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Economic Impact of Wildlife-Associated Recreation Expenditures in the Southeast United States: A General Equilibrium Analysis

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The economic impact of wildlife-associated recreation in the Southeast United States was evaluated using a general equilibrium model. Exogenous demand shocks to the regional economy were based on estimates of expenditures by wildlife recreationists on hunting, fishing, and wildlife watching activities. Counterfactual simulations were carried out, making alternative assumptions about labor and capital mobility and their supply. Without wildlife-associated recreation expenditures, regional employment would have been smaller by up to 783 thousand jobs, and value added would have been $22 to $48 billion less. These findings underscore the significance of regional factor market conditions in economic impact and general equilibrium analysis.

Key Words: general equilibrium modeling, input-output analysis, regional economic impact, wildlife-associated recreation activities

JEL Classifications: R13, R15, Q26

Wildlife-associated recreation activities (hunting, fishing, and wildlife watching) have assumed a significant role in the U.S. economy. According to the U.S. Fish and Wildlife Service (2007), 87.5 million people aged 16 and above participated in wildlife-associated recreation activities, spending $122.4 billion on trips and equipment. Substantial as these dollar estimates of direct expenditures may seem, they are just a component of the total economic impact associated with wildlife-associated activities because indirect and induced expenditures arise as well when industries respond to deliver wildlife recreation-related goods and services. Depending on a region's economic and natural resource base, wildlife-associated recreation expenses can be significant (Ingram and Lewandrowski, 1999; Reeder and Brown, 2005). Moreover, unlike traditional industries, economic development based on wildlife-associated recreation activities often has environmental benefits (English and Bergstrom, 1994).

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Numerous studies using non-market valuation and input-output (I-O) modeling have quantified wildlife-associated recreation welfare and economic impacts, and the U.S. Wildlife and Fish Service (USFWS) has also been publishing related data on visitation and expenditures since 1955 to facilitate state and county officials in formulation of wildlife management strategies and resource allocation decisions. However, gaps still remain in our understanding of outcomes induced by wildlife-associated recreation activities. In particular, non-market valuation methods fail to account for implications of these activities for the rest of the economy (Loomis et al., 1989). While traditional I-O and social accounting based multiplier analyses account for inter-sectoral linkages, they have restrictive assumptions (e.g., unlimited factor supplies, lack of relative prices influence on choices, linearity of behavioral relations), thus limiting their applicability.

To quantify the economic impact of wildlife-associated recreation activities in the Southeast U.S. regional economy, we used a general equilibrium model.[1] Particular attention was paid to assumptions underlying factor mobility and factor supply as results are sensitive to them (Cassey, Holland, and Razack, in press; Giesecke, 2009; Hoffmann, Robinson, and Subramanian, 1996). This study focused on the Southeast U.S. region for two important reasons. First, land in this part of the United States is largely privately owned; hunting lease markets are more developed, and many of the game species and wildlife viewing opportunities are unique to this region. These features likely induce different expenditure patterns and consequently different regional economic impacts. Second, for a variety of forestry issues (e.g., timber resources assessments, invasive species inventory), the Southeast United States is treated as a distinct management unit vis-à-vis the Northeast, Southwest, and Pacific Northwest. Given that wildlife and forest management are closely interlinked, it is appropriate that economic impacts associated with wildlife recreation expenditures are analyzed at this same geographic scale to provide a consistent perspective on the region's forestry and wildlife resource management.

Literature Review

Previous research on wildlife-associated recreation has used non-market valuation methods (Bockstael and McConnell, 1981; Keith, Fawson, and Chang, 1996) or I-O analysis (English and Bergstrom, 1994; Munn et al., 2010). Both of these methods have limitations; non-market valuation methods do not take into account market interactions and feedbacks even though pricing outcomes in one market usually have effects in other markets, and these effects, in turn, create ripples throughout the economy, perhaps even affecting the price-quantity equilibrium in the original market (Vargas et al., 1999). Although I-O analysis and its extensions such as social accounting matrix (SAM)-based I-O improve on non-market valuation methods as far as linkages are concerned, they assume unlimited resources thus ignoring the implications of economic expansion or contraction for changes in resource prices. By doing away with resource limitations, I-O analysis essentially ignores the opportunity cost of wildlife-associated recreational activities.

To better quantify the economic impacts of wildlife-associated recreation activities, it is necessary to use a general equilibrium model which allows for linkages between markets, interactions between industries, and implications of economic contraction or expansion for changes in resource prices (Schreiner et al., 1996). By accounting for inter-industry linkages and the implications of simulation shocks for resource prices, general equilibrium analysis enables quantification of the opportunity cost of wildlife-associated activities.

Applications of general equilibrium modeling aimed at analyzing economic impacts associated with wildlife recreation are limited. Lee (1993) was probably the first to use a 4-sector model to quantify economic impacts of resident and non-resident trout fishing on McCurtain County, Oklahoma. Distinguishing features of the study were treatment of a) fishing trips as non-market goods in contradistinction to other commodities, and b) non-resident fishing

[1] Southeast U.S. includes Alabama, Arkansas, Florida, Georgia, Louisiana, Mississippi, Tennessee, North Carolina, South Carolina, Virginia, Oklahoma, Kentucky, and Texas.

trips as exports of the study region. Otherwise, the model had standard features: it differentiated regionally produced goods from imported goods (the Armington assumption), assumed imperfect transformation between production for regional and export markets, and considered households to maximize utility and firms to maximize profits. Building on Lee (1993), Budiyanti (1996) used a 16-sector model to analyze economic impacts associated with agricultural pollution and recreational quality taxes on the Oklahoma state economy. The study found the opportunity cost of controlling agricultural pollution in terms of lost production to be much larger than benefits associated with wildlife-associated recreation. Budiyanti (1996) argued that the costs could be relatively lower if other benefits (e.g., option and existence values) associated with wildlife recreation were also considered. Seung et al. (2000) estimated an 8-sector dynamic model to analyze the temporal effects of reallocating water from agriculture to recreational use in Churchill County, Nevada. This study also found that the increase in recreational output was not sufficient to offset the reduction in agricultural output due to water withdrawal. Collectively, these applications shared a few features: they identified only one source of commodity imports and one destination for commodity exports lumping the rest of the United States with rest of the world; all of them used IMPLAN data to construct social accounting matrices; and all relied on the set of elasticities reported in de Melo and Tarr (1992) to calibrate benchmark equilibrium.

Elements of the Regional General Equilibrium Model

The current study used a regional general equilibrium model developed by Stodick, Holland, and Devadoss (2004). The model is an adaptation of the Lofgren et al. (2002) model and Rutherford's (1995) tools for building national economic models using IMPLAN social accounts. It distinguishes two sources of imports (Rest of the U.S. [RoUS] and Rest of the World [RoW]), two destinations for commodity exports (RoUS and RoW), and has more detail on inter-institutional transactions and the rest of the economy. Applications of the model have appeared in Cassey, Holland, and Razack (in press) and Devadoss et al. (2006). Consistent with neoclassical economics, producers are assumed to maximize profit subject to production technology, whereas consumers are assumed to maximize utility subject to a budget constraint. The model ensures that product and factor markets balance and macroeconomic identities hold. Equilibrium prices for commodities and factors, and the exchange rate are endogenously determined to clear the product, factor, and foreign exchange markets.[2] The model is written in general algebraic modeling system language and solved using the PATH solver. Key aspects of the model are presented below.

