

# The Economic Impact of Disaster

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ESRL-NCAR Seminar Series

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# CIRA's Rapid Assessment Tool

for estimating the economic consequences of natural and man-made disasters

## **Katrina could cost 400,000 jobs -- CBO**

Congressional Budget Office says storm could also knock up to 1 percent off economic growth.

September 7, 2005; 12:38 PM EDT

**NEW YORK (CNN/Money) - Hurricane Katrina could cost the U.S. over 400,000 jobs and shave up to 1 percent off the nation's economic growth in the second half of the year, the Congressional Budget Office said.**

The CBO said much of the loss will come from disruption of oil production. It added that the economy, growing at a projected rate of 3.7 percent in 2005, had been growing steadily at the time of the storm.

"The devastation in the Gulf Coast region is unlikely to knock the economy far from that course," the CBO said in a letter to Senate Majority Leader Bill Frist, dated Wednesday. "While making specific estimates is fraught with uncertainty, evidence to

### more on **HURRICANE KATRINA**

[Business after disaster](#)

[Don't be scared of September job loss](#)

[BP says Katrina, Rita will cost \\$700M](#)

[Man indicted in Katrina fraud case](#)

[Six more months of gasoline pain?](#)

[Gulf fisheries see slow recovery](#)

[Report: Computer woes hurt storm relief](#)



# Seminar Outline

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1. Economic Loss: Overview
  2. Importance of Indirect Economic Loss –  
Critical to the valuation of weather information
  3. A simple discussion of regional economics
  4. A brief discussion of the regional economics  
of disaster
  5. Proxy Economies speed the analysis
  6. What happened after Katrina?
  7. What happened after Andrew?
  8. Conclusions
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# Valuing Weather and Climate Information

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**Cost/Loss Model**

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# Decision to Adopt Forecast Sensitive Protection

Probabilities

		Flood Forecast	
		No	Yes
Flood	No	P1	P2
	Yes	P3	P4

Consequences

		Flood Forecast	
		No	Yes
Flood	No	0	$C_{\text{short-run}}$
	Yes	Loss	Loss, $C_{\text{short}}$

Adopt Short-run protection if  
 $C_{\text{short-run}} * (P2+P4) + \text{Loss} * P3 < \text{Loss} * (P3+P4)$

# Decision to Adopt Climate Long-Run Protection

Probabilities

		Flood Forecast	
Flood	No	P1	P2
	Yes	P3	P4

Consequences

		Flood Forecast	
Flood	No	$C_{\text{Long-run}}$	$C_{\text{Long-run}}$
	Yes	Loss or $C_{\text{Long-run}}$	Loss or $C_{\text{Long-run}}$

Adopt Long-run protection if  
 $C_{\text{long-run}} < \text{Loss}^*(P_3 + P_4)$



# The Value of Weather Information

Adapting to the climate

$\text{MIN} (C_{\text{Long-run}}, \text{Loss} * (P_3 + P_4))$  *Minus*

$C_{\text{Short-run}} * (P_2 + P_4) + \text{Loss} * (P_3 + P_4)$

Adjusting with the aid of forecasts

## Curtail Anthropogenic CO2 if ....

$$\frac{C_{control}}{L_{disaster}} >< ? P_{warm}$$

The decision boils down to the same factors that shaped the use of climate/weather information in the cost loss model. Research has value if the losses are sufficiently high, the control costs low, and the *a priori* probabilistic assessment of the connection between CO2 and climate change is high.





## Now for an Analysis of Losses

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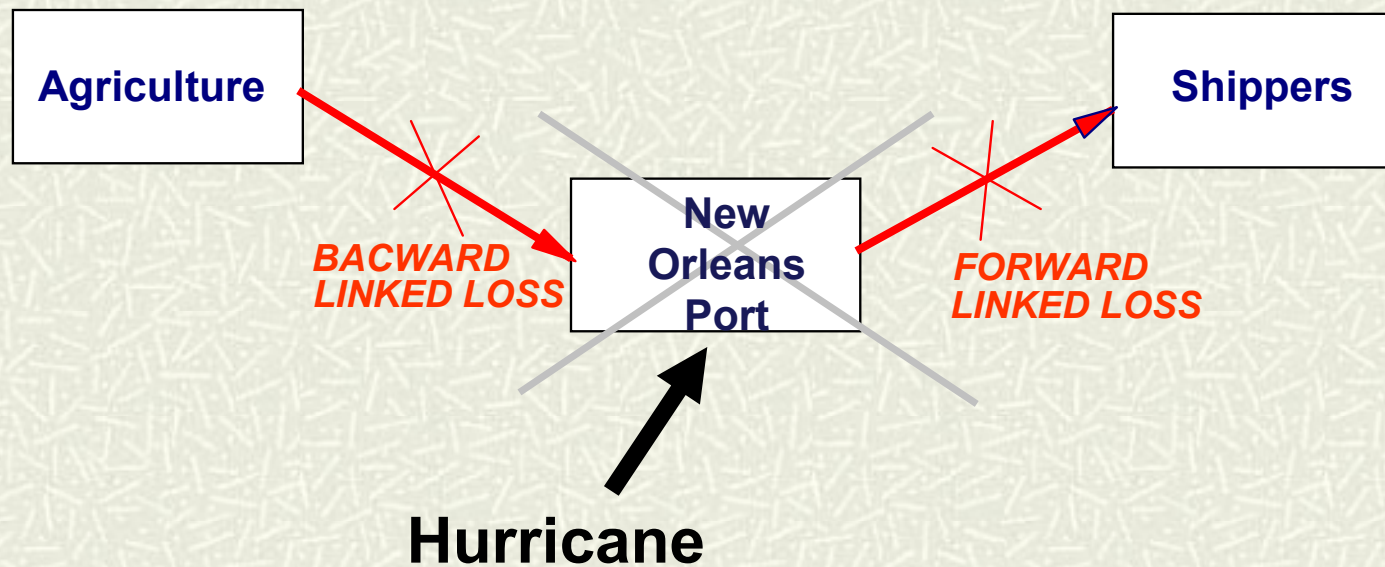
Mortality, morbidity, along with property damage are the best known.

