metropolitan statistical area. While the addition of the two counties to the Portland metro are were clearly spread effects from the Portland core, the growth of the Corvallis and Bend economies appear to have had less to do with the growth of the Portland core than with new export opportunities to the rest of the world. Understanding the spatial dynamics of economic interdependence will require a more nuanced framework in which spillovers are examined at a finer geographic scale and in which distance and agglomeration effects are given more attention.

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