Production and Trade

The model employs a Leontief-cum-Constant elasticity substitution (CES) production technology using intermediate and value added inputs in fixed proportions. Value added inputs are a function of capital and labor, aggregated according to CES production function, whereas intermediate inputs are a fixed proportion of output. The assumption of non-substitution between composite intermediate and primary factors is restrictive (Hertel and Tsigas, 1997), and ideally more flexible production functions should be used. However, due to lack of information on elasticities of substitution, the standard practice is to assume that value added and intermediate inputs are used in fixed proportions.

The first order conditions for profit maximization yield specifications for factor demands with net value added price, factor prices, and output as arguments. A CES Armington aggregation function is used to capture imperfect substitution between domestic and imported goods. The first order conditions from the Armington composite generate specifications for domestic and import demand. A decrease in import prices relative to domestic prices induces

[2] The term exchange rate in general equilibrium analysis refers to the price of non-traded commodities relative to traded commodities (de Melo and Robinson 1989).

increased demand for imports and reduced demand for domestic goods. A constant elasticity of transformation (CET) function is used to model the transformation between commodities for sale in the domestic and export markets. The first order conditions from the CET transformation generate the specification for domestic and export supply functions.[3] An increase in export prices relative to domestic prices will induce an increase in exports and a decrease in domestic sales.

Price Block

The price block includes specifications for a complex system of prices: import prices (foreign import prices, domestic import prices), export prices (foreign export prices, domestic export prices), domestic demand price, composite demand price (PQ), composite supply price (PX), net value added price, and activity price. The U.S. prices for import goods are a function of the world price, the exchange rate, and any import tariffs. In an analogous manner, U.S. prices for export goods are a function of the world price, the exchange rate, and tariffs in foreign countries. The composite demand price is a weighted sum of the import price and domestic demand price, whereas the composite supply price is a weighted sum of domestic demand price and export price. The net value added price is PX adjusted downward for intermediate input costs. The activity price is a weighted sum of composite supply prices with yields of commodities per unit of production activity as weights.

Institutions

The institutions block concerns sources of final demand, specifically households, state and federal government, RoUS, and RoW. It specifies equations for various notions of income (e.g., factor income, gross household income, net household income), demand (e.g., household consumption demand, government demand, inventory demand), government revenue and expenditure, and indirect taxes. Factor income is the factor use level times its return. Gross household income is the sum of factor income, borrowing, and transfers from government, households, and the RoW. Net household income is gross income minus household transfers, savings, income tax, and transfers to the RoW. Consumer behavior is modeled using a Stone-Geary utility function which generates a linear expenditure demand system. Investment demand is equal to the investment adjustment factor times the initial level of investment. Government revenue is the sum of income taxes from households, investment income, and indirect tax receipts. Government expenditures include transfers to households, payments to foreigners, government spending, and subsidies. Indirect tax receipts are collected from production activities.

Economy-Wide Constraints

The system constraints block includes specifications for factor and commodity market equilibrium, savings-investment balance, price normalization, trade with RoUS, and RoW. In equilibrium, the sum of factor use in each sector equals total factor supply, and quantity supplied of a commodity equals quantity demanded for intermediate input use, household consumption, government consumption, and investment. The factor market allows for various options to maintain equilibrium between factor demand and factor supply. For the factor supply function, there are three possible closures. First, total supply of the factor is fixed and the price (wage) of the factor varies to close the model. This is essentially a vertical supply function. Second, the price (wage) of the factor is fixed and quantities of the factor shift between sectors to close the model. This is essentially a horizontal supply function. Third is an exponential supply function; this is the standard upward sloping supply. Variations of these where some sectors are closed using one method and other sectors are closed using another method are also possible.

[3] This indeed is restrictive because important variables such as income are not included; the trade flows generated thus might not correctly portray reality.

Table 1. Bridging of the General Equilibrium Model Sectors and USFWS Wildlife-Associated Recreation Expenditures to IMPLAN Sectors

General Equilibrium Model Sector	IMPLAN Sector	Wildlife-Associated Recreation Spending[a] Category	MM$	%[b]
Agriculture	1–18			
Mining	19–29			
Construction	33–45			
Utilities	30–32; 495; 498			
Wholesale trade	390; 400			
Retail trade	401–404; 406–412	Other expenditures[c]	9,261	3.31
Manufacturing	46–389	Equipment	19,107	3.30
Food and lodging	405; 479–481	Food and lodging	5,626	9.44
Transportation	395; 407; 482–483; 497	Transportation	4,285	7.97
Services	398–399; 413–478; 484–494; 496; 499–509			
Transportation services	391–394; 396–397			

[a] Source: U.S. Fish and Wildlife Service (2007).
[b] Percent of Southeast U.S. household demand for retail, manufacturing, food and lodging, and transportation services.
[c] An aggregate of other trip-related expenditures and other equipment expenditures.
MM$, Model benchmark equilibrium values.

The balance of payment equation equates the sum of export earnings, household transfers from foreigners, government transfers from foreigners, and capital inflow to import spending, factor income transfer to foreigners, and institutional transfer to foreigners. The balance of payments specification allows for options to keep foreign savings fixed and let exchange rates vary or the other way around. Savings include household, government, and foreign savings. Investment includes commodity, institutional, and foreign sectors' investments. In the saving-investment closure, savings adjusts to investment. In the price normalization equation, the consumer price index (CPI) is equal to a weighted sum of composite commodity prices (PQ adjusted for indirect taxes) with weights based on the composition of commodity baskets consumed by households.

Methods and Data

The social accounting matrix (SAM) for the Southeast U.S. region for the year 2006 was developed according to the mapping scheme listed in Table 1. IMPLAN[4] sectors for food and lodging, transportation, retail trade, and manufacturing were of particular interest as they are directly impacted by the demand shock corresponding to the withdrawal of wildlife-associated recreation expenditures, and hence treated as distinct sectors in this study. To simulate the economic impact of wildlife-associated recreation activities, Budiyanti (1996) and Seung et al. (2000) targeted these same sectors. To further distinguish the demand shock from typical tourism-based expenditures and other non-recreation activities, a recreation equipment sector consisting of the production of equipment such as small arms, ammunition, travel trailers and campers, all terrain vehicles, boats, photographic services, and sporting goods was initially considered. However, the base year IMPLAN output estimate for this composite sector was smaller than the estimated expenditures on fishing, hunting, and wildlife watching equipment provided by the USFWS. This recreation equipment sector was, therefore, left as part of the manufacturing sector.

Of the set of parameters used to calibrate the model, the choice of trade elasticities is probably the most debated issue in regional general equilibrium analysis. The core issue is this: do regional trade patterns mimic national trade patterns? Berck et al. (1996) assumed so, arguing

[4] IMPLAN (input-output analysis software) relies on non-survey economic accounts.