Loss of environmental services, cultural icons, historic monuments, and a sense of place are less well known and understood.

Loss of regional economic activity is also not well understood. We now turn attention to this aspect of damage.

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# How Indirect Losses are Modeled





# Example Input Output Table

A typical inter-industry table

	S1	S2	Households	Exports	Gross Shipments
S1	20	45	30	5	100
S2	40	15	30	65	150
Households	20	60	0	0	80
Imports	20	30	20	0	70
Gross product	100	150	80	70	400

# Input-Output analysis is the Foundation of the Algorithm

Inter-industry Demand

	S1	S2	Households	Exports	Gross Shipments
S1	Inter-industry Demand		30	5	100
S2			30	65	150
Households	20	60	0	0	80
Imports	20	30	20	0	70
Gross product	100	150	80	70	400



# Sector Supply and Demand

Sector Supplies and Demands

	S1	S2	Households	Exports	Gross Shipments
S1	20	45	30	5	<b>Sector Demand</b>
S2	40	15	30	65	
Households	20	60	0	0	80
Imports	20	30	20	0	70
Gross product	<b>Sector Supply</b>		80	70	400

# Household Spending and Income

Household Spending

	S1	S2	Households	Exports	Gross Shipments
S1	20	45	Spending	5	100
S2	40	15		65	150
Households	20	60		0	80
Imports	20	30		0	70
Gross product	100	150	Total Spending	70	400

Household Income

	S1	S2	Households	Exports	Gross Shipments
S1	20	45	30	5	100
S2	40	15	30	65	150
Households	Income				Total
Imports	20	30	20	0	70
Gross product	100	150	80	70	400



# How Disruptions are Treated

## Shock to Production and Rebalancing

	<b>.50</b> S1	<b>.50</b> S2	Households	Exports	Gross Shipments
S1	10	22.5	15	2.5	50
S2	20	7.5	15	32.5	75
Households	10	30	0	0	40
Imports	10	15	10	0	35
Gross product	<b>50</b>	<b>75</b>	40	35	200

**50% Loss**





# The Goal and Constraints

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The goal is to maximize post disaster income while maintaining a balance between production and shipments.

Production is augmented by imports and excess capacity (sensitive to the the pre-disaster level of unemployment).

Reconstruction spending is included.

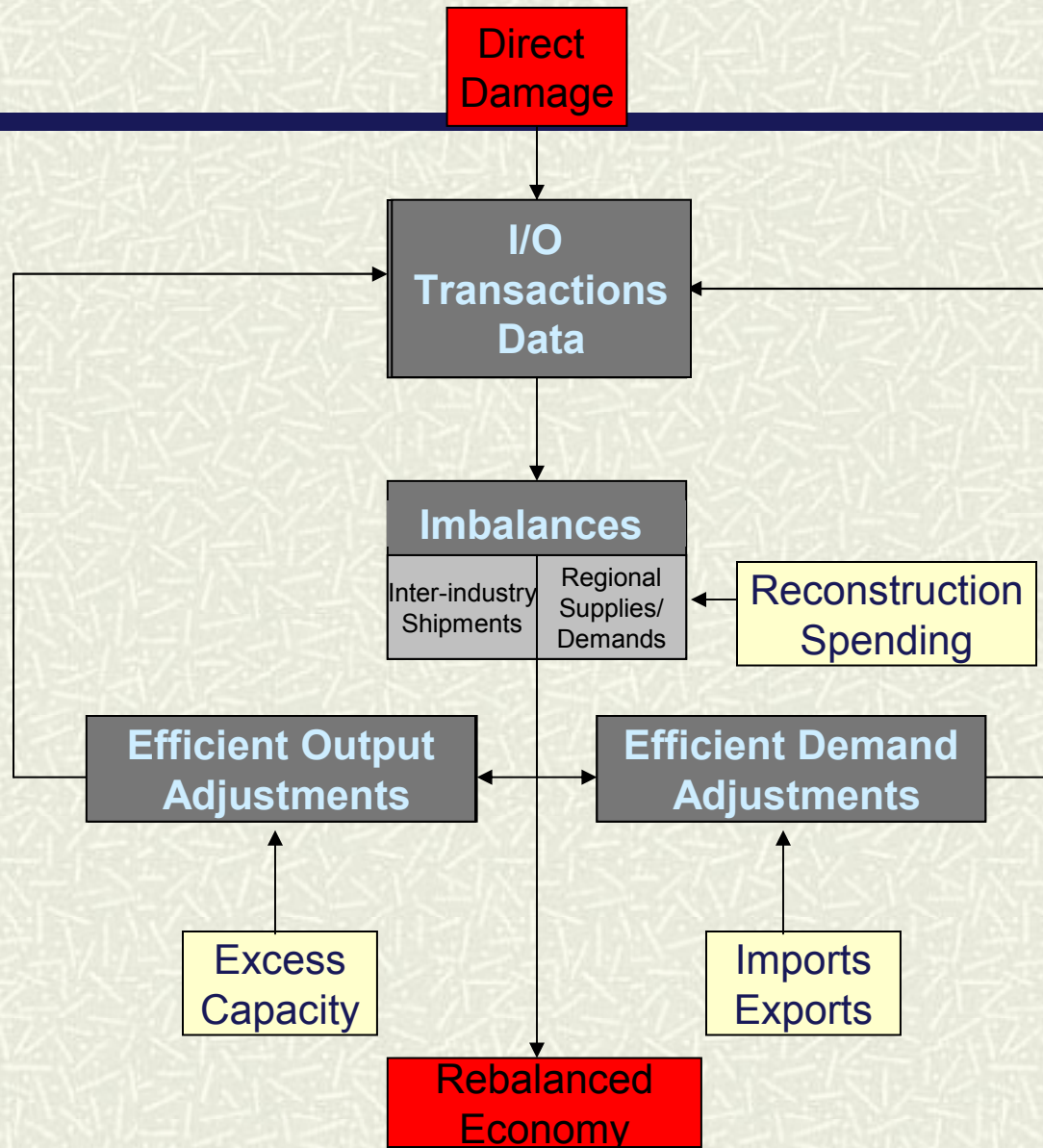
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# Rebalancing Algorithm

# A Schematic





# Optimizer (Equations and Variables)

Equations for Rebalancing

Production Adjusters

The screenshot displays two windows from a software application. The 'Rules' window on the left contains a list of equations for rebalancing, all with a 'Satisfied' status. The 'Variables' window on the right lists production adjusters, including dx19 through dx21 and xaddimp1 through xaddimp12, with their respective input, output, and unit values.