Table 2. Exogenous Parameter Estimates Used in the Model

Parameter	Value	Definition
esubp(A)	0.99	Elasticity of substitution for production function
esubd(C)	0.75	Elasticity of substitution (Armington) between regional output and imports
esubm(C)	1.50	Elasticity of substitution (Armington) between RoW and RoUS imports
esubs(C)	0.75	Elasticity of transformation between regional output and exports
esube(C)	1.75	Elasticity of transformation between RoW and RoUS exports
ine(C,H)	1	Income elasticity
income_Ine	1	Investment on commodities elasticity
frisch(C)	−1	Frisch parameter for Stone-Geary utility function
ifrisch(C)	−1	Investment demand flexibility
efac(LAB)	2.00	Labor supply elasticity
efac(CAP)	0.50	Capital supply elasticity

that a region's goods are more price sensitive than those of a nation because of fewer non-price trade restrictions. In contrast, Bilgic et al. (2002) argue that since regions are more specialized in the production of domestic commodities, they are expected to be less sensitive to differences in prices of domestically produced products relative to regional imports. Providing a more complete perspective, Holland (2010) argues that regional models should be characterized by lower elasticities of substitution and higher elasticities of transformation than national models; else they would be in error regarding regional trading behavior. Elasticities of substitution are expected to be smaller because regions are characterized by less variety for a given regionally produced commodity than would characterize imports from the national economy; relatively large changes in regional commodity prices relative to imported commodities prices would, thus, result in little change in regional commodity imports. In contrast, elasticities of transformation are expected to be higher because there is less product differentiation for traded commodities at the regional level than at the national level. Regional firms should, thus, find it relatively easy to substitute between regional and national export markets.

The Southeast U.S. region's unique characteristics (e.g., a predominance of private forestland ownership, different game species) with implications for wildlife-associated recreation expenditure patterns, suggested the use of elasticities of substitution consistent with arguments by Holland (2010). Parameter estimates for factor substitution in production, substitution between domestic and imported goods, substitution between domestic and export markets, income, and Frisch flexibility were compiled from Holland and Razack (2006) and Hodges, Stevens, and Rahmani (2010), whereas a list of the calibrated parameters is given in Stodick, Holland, and Devadoss (2004). For the specific estimates of elasticities of substitution and transformation used in this study see Table 2.

To quantify the impact of wildlife-associated recreation expenditures incurred by wildlife recreationists (hunters, anglers, and wildlife-watchers), expenditure profiles were obtained from the 2006 U.S. Fish and Wildlife Service survey. Broadly, these profiles fall in three categories: trip-related expenditures (e.g., food and lodging, transportation), equipment (e.g., boats, fishing rods, travel trailers, guns), and other expenditures (e.g., hunting license fees, hunting leases). According to the survey, recreationists spent a total of $22.9 billion on hunting, $42.0 billion on fishing, and $45.7 billion on wildlife watching activities in all U.S. states for a total of $110.6 billion. The corresponding figures for the 13 southeastern states were $8.7 billion on hunting, $16.2 billion on fishing, and $13.5 billion on wildlife watching activities for a total of $38 billion. Classified according to broad expense categories, these expenditures were distributed as follows: food and lodging - $5.6 billion, transportation - $4.3 billion, equipment - $19.1 billion, and miscellaneous expenses (e.g., land leasing, licenses, and expenses on magazines subscriptions) - $9.3 billion. While distinguishing between resident and non-resident expenditures was desirable so that non-resident expenditures could be treated as regional exports, it was only possible at the state level with this data.[5] Thus, for the Southeast United States, we computed wildlife recreation-associated expenditure as the sum of expenditures incurred by recreationists (resident and non-residents) in each of the 13 southeastern states.

General equilibrium modeling involves describing specific mechanisms for how an economy responds to a given exogenous shock under different closure rules, whereby the choice of particular closure rules is governed by the user's perceptions of the functioning of the macroeconomy (Robinson et al., 1999; Thurlow and Van Seventer, 2002). As these models contain more variables than equations, some variables are set outside the model as exogenous while others are determined by the model (Dervis and de Melo, 1989). This study, thus, assumed that: a) the CPI adjusts to maintain equilibrium between savings and investment; b) foreign savings adjust to maintain equilibrium with the RoW; and c) domestic savings adjust to maintain equilibrium with RoUS. In addition, the study assumed that the regional exporter faced a perfectly elastic export demand function (there are provisions in the code to relax this assumption if a given regional industry is a major source of world output), and the regional importer faced a perfectly elastic import supply function. The Southeast U.S. regional economy is too small relative to the U.S. and world economy to influence prices.

To conduct counterfactual simulations, three models were specified that differed as to whether capital was sector-specific (model 1), perfectly inelastic at the regional level (model 2), or elastic at the regional level (model 3). Each model was then used to simulate the economic impact of wildlife-associated recreation expenditures under the assumption of perfectly inelastic, elastic, and infinitely elastic labor supply. Giesecke (2009) argues that it is more plausible for a regional economy to source as much capital as required at exogenously determined real rates of return than to assume that it can source as much labor at an exogenously determined real regional wage due to location preferences of skilled workers. However, we could not explore the implications of an infinitely elastic capital closure as the current version of the Stodick, Holland, and Devadoss (2004) model does not have this option.

Given the above mentioned closure settings, the specific question addressed was: how would producer prices and output supply, factor use and earnings, and regional trade patterns respond if wildlife-associated recreation expenditures incurred by recreationists in 2006 on retail trade, equipment, food and lodging, and transportation according to the USFWS were withdrawn from the Southeast U.S. regional economy. In the Stodick, Holland, and Devadoss (2004) model, the demand shock can be implemented by shocking a category of exogenous demand (e.g., inventory or government demand). Comparative static analysis of the results involves tracing out the direct and indirect impacts, including changes in all prices. This study implemented the exogenous demand shock by reducing inventory demand by an amount equal to wildlife-associated recreation expenditures (Table 1, column 4) times an inventory adjustment factor following Stodick, Holland, and Devadoss (2004).

Simulation Results

The Southeast U.S. Regional Economy

Sectoral contributions to overall production, consumption, and trade play important role in determining how the economy responds to exogenous shocks under a particular closure and exogenous parameter estimates (e.g., factor substitution elasticities, trade elasticities). Key data on sectoral contributions in the Southeast U.S. regional economy in benchmark equilibrium in 2006 are summarized in Table 3. Accordingly,

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[5] Resident and non-resident expenditures are reported by state; however, non-residents in one state may be residents in other states in the region so in aggregating across states, it is impossible to maintain the distinction between resident and non-resident expenditures.

Table 3. Structure of Production, Consumption and Trade in the Southeast U.S. Regional Economy in 2006

Sector	Output (X)	Jobs (%)	Exports (E)	(E/X)%	Domestic Sales (QD)	Imports (M)	Absorption (Q=QD+M)	(M/Q)%
Retail trade	339,855	8.71	32,136	9.46	307,521	32,333	339,854	9.51
Manufacturing	2,400,171	8.08	1,240,190	51.67	989,834	1,410,337	2,400,171	58.76
Food and lodging	280,107	8.44	32,654	11.66	245,184	34,923	280,107	12.47
Transportation	79,919	1.77	6,089	7.62	66,186	13,733	79,919	17.18
Agriculture	111,402	2.37	38,209	34.30	66,433	44,969	111,402	40.37
Mining	527,713	7.19	3,220	0.61	478,116	49,597	527,713	9.40
Construction	358,132	0.85	29,979	8.37	229,760	128,372	358,132	35.84
Utilities	173,342	0.42	5,996	3.46	158,297	15,045	173,342	8.68
Wholesale trade	370,187	4.07	21,143	5.71	362,684	7,503	370,187	2.03
Services	3,859,377	55.83	590,437	15.30	3,089,154	770,223	3,859,377	19.96
Transportation services	186,904	2.28	61,859	33.10	158,373	28,531	186,904	15.27
Total	8,687,109	100.00	2,061,911	23.74	6,151,543	2,535,566	8,687,109	29.19

MM$, Model benchmark equilibrium values.

the Southeast regional U.S economy total gross output of goods and services (composite supply) was $8.7 trillion. Twenty-four percent ($2.06 trillion) of it was exported and the remainder consumed domestically. At the same time, the region imported $2.5 trillion of goods and services that accounted for 29% of its usage of commodities. Foreign exports accounted for 20% (Table 4) of the total regional exports, whereas foreign imports were 26% of the total regional imports. This suggested that the Southeast U.S. regional economy was more dependent on foreign markets than the U.S. economy in general.