Status	Rule
Satisfied	$xx17x26=Q[26]*((1-MAXLOSS)*dx17)$
Satisfied	$xx18x26=R[26]*((1-MAXLOSS)*dx18)$
Satisfied	$xx19x26=S[26]*((1-MAXLOSS)*dx19)$
Satisfied	$xx20x26=T[26]*((1-MAXLOSS)*dx20)$
Satisfied	$xx21x26=U[26]*((1-MAXLOSS)*dx21)$
Comment	;Total production
Satisfied	$xx1x27=A[27]*((1-MAXLOSS)*dx1)$
Satisfied	$xx2x27=B[27]*((1-MAXLOSS)*dx2)$
Satisfied	$xx3x27=C[27]*((1-MAXLOSS)*dx3)$
Satisfied	$xx4x27=D[27]*((1-MAXLOSS)*dx4)$
Satisfied	$xx5x27=E[27]*((1-MAXLOSS)*dx5)$
Satisfied	$xx6x27=F[27]*((1-MAXLOSS)*dx6)$
Satisfied	$xx7x27=G[27]*((1-MAXLOSS)*dx7)$
Satisfied	$xx8x27=H[27]*((1-MAXLOSS)*dx8)$
Satisfied	$xx9x27=I[27]*((1-MAXLOSS)*dx9)$
Satisfied	$xx10x27=J[27]*((1-MAXLOSS)*dx10)$

Status	Input	Name	Output	Unit	Comment
L	1.267	dx19			
L	1.279	dx20			
L	1.256	dx21			
L		xaddimp1	0		
L		xaddimp2	0		
L		xaddimp3	0		
L		xaddimp4	0		
L		xaddimp5	0		
L		xaddimp6	1.22488		
L		xaddimp7	0		
L		xaddimp8	0		
L		xaddimp9	0		
L		xaddimp10	0		
L		xaddimp11	0		
L		xaddimp12	0		

# Optimizer (Target and Conditions)

Maximize regional income

subject to production limits

Optimization Parameters

Set Target Variable:  ...

Equal To:  Maximize  Minimize  Value of:

By Changing Variables:

...

Subject to the Constraints:

abs(DIFF1-xaddimp1) <= PLIM\*A[27]  
abs(DIFF2-xaddimp2) <= PLIM\*B[27]  
abs(DIFF3-xaddimp3) <= PLIM\*C[27]  
abs(DIFF4-xaddimp4) <= PLIM\*D[27]  
abs(DIFF5-xaddimp5) <= PLIM\*E[27]  
abs(DIFF6-xaddimp6) <= PLIM\*F[27]  
abs(DIFF7-xaddimp7) <= PLIM\*G[27]  
abs(DIFF8-xaddimp8) <= PLIM\*H[27]  
abs(DIFF9-xaddimp9) <= PLIM\*I[27]  
abs(DIFF10-xaddimp10) <= PLIM\*J[27]

Add...  
Change...  
Delete

Optimize...  
Options...  
Reset All  
Help

OK  
Cancel  
Bounds...