Economy-Wide Response

Economy-wide impacts (measured relative to benchmark data) induced by withdrawal of wildlife-associated recreation expenditures are presented in Table 4. Changes in CPI suggest a clear pattern: the percent decrease in the index becomes smaller as the capital supply constraint is relaxed (compare a particular simulation across model 1, 2, and 3). Moreover, for a given capital supply constraint, the percent decrease in the index gets smaller as the labor supply constraint is relaxed (compare simulation 1, 2, and 3 for a particular model). Thus, the percent decrease in CPI is greatest for model 1 (simulation 1) and smallest for model 3 (simulation 3), with results for the rest of the simulations falling in between. Across the three models and all simulations, the percent decrease in CPI ranges from −0.273 (model 3, simulation 3) to −0.719 (model 1, simulation 1).

The pattern of job losses is not so straightforward. Only when the labor supply constraint is relaxed do we observe a pattern of increased job losses (compare simulation 1, 2, and 3 for a given model). Relaxation of the capital supply constraint induces the greatest job losses under model 3 followed by model 1, with losses under model 2 falling in between (compare any simulation across model 1, 2, and 3). Across the three models and all simulations, job losses range from 0 (model 1, 2, 3 simulation 1) to 783,654 (model 3, simulation 3). Value added losses range from $22.8 billion (simulation 1 model 2) to $48.4 billion (simulation 3 model 3), and are greater under model 3 followed by model 2. For a given model, there is a clear indication that value added losses heighten as labor supply becomes more elastic (compare simulation 1, 2, and 3 for model 2). Results under simulation 1 for model 1 and model 3 depict a bit different picture where losses in value added are greater for model 1; the effects of capital supply constraint seem to dominate the effects of

Table 4. Macroeconomic Impacts Induced by the Withdrawal of Wildlife-Associated Recreation Expenditures Under Various Factor Availability and Mobility Assumptions

		Levels ($MM)			Percent		
		1	2	3	1	2	3
Sector	Base	Model 1: Capital Sector-Specific; Labor Mobile					
Consumer price index	1.000	0.993	0.995	0.996	−0.719	−0.521	−0.387
Employment	57,251,937	0.000	−432,492	−721,742	0.000	−0.755	−1.261
Value added	4,105,436	−25,789	−35,684	−42,303	−0.628	−0.869	−1.030
Labor earnings	2,237,861	−15,285	−20,023	−23,190	−0.683	−0.895	−1.036
Capital earnings	1,553,136	−7,427	−11,785	−14,701	−0.478	−0.759	−0.947
Indirect business taxes	314,439	−3,077	−3,877	−4,412	−0.978	−1.233	−1.403
Total imports	2,535,566	−19,707	−26,546	−31,128	−0.777	−1.047	−1.228
Foreign	665,146	−5,329	−7,511	−8,973	−0.801	−1.129	−1.349
Domestic	1,870,420	−14,378	−19,035	−22,155	−0.769	−1.018	−1.185
Total exports	2,061,911	15,349	2,465	−6,176	0.744	0.120	−0.300
Foreign	418,018	3,375	744	−1,021	0.807	0.178	−0.244
Domestic	1,643,893	11,974	1,721	−5,155	0.728	0.105	−0.314
		Model 2: Capital Regionally Fixed; Capital and Labor Mobile					
Consumer price index	1.000	0.994	0.995	0.997	−0.601	−0.453	−0.343
Employment	57,251,937	0.000	−396,610	−688,580	0.000	−0.693	−1.203
Value added	4,105,436	−22,756	−33,380	−41,205	−0.554	−0.813	−1.004
Labor earnings	2,237,861	−13,212	−18,567	−22,509	−0.590	−0.830	−1.006
Capital earnings	1,553,136	−6,617	−11,055	−14,324	−0.426	−0.712	−0.922
Indirect business taxes	314,439	−2,927	−3,759	−4,371	−0.931	−1.195	−1.390
Total imports	2,535,566	−19,016	−25,876	−30,932	−0.750	−1.021	−1.220
Foreign	665,146	−5,232	−7,337	−8,888	−0.787	−1.103	−1.336
Domestic	1,870,420	−13,784	−18,539	−22,044	−0.737	−0.991	−1.179
Total exports	2,061,911	16,925	4,313	−4,991	0.821	0.209	−0.242
Foreign	418,018	3,874	1,259	−669	0.927	0.301	−0.160
Domestic	1,643,893	13,050	3,053	−4,321	0.794	0.186	−0.263
		Model 3: Capital Regionally Variable; Capital and Labor Mobile					
Consumer price index	1.000	0.994	0.996	0.997	−0.587	−0.412	−0.273
Employment	57,251,937	0.000	−437,900	−783,654	0.000	−0.765	−1.369
Value added	4,105,436	−24,769	−37,968	−48,380	−0.603	−0.925	−1.178
Labor earnings	2,237,861	−14,333	−21,062	−26,369	−0.640	−0.941	−1.178
Capital earnings	1,553,136	−7,359	−12,800	−17,093	−0.474	−0.824	−1.101
Indirect business taxes	314,439	−3,078	−4,106	−4,918	−0.979	−1.306	−1.564
Total imports	2,535,566	−20,215	−28,665	−35,337	−0.797	−1.131	−1.394
Foreign	665,146	−5,579	−8,156	−10,191	−0.839	−1.226	−1.532
Domestic	1,870,420	−14,636	−20,509	−25,146	−0.783	−1.096	−1.344
Total exports	2,061,911	14,777	−722	−12,974	0.717	−0.035	−0.629
Foreign	418,018	3,422	203	−2,341	0.819	0.049	−0.560
Domestic	1,643,893	11,355	−925	−10,633	0.691	−0.056	−0.647

Notes: Simulation 1-Labor supply (perfectly inelastic); Simulation 2-Labor supply (elastic); Simulation 3-Labor supply (infinitely elastic).

labor supply elasticity. Changes in labor and capital returns, and indirect business taxes exhibit essentially the same pattern as aggregate value added.

Decreases in imports (domestic and foreign) follow the same pattern as value added. They are greater under model 3 followed by model 1 and decrease gradually across simulations 1, 2, and 3. Regional exports (domestic and foreign) increase under simulation 1 and 2 across all models. This happens because regional prices fall relative to RoUS and RoW prices, making regional exports more competitive. Regional exports fall under simulation 3 across all models as labor supply becomes infinitely elastic.