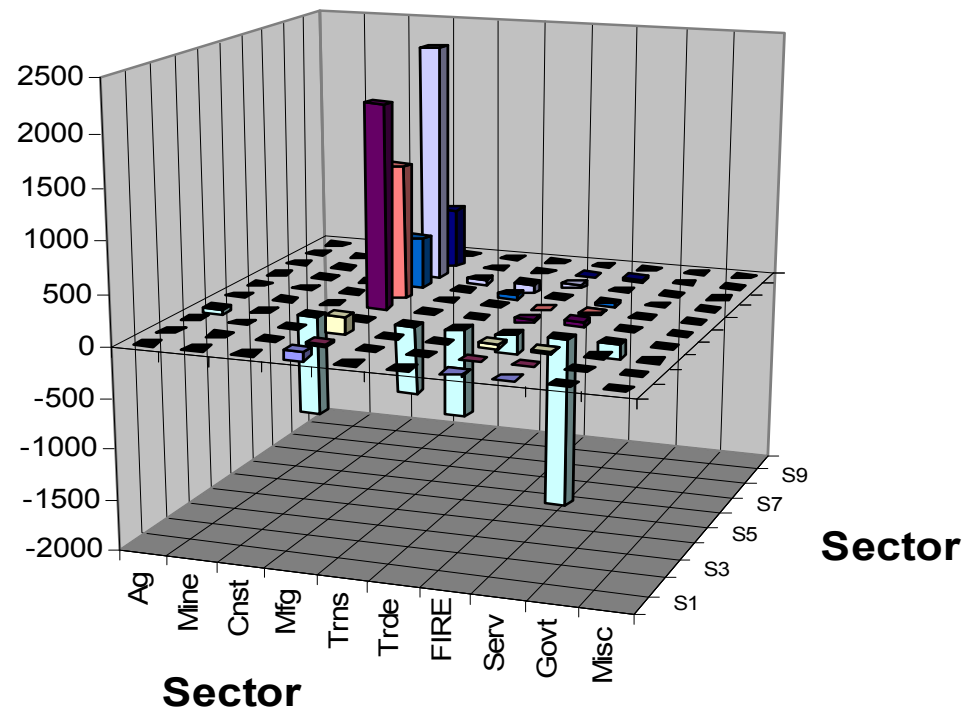




# Rebalancing Visuals

## Sectoral Imbalances

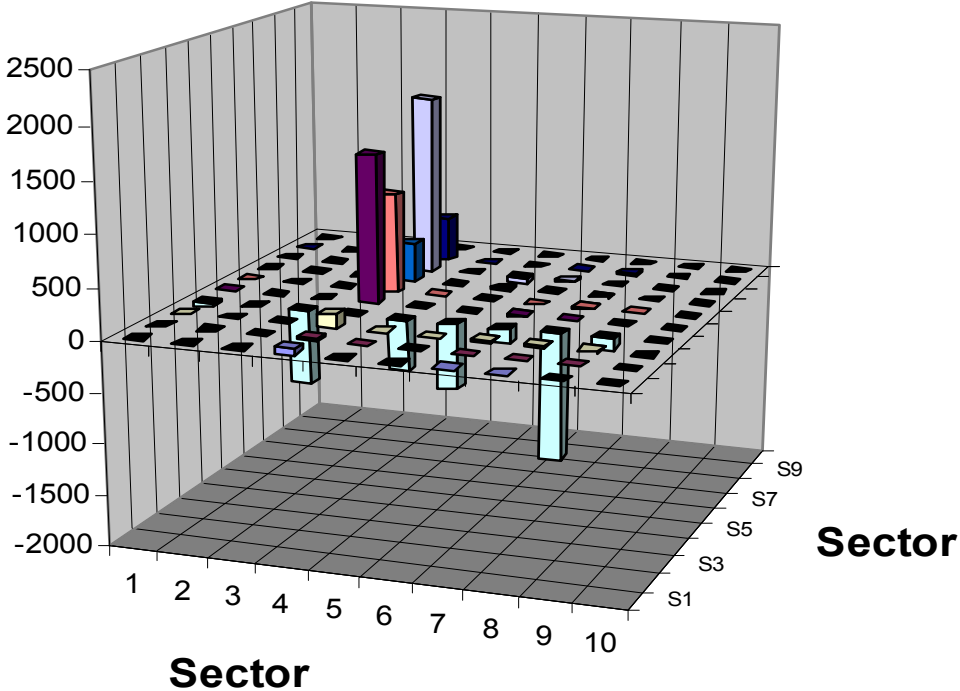
**Excess  
Supplies and  
Demands**



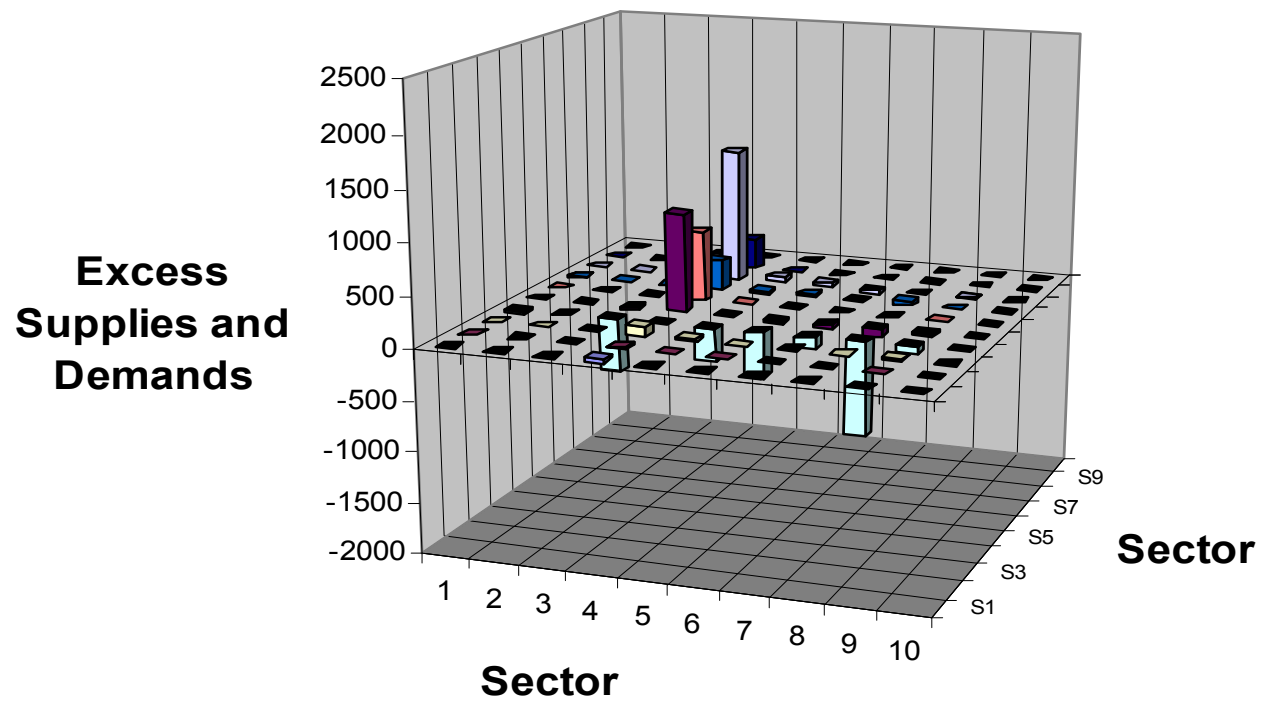


# Sectoral Imbalances

**Excess  
Supplies and  
Demands**

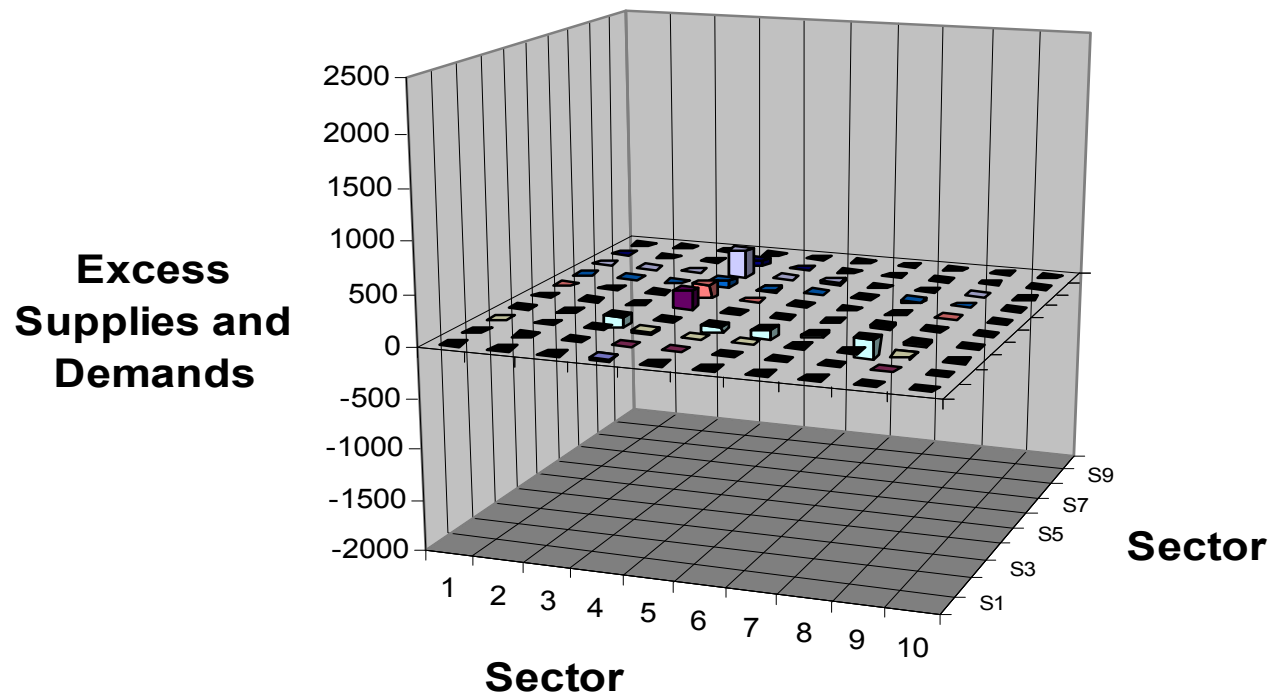


## Sectoral Imbalances



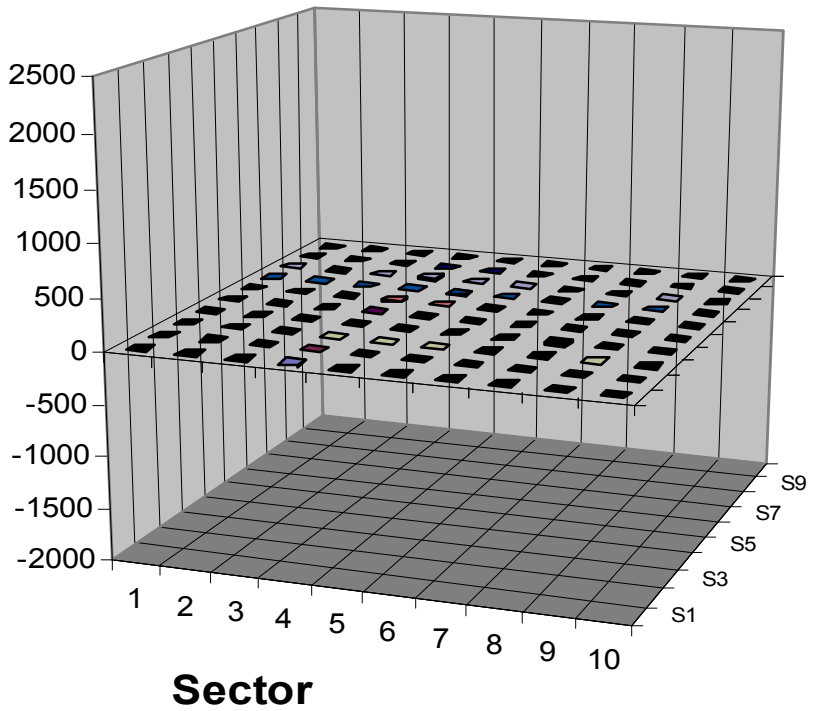


## Sectoral Imbalances



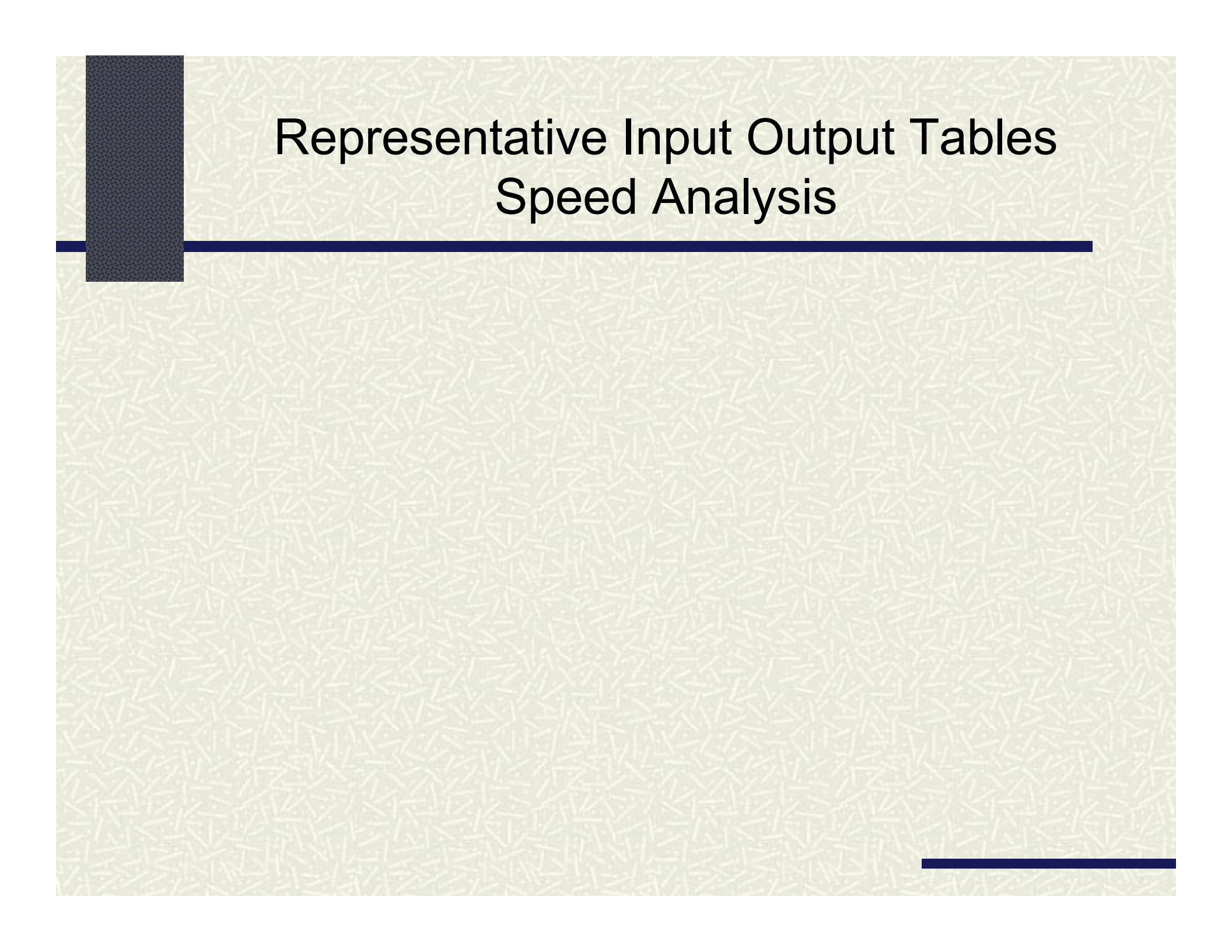
# Sectoral Imbalances

**Excess  
Supplies and  
Demands**



**Sector**





# Representative Input Output Tables Speed Analysis

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# Economic Sectors Included

Level I 10 Sector	Level II 21 Sector
Agriculture	Agriculture
Mining	Mining
Construction	Electric Utilities
Utilities	Natural Gas Distribution
Manufacturing	Water and Sanitary Services
Trade	Construction
Transport, Comm. & Info	Food Products
FIRE	Chemicals
Services	Petroleum Refining
Government	Other Manufacturing
	Wholesale Trade
	Retail Trade
	Transportation and Warehousing
	Communication and Information
	Finance and Insurance
	Real Estate
	Health Care and Social Assistance
	Waste Management & Remediation
	Other Services
	Recreation and Tourism
	Other Public Administration (Gov't)