Sectoral Responses

Considering the elaborate system of prices and quantities in regional general equilibrium model, it is important to highlight relations between the various prices (PQ, domestic demand prices, import prices) and quantities (composite quantities, domestic quantities, composite imports) before describing simulation results. Specifically, composite commodity prices change either because of changes in domestic demand prices or composite import prices or both. Changes in composite import prices in turn depend on changes in foreign import prices or domestic import prices where the latter are indexed to CPI. Likewise, composite supply prices change because of changes in domestic demand prices, composite export prices or both. Composite export prices in turn depend on foreign export prices or domestic export prices where the latter are indexed to CPI.

As we make the assumption that the Southeast U.S. region is small and cannot influence world prices (RoW export demand and import supply are perfectly elastic), foreign import prices and foreign export prices are fixed by definition. Therefore, any changes in PQ and PX are due to changes in domestic demand prices, domestic import prices, domestic export prices, and the consumer price index. In an analogous manner, composite quantities (QQ) change because of changes in domestic quantities, composite imports, or both. Composite imports depend on changes in foreign imports or domestic imports. Composite supply changes because of changes in domestic quantities, composite exports, or both. Composite exports depend on changes in foreign exports or domestic exports.

Commodity prices and quantities. The exogenous demand shock represented by the withdrawal of wildlife-associated recreation expenditures induces changes in prices and quantities. Specifically, as excess commodity supply develops in the directly impacted sectors of retail trade, food and lodging, transportation, and manufacturing, respective commodity prices adjust downward. This downward adjustment in commodity prices suggests a common pattern across simulations and models (Table 5): a) as labor supply becomes more elastic, the percent decrease in prices gets milder (compare simulation 1, 2, and 3 for a given model for the directly impacted sectors); b) as capital supply becomes more elastic, the percent decrease in prices gets less and less pronounced with the exception of manufacturing commodity prices, which decrease more under model 2 than model 3. In a similar manner as commodity prices adjust, commodity supply in all the directly impacted sectors decreases across all models and all simulations except manufacturing which decreases only under simulation 2 and 3. However, unlike commodity prices, the decrease in commodity supply gets more pronounced as labor supply gets more elastic (Table 6).

The withdrawal of wildlife-associated recreation spending leads to excess commodity supply in the indirectly impacted sectors (rest of the economy) as well (Table 5). However, while commodity prices decrease across all models and all simulations for each model, the tendency is more pronounced under model 2. Moreover, as the labor supply constraint relaxes, the decrease in commodity prices for agriculture, mining, and utilities gets more pronounced whereas the decrease in commodity prices corresponding to wholesale trade, services, and transportation services gets less and less pronounced. Commodity supply response in the indirectly impacted sectors exhibits a more complex pattern as all of them expand under simulation 1 across all models and contract under simulation 3 across all models. Supply response under simulation 2 (model 1 and model 2) is the most varied: there are some indirectly impacted sectors (e.g., agriculture, mining, and transportation services) that expand, whereas others (e.g., construction, utilities, wholesale trade, and services) contract (Table 6).

Table 5. Percent Changes in Prices Induced by Withdrawal of Wildlife-Associated Recreation Expenditures under Various Factor Availability and Mobility Assumptions (Benchmark Prices = 1)

	Composite Demand Price			Domestic Demand Price			Composite Supply Price		
Sector	1	2	3	1	2	3	1	2	3
	Model 1: Capital Sector-Specific; Labor Mobile								
Retail trade	−1.241	−0.936	−0.729	−1.371	−1.034	−0.805	−1.241	−0.935	−0.729
Manufacturing	−0.493	−0.399	−0.335	−1.192	−0.965	−0.811	−0.528	−0.427	−0.359
Food and lodging	−1.027	−0.765	−0.588	−1.173	−0.874	−0.671	−1.035	−0.771	−0.592
Transportation	−1.773	−1.561	−1.418	−2.137	−1.883	−1.711	−1.956	−1.723	−1.566
Agriculture	−0.254	−0.284	−0.304	−0.426	−0.476	−0.509	−0.270	−0.302	−0.323
Mining	−0.683	−0.404	−0.216	−0.753	−0.446	−0.238	−0.748	−0.443	−0.236
Construction	−0.073	−0.249	−0.366	−0.114	−0.387	−0.570	−0.101	−0.342	−0.504
Utilities	−0.530	−0.647	−0.725	−0.580	−0.709	−0.794	−0.559	−0.683	−0.765
Wholesale trade	−0.780	−0.479	−0.276	−0.796	−0.489	−0.282	−0.752	−0.462	−0.266
Services	−0.642	−0.426	−0.280	−0.802	−0.532	−0.350	−0.673	−0.446	−0.293
Transp. services	−0.759	−0.488	−0.304	−0.896	−0.576	−0.359	−0.644	−0.414	−0.258
	Model 2: Capital Regionally Fixed; Capital and Labor Mobile								
Retail trade	−0.666	−0.449	−0.288	−0.736	−0.496	−0.318	−0.666	−0.449	−0.288
Manufacturing	−0.525	−0.423	−0.346	−1.270	−1.023	−0.839	−0.562	−0.453	−0.372
Food and lodging	−0.639	−0.444	−0.300	−0.730	−0.508	−0.342	−0.644	−0.448	−0.302
Transportation	−0.568	−0.419	−0.307	−0.685	−0.505	−0.371	−0.628	−0.463	−0.340
Agriculture	−0.521	−0.470	−0.432	−0.872	−0.787	−0.724	−0.553	−0.499	−0.459
Mining	−0.569	−0.411	−0.293	−0.628	−0.453	−0.323	−0.624	−0.450	−0.321
Construction	−0.373	−0.401	−0.421	−0.581	−0.625	−0.656	−0.514	−0.552	−0.580
Utilities	−0.479	−0.539	−0.583	−0.524	−0.590	−0.638	−0.505	−0.568	−0.615
Wholesale trade	−0.681	−0.478	−0.326	−0.695	−0.488	−0.333	−0.657	−0.461	−0.314
Services	−0.609	−0.457	−0.344	−0.760	−0.571	−0.430	−0.638	−0.479	−0.361
Transp. services	−0.762	−0.552	−0.395	−0.898	−0.651	−0.467	−0.645	−0.468	−0.335
	Model 3: Capital Regionally Variable; Capital and Labor Mobile								
Retail trade	−0.664	−0.423	−0.229	−0.733	−0.467	−0.253	−0.664	−0.423	−0.229
Manufacturing	−0.506	−0.378	−0.276	−1.223	−0.915	−0.667	−0.542	−0.405	−0.296
Food and lodging	−0.633	−0.414	−0.238	−0.723	−0.473	−0.272	−0.638	−0.417	−0.240
Transportation	−0.557	−0.384	−0.245	−0.672	−0.463	−0.295	−0.615	−0.424	−0.271
Agriculture	−0.488	−0.408	−0.344	−0.818	−0.684	−0.576	−0.519	−0.434	−0.366
Mining	−0.561	−0.379	−0.233	−0.619	−0.418	−0.257	−0.614	−0.415	−0.256
Construction	−0.334	−0.335	−0.336	−0.520	−0.522	−0.523	−0.460	−0.462	−0.462
Utilities	−0.422	−0.446	−0.464	−0.462	−0.488	−0.508	−0.445	−0.471	−0.490
Wholesale trade	−0.674	−0.444	−0.260	−0.688	−0.453	−0.265	−0.650	−0.428	−0.250
Services	−0.595	−0.417	−0.274	−0.743	−0.521	−0.343	−0.623	−0.437	−0.288
Transp. services	−0.749	−0.508	−0.315	−0.884	−0.599	−0.371	−0.635	−0.431	−0.267

Notes: Simulation 1-Labor supply (perfectly inelastic); Simulation 2-Labor supply (elastic); Simulation 3-Labor supply (infinitely elastic). Directly impacted sectors are shown in italics.