# Proxy Inter-industry Tables

	Agriculture	Mining	Electric	Natural Gas	Water	Construction	Food	Chemicals	Petroleum	Other	Wholesale	Retail	Transportation	Communications	Finance	Real Estate	Health	Waste	Other	Services	Recreation	Emergency	Other	Public	Household
<b>Agriculture</b>	0.071041	2.25E-05	6.57E-06	5.42E-06	1.51E-06	0.000426	0.067278	0.000861	4.03E-06	0.002107	1.48E-05	1.63E-05	1.52E-05	1.29E-05	8.88E-06	0.000266	0.000162	7.3E-06	0.000302	0.003521	0	1.35E-05	0	0	0
<b>Mining</b>	0.000927	0.073236	0.052467	0.192309	0.000192	0.002233	0.000154	0.005718	0.231767	0.00221	6.1E-05	9.2E-05	0.0016	1.12E-05	7.84E-06	0.000173	8.03E-05	0.00071	3.6E-05	3.75E-05	0	0.001185	0.0	0	0
<b>Electric Utilities</b>	0.006997	0.006507	0.000166	0.000305	0.009621	0.001749	0.005473	0.007628	0.006967	0.006093	0.003745	0.00949	0.002502	0.001751	0.001188	0.008222	0.004911	0.008221	0.002716	0.010029	0	0.002753	0.0	0	0
<b>Natural Gas Distribution</b>	0.000816	0.000679	0.000218	0.000799	0.009022	0.000649	0.004635	0.005636	0.010167	0.003385	0.001581	0.001532	0.000998	0.000464	0.000138	0.002168	0.001769	0.006387	0.001185	0.003216	0	0.00016	0.0	0	0
<b>Water and Sanitary Services</b>	0.000311	2.89E-05	0.000283	2.48E-05	0	3.26E-05	5.48E-06	1.67E-05	4.8E-06	7.53E-06	3.32E-05	6.21E-05	3.94E-05	4.03E-05	2.55E-05	0.000101	0.000113	0.000286	4.41E-05	0.000145	0	0.000146	0.0	0	0
<b>Construction</b>	0.003653	0.000255	0.026565	0.000718	0.101833	0.000991	0.001755	0.002665	0.000661	0.001949	0.002575	0.004807	0.002996	0.002814	0.002685	0.014494	0.005186	0.000391	0.003893	0.007355	0	0.009472	0.0	0	0
<b>Food Products</b>	0.035395	2.93E-05	5.94E-06	1.03E-06	2.13E-05	4.35E-05	0.088007	0.002843	7.01E-05	0.000563	0.000241	1E-05	0.001223	0.000184	1.37E-06	8.02E-06	0.007738	1.68E-05	0.00207	0.072086	0	0.00029	0.0	0	0
<b>Chemicals</b>	0.026683	0.006187	0.001009	5.66E-05	0.00453	0.005797	0.004413	0.133768	0.101676	0.020827	0.001221	0.000724	0.001407	0.001175	0.000212	0.001584	0.020121	0.004042	0.002344	0.001382	0	0.001837	0.0	0	0
<b>Petroleum Refining</b>	0.022996	0.012476	0.010942	0.001233	0.008668	0.010416	0.000946	0.023176	0.078597	0.004504	0.002718	0.004206	0.046979	0.000351	0.000332	0.000222	0.002554	0.032849	0.001234	0.001194	0	0.003048	0.0	0	0
<b>Other Manufacturing</b>	0.02004	0.036957	0.017875	0.0077	0.025075	0.147754	0.059728	0.046557	0.009128	0.209837	0.026792	0.01773	0.031958	0.043546	0.004386	0.01221	0.041088	0.01484	0.036843	0.019727	0	0.010553	0.0	0	0
<b>Wholesale Trade</b>	0.04446	0.013191	0.00793	0.001851	0.015278	0.036692	0.078661	0.061241	0.050389	0.066264	0.031219	0.006585	0.027437	0.011258	0.0012	0.003475	0.0228	0.018237	0.009429	0.03569	0	0.004512	0.0	0	0
<b>Retail Trade</b>	0.000985	0.001313	0.000447	0.000531	0.003791	0.061559	0.00424	0.002481	0.000406	0.005384	0.005707	0.010551	0.005365	0.001197	0.000679	0.010802	0.004685	0.003763	0.00698	0.006151	0	0.000166	0.0	0	0
<b>Transportation and Warehousing</b>	0.01744	0.012681	0.042288	0.12002	0.066737	0.015525	0.027383	0.023145	0.028706	0.020922	0.021133	0.021871	0.08934	0.008439	0.009917	0.003958	0.018901	0.016264	0.009624	0.012128	0	0.003285	0.0	0	0
<b>Communication and Information</b>	0.001663	0.005061	0.002048	0.000858	0.004897	0.005497	0.003963	0.005357	0.001762	0.005057	0.007941	0.009209	0.007871	0.046651	0.004936	0.003376	0.009828	0.006698	0.008157	0.006954	0	0.001091	0.0	0	0
<b>Finance and Insurance</b>	0.013229	0.010005	0.00901	0.007975	0.009091	0.014289	0.013123	0.009746	0.008304	0.010274	0.014082	0.018624	0.020677	0.008963	0.170317	0.037545	0.02292	0.009814	0.009008	0.013559	0	0.001919	0.0	0	0
<b>Real Estate</b>	0.036281	0.00243	0.003945	0.000954	0.002982	0.003402	0.001804	0.001312	0.000407	0.002861	0.014158	0.037142	0.009476	0.006121	0.014285	0.03532	0.045116	0.001246	0.018954	0.026193	0	0.002752	0.0	0	0
<b>Health Care and Social Assistance</b>	0	0	0	0	0	0	0	0	0	0	0	0	3.67E-06	7.15E-05	0	5.86E-07	0	0.004652	1.7E-05	4.59E-05	2.65E-05	0	0	0	0
<b>Waste Management &amp; Remediation</b>	0.001605	0.000521	0.000583	0.001152	0.000194	0.001108	0.001215	0.002259	0.001874	0.001423	0.000414	0.000952	0.001839	0.000195	0.000449	0.003784	0.00183	0.06644	0.00058	0.001658	0	0.000138	0.0	0	0
<b>Other Services</b>	0.024464	0.131929	0.03579	0.021502	0.058249	0.087371	0.070976	0.109926	0.043673	0.072435	0.105056	0.135394	0.108068	0.087982	0.059386	0.057556	0.11409	0.110235	0.080711	0.078878	0	0.01733	0.0	0	0
<b>Recreation and Tourism</b>	0.001288	0.007146	0.004595	0.001515	0.001095	0.00169	0.00438	0.003843	0.003228	0.003916	0.005266	0.005742	0.00836	0.009791	0.007075	0.002718	0.013505	0.005864	0.006415	0.021431	0	0.000312	0.0	0	0
<b>Emergency Services</b>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<b>Other Public Administration (Government)</b>	0.002628	0.000462	0.002287	0.001036	0.000571	0.001358	0.0016	0.001353	0.000848	0.001764	0.001128	0.002034	0.001705	0.001137	0.006189	0.001567	0.002565	0.002969	0.001312	0.003364	0	0.002911	0.0	0	0
<b>Employee Compensation &amp; Benefits</b>	0.171013	0.250128	0.233507	0.120978	0.394003	0.496037	0.134945	0.163487	0.037105	0.262885	0.386628	0.474147	0.428031	0.322398	0.357734	0.063759	0.483334	0.397416	0.536614	0.445615	0.852265	0.767298	0	0	0
<b>Other Property Income</b>	0.207627	0.142897	0.302093	0.052318	0.255838	0.041444	0.116745	0.196943	0.007663	0.110019	0.095457	0.045844	0.057458	0.214269	0.214211	0.531558	0.04568	0.163556	0.168998	0.042122	0.147735	0.148805	0	0	0
<b>Indirect Business Taxes</b>	0.023295	0.084356	0.110393	0.074154	0.036635	0.009853	0.01077	0.017091	0.005338	0.008159	0.194601	0.104058	0.025604	0.048706	0.029338	0.140877	0.004972	0.051409	0.018066	0.059863	0	0.000433	0.0	0	0
<b>Domestic Trade</b>	0.252514	0.160164	0.106738	0.293215	0.049499	0.120265	0.282402	0.153804	0.342737	0.152815	0.075118	0.086973	0.114565	0.177252	0.114337	0.062661	0.115047	0.07669	0.07221	0.12305	0	0.017708	0.0	0	0
<b>Foreign Trade</b>	0.012648	0.04134	0.028807	0.09879	0.003177	0.016707	0.0154	0.019144	0.119518	0.024358	0.00311	0.002198	0.005418	0.005295	0.000961	0.001598	0.006354	0.00263	0.004122	0.004625	0	0.001881	0.0	0	0
<b>Totals</b>	8450.241	5936.16	10093.91	3256.21	199.6612	42867.79	33126.88	24196.36	13990.33	128423.3	51690.5	38336.21	32646.8	33682	75301.25	63752.24	52115.09	2595.265	135309.5	26442.12	18549.4	30288.54	0	0	0

# Proxy Table Classification

Economy Size (Employment)	Economy Type		
	Manufacturing	Tourism; Service/Gov't	Trade/Transportation
0 to 49,999	1	2	3
50,000 to 199,999	4	5	6
200,000 to 999,999	7	8	9
1,000,000 +	10	11	12