Labor and capital input demand. Changes in labor and capital use induced by the withdrawal of wildlife-associated recreation spending are presented in Table 7. The specific assumptions about factor mobility and regional factor supply induce certain response patterns in how labor and capital use change in the directly, as well as indirectly, impacted sectors. Thus, across all models and all simulations for each model, the use of labor in all directly impacted sectors decreases (except manufacturing under simulation 1). Note, however, that for each model the

Table 6. Percent Changes in Quantities Induced by the Withdrawal of Wildlife-Associated Recreation Expenditures under Various Factor Availability and Mobility Assumptions

	Composite Demand Quantity			Domestic Demand Quantity			Composite Supply Quantity		
Sector	1	2	3	1	2	3	1	2	3
				Model 1: Capital Sector-Specific; Labor Mobile					
Retail trade	−2.087	−2.518	−2.807	−1.990	−2.445	−2.751	−1.893	−2.373	−2.694
Manufacturing	−0.652	−1.011	−1.252	−0.125	−0.587	−0.897	0.378	-0.182	−0.558
Food and lodging	−1.560	−1.986	−2.272	−1.451	−1.906	−2.210	−1.348	−1.829	−2.152
Transportation	−4.437	−4.823	−5.081	−4.170	−4.589	−4.869	−4.037	−4.472	−4.764
Agriculture	0.276	−0.168	−0.466	0.406	−0.023	−0.312	0.524	0.108	−0.172
Mining	0.030	−0.072	−0.141	0.084	−0.041	−0.124	0.088	−0.039	−0.123
Construction	0.279	−0.124	−0.394	0.309	−0.020	−0.241	0.319	0.014	−0.191
Utilities	0.058	−0.198	−0.369	0.096	−0.151	−0.318	0.112	−0.132	−0.296
Wholesale trade	0.224	−0.216	−0.511	0.236	−0.208	−0.506	0.269	−0.188	−0.495
Services	0.134	−0.241	−0.493	0.255	−0.161	−0.441	0.353	−0.097	−0.399
Transp. services	0.271	−0.165	−0.458	0.375	−0.099	−0.417	0.566	0.023	−0.341
				Model 2: Capital Regionally Fixed; Capital and Labor Mobile					
Retail trade	−2.526	−2.889	−3.157	−2.474	−2.854	−3.135	−2.423	−2.820	−3.113
Manufacturing	−0.589	−0.956	−1.226	−0.027	−0.506	−0.859	0.510	−0.076	−0.509
Food and lodging	−1.811	−2.188	−2.466	−1.744	−2.141	−2.435	−1.680	−2.097	−2.405
Transportation	−5.227	−5.567	−5.818	−5.142	−5.505	−5.773	−5.101	−5.475	−5.751
Agriculture	0.506	0.004	−0.366	0.773	0.244	−0.146	1.016	0.462	0.053
Mining	0.023	−0.065	−0.130	0.067	−0.033	−0.108	0.071	−0.031	−0.106
Construction	0.388	−0.043	−0.361	0.545	0.125	−0.185	0.596	0.180	−0.127
Utilities	0.058	−0.218	−0.422	0.092	−0.180	−0.381	0.107	−0.164	−0.363
Wholesale trade	0.244	−0.168	−0.472	0.255	−0.160	−0.467	0.284	−0.140	−0.453
Services	0.134	−0.201	−0.448	0.249	−0.115	−0.384	0.341	−0.046	−0.332
Transp. services	0.327	−0.094	−0.405	0.431	−0.019	−0.351	0.623	0.119	−0.253
				Model 3: Capital Regionally Variable; Capital and Labor Mobile					
Retail trade	−2.562	−2.990	−3.328	−2.511	−2.957	−3.311	−2.460	−2.925	−3.293
Manufacturing	−0.655	−1.108	−1.466	−0.114	−0.707	−1.175	0.402	−0.324	−0.898

Table 6. Continued.

Sector	Composite Demand Quantity			Domestic Demand Quantity			Composite Supply Quantity		
	1	2	3	1	2	3	1	2	3
				Model 1: Capital Sector-Specific; Labor Mobile					
Food and lodging	−1.857	−2.307	−2.662	−1.791	−2.263	−2.637	−1.727	−2.222	−2.614
Transportation	−5.277	−5.689	−6.016	−5.194	−5.633	−5.980	−5.154	−5.605	−5.962
Agriculture	0.403	−0.226	−0.724	0.653	−0.019	−0.550	0.881	0.170	−0.392
Mining	0.010	−0.098	−0.183	0.053	−0.068	−0.164	0.057	−0.066	−0.163
Construction	0.303	−0.235	−0.660	0.444	−0.094	−0.519	0.490	−0.049	−0.474
Utilities	−0.020	−0.383	−0.670	0.010	−0.351	−0.637	0.023	−0.338	−0.623
Wholesale trade	0.181	−0.321	−0.718	0.191	−0.314	−0.714	0.220	−0.295	−0.703
Services	0.083	−0.324	−0.646	0.195	−0.246	−0.595	0.286	−0.183	−0.554
Transp. services	0.259	−0.256	−0.663	0.361	−0.187	−0.621	0.550	−0.060	−0.542

Notes: Simulation 1-Labor supply (perfectly inelastic); Simulation 2-Labor supply (elastic); Simulation 3-Labor supply (infinitely elastic). Directly impacted sectors are shown in italics.

percent decrease gets more pronounced as assumption about labor availability is relaxed (compare simulation 1, 2, 3 for any model), and the percent decrease is more severe under model 1 followed by model 3 (compare results for a particular simulation under model 1, 2, 3).

The use of labor in manufacturing increases under simulation 1 across all models because the decrease in the demand for the products (QQ) of directly impacted sectors (including manufacturing) causes them to contract which results in excess labor supply. Given the equilibrating role played by wages in simulation 1 across all models, wages adjust downward to restore labor market equilibrium while at the same time making it economical for the indirectly impacted sectors to expand. This expansion induces an increase in the demand for labor and other inputs (including manufacturing goods used as intermediate inputs) in these sectors. Despite that spending on recreation equipment (a manufacturing sector good) accounts for 50% ($19 billion) of the total wildlife-associated recreation spending (Table 2), it accounts only for 3.2% of the manufacturing sector commodity sales (QQ). Thus, the contraction caused by reduced recreation-related demand spending is more than offset by the demand for manufacturing goods in the indirectly expanding sectors.

The response pattern of capital use is given in the last three columns of Table 7. Clearly the results are model-specific; there are no commonalities across models. Given the assumption of sector-specific capital under model 1, the percent change in capital use is zero by construction for all simulations. Under model 2 with capital fixed regionally but mobile between sectors, capital use by all the directly impacted sectors except manufacturing decreases. The decrease, however, gets less pronounced as labor supply constraint is relaxed (compare simulation 1, 2, and 3), and the assumed increase in supply of labor in simulation 2 and 3 makes it economical for sectors to shed capital at a lower rate than what happens under simulation 1. The mechanism underlying the unique pattern exhibited by capital use in manufacturing is the same as described above with regards to labor input response pattern.

Table 7. Changes in Factor Use (QF) Induced by the Withdrawal of Wildlife-Associated Recreation Expenditures under Alternative Factor Mobility and Supply Assumptions

Sector	Base-Labor (jobs)	Base-Capital (MM$)	Labor (QF- No. of Jobs) %			Capital (QF- $) %		
			1	2	3	1	2	3
			Model 1: Capital Sector-Specific; Labor Mobile					
Retail trade	4,985,408	46,467	−2.577	−3.226	−3.660	0	0	0
Manufacturing	4,623,646	215,518	0.673	−0.327	−0.995	0	0	0
Food and lodging	4,832,457	32,879	−1.942	−2.630	−3.091	0	0	0
Transportation	1,012,379	12,035	−6.226	−6.888	−7.332	0	0	0
Agriculture	1,357,175	22,940	1.531	0.313	−0.499	0	0	0
Mining	4,113,912	64,925	0.128	−0.056	−0.180	0	0	0
Construction	489,256	116,375	1.341	0.061	−0.792	0	0	0
Utilities	238,179	70,738	0.354	−0.590	−1.220	0	0	0
Wholesale trade	2,330,639	65,391	0.395	−0.276	−0.725	0	0	0
Services	31,961,429	874,674	0.627	−0.171	−0.704	0	0	0
Transp. services	1,307,457	31,194	0.856	0.037	−0.511	0	0	0
			Model 2: Capital Regionally Fixed; Capital and Labor Mobile					
Retail trade	4,985,408	46,467	−2.327	−2.918	−3.353	−2.702	−2.565	−2.463
Manufacturing	4,623,646	215,518	0.680	−0.236	−0.910	0.292	0.126	0.003
Food and lodging	4,832,457	32,879	−1.670	−2.306	−2.774	−2.048	−1.950	−1.878
Transportation	1,012,379	12,035	−4.973	−5.601	−6.063	−5.338	−5.257	−5.198
Agriculture	1,357,175	22,940	1.291	0.236	−0.539	0.902	0.600	0.377
Mining	4,113,912	64,925	0.193	−0.146	−0.396	−0.192	0.218	0.522
Construction	489,256	116,375	0.893	−0.095	−0.821	0.505	0.269	0.093
Utilities	238,179	70,738	0.374	−0.457	−1.067	−0.012	−0.094	−0.155
Wholesale trade	2,330,639	65,391	0.407	−0.256	−0.744	0.021	0.107	0.171
Services	31,961,429	874,674	0.518	−0.193	−0.717	0.132	0.170	0.198
Transp. services	1,307,457	31,194	0.757	0.000	−0.557	0.370	0.363	0.359
			Model 3: Capital Regionally Variable; Capital and Labor Mobile					
Retail trade	4,985,408	46,467	−2.323	−2.972	−3.486	−2.852	−2.811	−2.778
Manufacturing	4,623,646	215,518	0.641	−0.399	−1.218	0.096	−0.233	−0.493

Table 7. Continued.

Sector	Base-Labor (jobs)	Base-Capital (MM$)	Labor (QF- No. of Jobs) % 1	2	3	Capital (QF- $) % 1	2	3
			Model 1: Capital Sector-Specific; Labor Mobile					
Food and lodging	4,832,457	32,879	−1.677	−2.385	−2.944	−2.210	−2.223	−2.233
Transportation	1,012,379	12,035	−4.972	−5.664	−6.211	−5.486	−5.507	−5.524
Agriculture	1,357,175	22,940	1.256	0.066	−0.871	0.708	0.232	−0.145
Mining	4,113,912	64,925	0.229	−0.119	−0.394	−0.314	0.048	0.337
Construction	489,256	116,375	0.907	−0.174	−1.025	0.360	−0.008	−0.300
Utilities	238,179	70,738	0.409	−0.483	−1.186	−0.135	−0.317	−0.461
Wholesale trade	2,330,639	65,391	0.394	−0.348	−0.934	−0.150	−0.182	−0.208
Services	31,961,429	874,674	0.522	−0.260	−0.878	−0.022	−0.094	−0.151
Transp. services	1,307,457	31,194	0.737	−0.114	−0.785	0.191	0.052	−0.058

Notes: Simulation 1-Labor supply (perfectly inelastic); Simulation 2-Labor supply (elastic); Simulation 3-Labor supply (infinitely elastic). Directly impacted sectors are shown in italics.

Capital use in all the indirectly impacted sectors increases except in utilities (compare simulation 1, 2, 3) and mining (simulation 1). The increased use of capital as more labor becomes available is suggestive of complementary relation between the two inputs for a certain range of productive operations in these sectors. Under model 3, with capital regionally variable, capital use decreases in all the directly impacted economic sectors except manufacturing that show increased use of capital under simulation 1. Capital use in the indirectly impacted sectors varies across sectors and simulations. For instance, capital use in utilities, wholesale trade, and services decreases in all simulations; its use in construction decreases in simulation 2 and 3, and its use in agriculture and transportation services decreases only under simulation 3.

Capital and labor earnings. Changes in labor and capital income induced by the exogenous demand shock involving withdrawal of wildlife-associated recreation are presented in Table 8. Across all models and simulation 1 and 2 for each model, these changes display a common pattern: labor and capital income decrease in the directly and indirectly impacted sectors. The changes are more pronounced under model 3 followed by model 1 and as the labor supply constraint is relaxed (compare simulation 1, 2, and 3 for a particular sector). Agriculture and construction are the only sectors where labor and capital income actually increase under simulation 1 across all models.

Discussion and Conclusions

Results based on general equilibrium models are predictable. The reasons these models are used do not include concerns as to what the results are going to be. Their use is rather motivated by our inability to keep track of multi-market interactions that occur following exogenous policy shocks and the urge to have an empirical sense of the pattern and size of responses. Thus, to get an idea about the impact of wildlife-associated recreation in the Southeast United States, this study used a general equilibrium model. Consistent with *a priori* expectations, the results varied depending on assumptions about factor mobility

Table 8. Changes in Factor Earnings Impacts Induced by the Withdrawal of Wildlife-Associated Recreation Expenditures under Various Factor Availability and Mobility Assumptions

Sector	Base-Labor Earnings	Base-Capital Earnings	Labor Earnings (%)			Capital Income (%)		
			1	2	3	1	2	3
			Model 1: Capital Sector-Specific; Labor Mobile					
Retail trade	127,884	46,467	−3.490	−3.592	−3.660	−3.515	−3.624	−3.696
Manufacturing	277,992	215,518	−0.270	−0.704	−0.995	−0.263	−0.707	−1.005
Food and lodging	88,977	32,879	−2.860	−2.998	−3.091	−2.880	−3.024	−3.121
Transportation	21,519	12,035	−7.105	−7.241	−7.332	−7.165	−7.308	−7.403
Agriculture	12,423	22,940	0.580	−0.066	−0.499	0.595	−0.063	−0.504
Mining	140,186	64,925	−0.810	−0.435	−0.180	−0.809	−0.435	−0.182
Construction	36,749	116,375	0.391	−0.318	−0.792	0.405	−0.317	−0.800
Utilities	20,971	70,738	−0.586	−0.966	−1.220	−0.583	−0.972	−1.233
Wholesale trade	139,793	65,391	−0.545	−0.653	−0.725	−0.541	−0.656	−0.732
Services	1,309,413	874,674	−0.316	−0.549	−0.704	−0.310	−0.550	−0.711
Transp. services	61,954	31,194	−0.089	−0.342	−0.511	−0.080	−0.342	−0.516
			Model 2: Capital Regionally Fixed; Capital and Labor Mobile					
Retail trade	127,884	46,467	−3.121	−3.255	−3.353	−3.117	−3.258	−3.362
Manufacturing	277,992	215,518	−0.139	−0.583	−0.910	−0.135	−0.586	−0.919
Food and lodging	88,977	32,879	−2.469	−2.645	−2.774	−2.465	−2.648	−2.783
Transportation	21,519	12,035	−5.745	−5.928	−6.063	−5.741	−5.932	−6.072
Agriculture	12,423	22,940	0.468	−0.112	−0.539	0.472	−0.116	−0.548
Mining	140,186	64,925	−0.621	−0.492	−0.396	−0.618	−0.496	−0.405
Construction	36,749	116,375	0.073	−0.441	−0.821	0.077	−0.445	−0.830
Utilities	20,971	70,738	−0.442	−0.802	−1.067	−0.438	−0.806	−1.076
Wholesale trade	139,793	65,391	−0.409	−0.602	−0.744	−0.405	−0.605	−0.753
Services	1,309,413	874,674	−0.299	−0.540	−0.717	−0.295	−0.543	−0.726
Transp. services	61,954	31,194	−0.062	−0.347	−0.557	−0.058	−0.351	−0.567
			Model 3: Capital Regionally Variable; Capital and Labor Mobile					
Retail trade	127,884	46,467	−3.164	−3.344	−3.486	−3.159	−3.346	−3.493
Manufacturing	277,992	215,518	−0.226	−0.780	−1.218	−0.221	−0.782	−1.225

Table 8. Continued.

Sector	Base-Labor Earnings	Base-Capital Earnings	Labor Earnings (%)			Capital Income (%)		
			1	2	3	1	2	3
			Model 1: Capital Sector-Specific; Labor Mobile					
Food and lodging	88,977	32,879	−2.524	−2.759	−2.944	−2.519	−2.761	−2.951
Transportation	21,519	12,035	−5.790	−6.026	−6.211	−5.785	−6.027	−6.218
Agriculture	12,423	22,940	0.384	−0.317	−0.871	0.389	−0.319	−0.879
Mining	140,186	64,925	−0.635	−0.501	−0.394	−0.629	−0.503	−0.401
Construction	36,749	116,375	0.038	−0.557	−1.025	0.043	−0.558	−1.033
Utilities	20,971	70,738	−0.456	−0.864	−1.186	−0.451	−0.866	−1.193
Wholesale trade	139,793	65,391	−0.471	−0.730	−0.934	−0.466	−0.732	−0.941
Services	1,309,413	874,674	−0.344	−0.642	−0.878	−0.338	−0.644	−0.885
Transp. services	61,954	31,194	−0.131	−0.497	−0.785	−0.126	−0.498	−0.792

Notes: Simulation 1-Labor supply (perfectly inelastic); Simulation 2-Labor supply (elastic); Simulation 3-Labor supply (infinitely elastic). Directly impacted sectors are shown in italics.

and factor supply; the physical impacts got larger whereas impacts on relative prices tended to be smaller as constraints about factor mobility and factor supply were relaxed.

Simulation results suggested that without wildlife-associated recreation expenditures, regional employment would have been smaller by up to 783 thousand jobs, and value added would have been $22 to $48 billion less, depending on assumptions about factor supply and factor mobility across sectors and regional borders. These estimates of economic impacts (value added and employment) induced by the exogenous demand shock encompass corresponding estimates reported in Munn et al. (2010). Using a SAM based analysis, Munn et al. (2010) estimated that wildlife-associated recreation expenditures of $38 billion (the same amount as considered in this study) generated 397 thousand jobs and $28 billion in value added, whereas the current study estimates range from 396 thousand to 783 thousand jobs and $22–48 billion in value added, depending on assumptions about regional factor supply and factor mobility across sectors and regional borders. While these estimates of economic impacts suggest that the Southeast U.S. regional economy is more sensitive to wildlife-associated activities than previously thought based on I-O analysis, important differences between the current and Munn et al. (2010) research needs to be noted. First, Munn et al. (2010) simulated the impact of wildlife-associated recreation activities in the Southeast United States by injecting $38 billion into the system whereas the current study withdrew the same amount. The comparison is, however, still valid keeping in view of the fact that SAM-based analysis is a linear model; withdrawals and injections of a given sum of exogenous expenditures induce the same impact except for sign. Second, Munn et al. (2010) used a disaggregated expenditure profile (as reported in the U.S. Fish and Wildlife Service (2007) survey) whereas the current study used a highly aggregated expenditure profile made necessary by the relative simplicity of the general equilibrium model employed, raising the possibility of aggregation bias.

Reasons underlying the size of response by regional economies to exogenous shocks have been of considerable interest in general equilibrium modeling studies. In general, the response depends on assumptions regarding factor (labor and capital) mobility and supply elasticities. The neoclassical model assumes that labor and capital supplies are fixed, the I-O model allows them to change, and the regional general equilibrium model can make either assumption. In regional models where labor and capital markets are likely to be fairly open and hence exhibit elastic supply, a positive exogenous shock will result in an increased stock of resources of primary factors in the counterfactual that can account for large increases in regional jobs and income. Assuming the region is relatively open, the endowment will change and give results different from the neoclassical model and possibly larger than the I-O model (Cassey, Holland, and Razack, in press). On the other hand, a regional general equilibrium model that assumed capital and labor supplies were fixed by region would exhibit a smaller response than I-O models to the same shock because of the general equilibrium model's ability to account for re-allocation of resource flows across sectors (Zhou et al., 1997).

Limitations and Implications for Research

Future research on wildlife-associated recreation may improve in the following respects. First, the assumption of sector-specific capital may be plausible only for certain sectors (e.g., agriculture, mining, construction). Likewise, the assumption of infinite labor supply may be true for certain categories of labor (e.g., unskilled labor). Therefore, future applications of general equilibrium modeling to wildlife-associated recreation activities would improve on this study by implementing factor market closures accordingly. Second, to minimize biases induced due to researchers arbitrarily bridging USFWS surveys expenditures to various IMPLAN industries, the U.S. Fish and Wildlife Service should include North American Industry Classification System sector codes along with specific goods and services purchased by wildlife recreationists. Third, to take advantage of general equilibrium models' ability to quantify welfare, the agency needs to collect expenditure information on anglers, hunters, and wildlife watchers by income category. Combined with information on labor occupational skills class, expenditures by income category would allow general equilibrium modelers to demonstrate how wildlife-associated recreation activities impact different types of households in regional economies. Kilkenny and Otto (1994) emphasized that correctly portraying feedbacks and identifying which groups benefit and which lose is important to the political feasibility of solutions. Overall, economy-wide welfare measures are not helpful in this respect. Fourth, similar regional general equilibrium modeling applications in other U.S. regions are needed to gauge the significance of wildlife-associated recreation activities, and the role they play in rural development without adversely impacting ecosystem integrity. We expect that economic impacts associated with wildlife-related recreation activities in other regions are likely to be different to the extent they differ from the Southeast U.S. region in terms of the relative composition of wildlife-recreation associated expenditures, their ability to meet local demand for goods and services, structure of production, and constraints on factor mobility and factor supply.

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