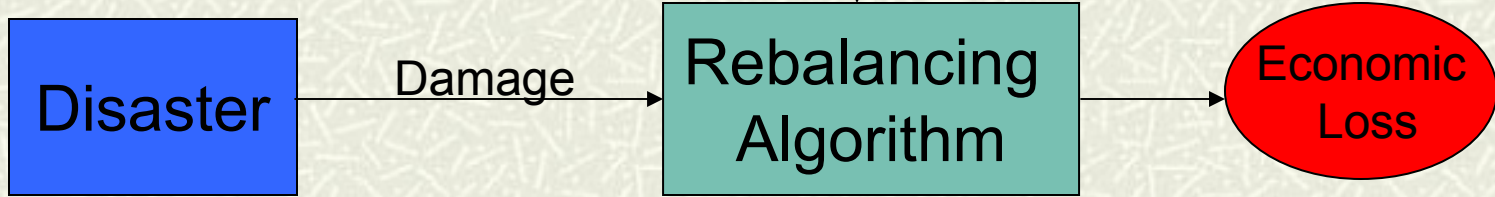
# A Simple Schematic

1 ↑

Category	Agri	Mining	Electric	Natural	Water	Construction	Food	Chemical	Petroleum	Other	M	Wholesale	Retail	Transport	Common	Finance	Real	Est	Health	C	V	M	Other	Se	Recreation	Emergence	Other	P	Ho
Agriculture	0.07544	1.2E-05	0.57E-05	0.43E-04	1.5E-04	0.00424	0.00271	0.00014	0.0001	0.00031	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001

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↑ Model Economies ↓



Economic Loss

Disaster

Damage

Rebalancing Algorithm



# Proxy Table Selection

## New Orleans

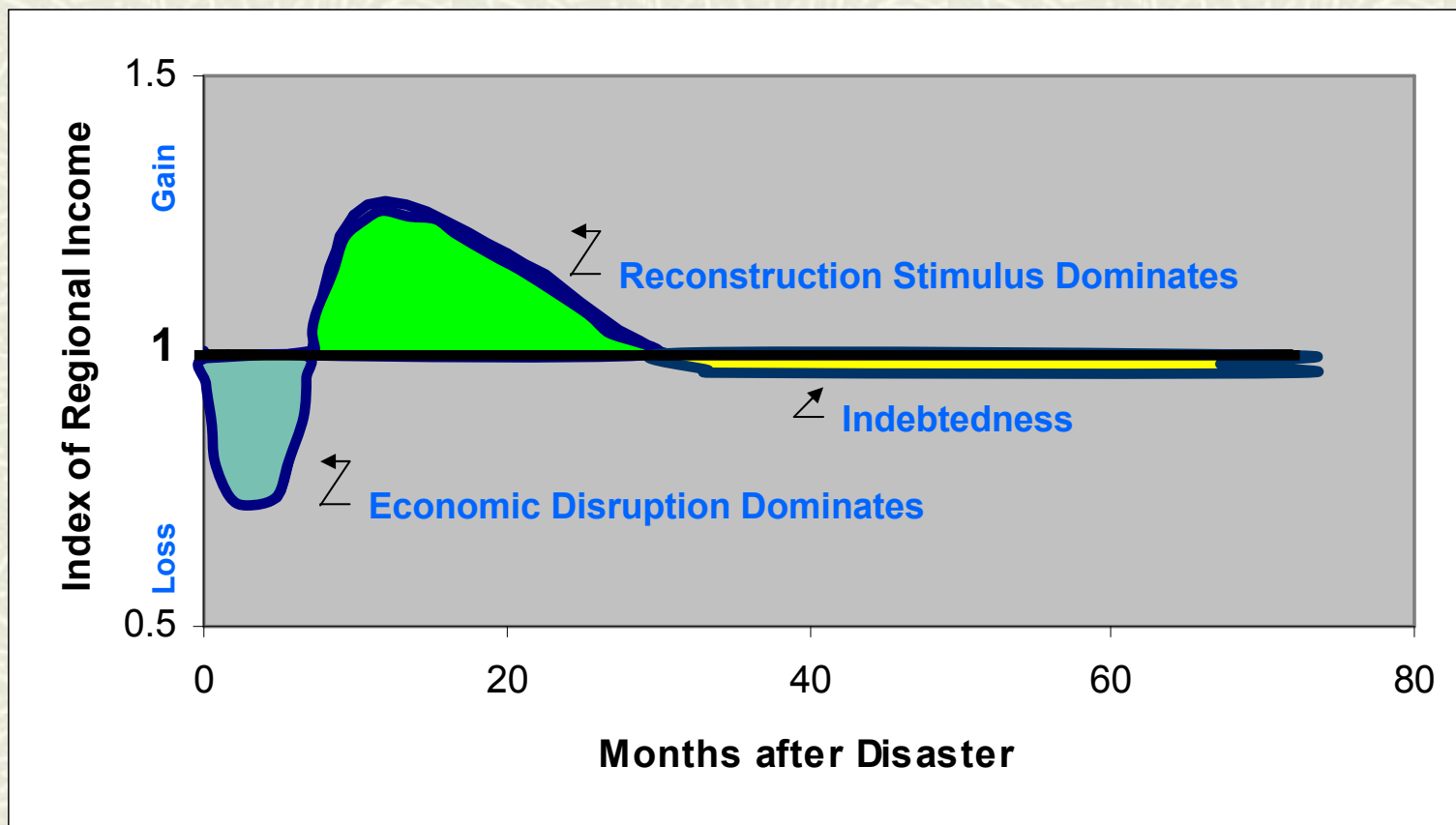
Economy Size (Employment)	Economy Type		
	Manufacturing	Tourism, Service/Gov't	Trade/Transportation
0 to 49,999	1	2	3
50,000 to 199,999	4	5	6
200,000 to 999,999	7	8	9
1,000,000 +	10	11	12

Industry	Electricity	Water	Construction	Food	Chemicals	Textiles	Other Mfg	Retail	Transportation	Finance	Real Estate	Health	Education	Government	Other	Research	Development	Other	Public	Utilities
Agriculture	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
Mining	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
Electric Utilities	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
Water and Sewerage	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
Construction	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
Food	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
Chemicals	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
Textiles	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
Other Manufacturing	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
Retail	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
Transportation	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
Finance	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
Real Estate	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
Health	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
Education	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
Government	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
Other	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
Research	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
Development	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
Other Public Utilities	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000

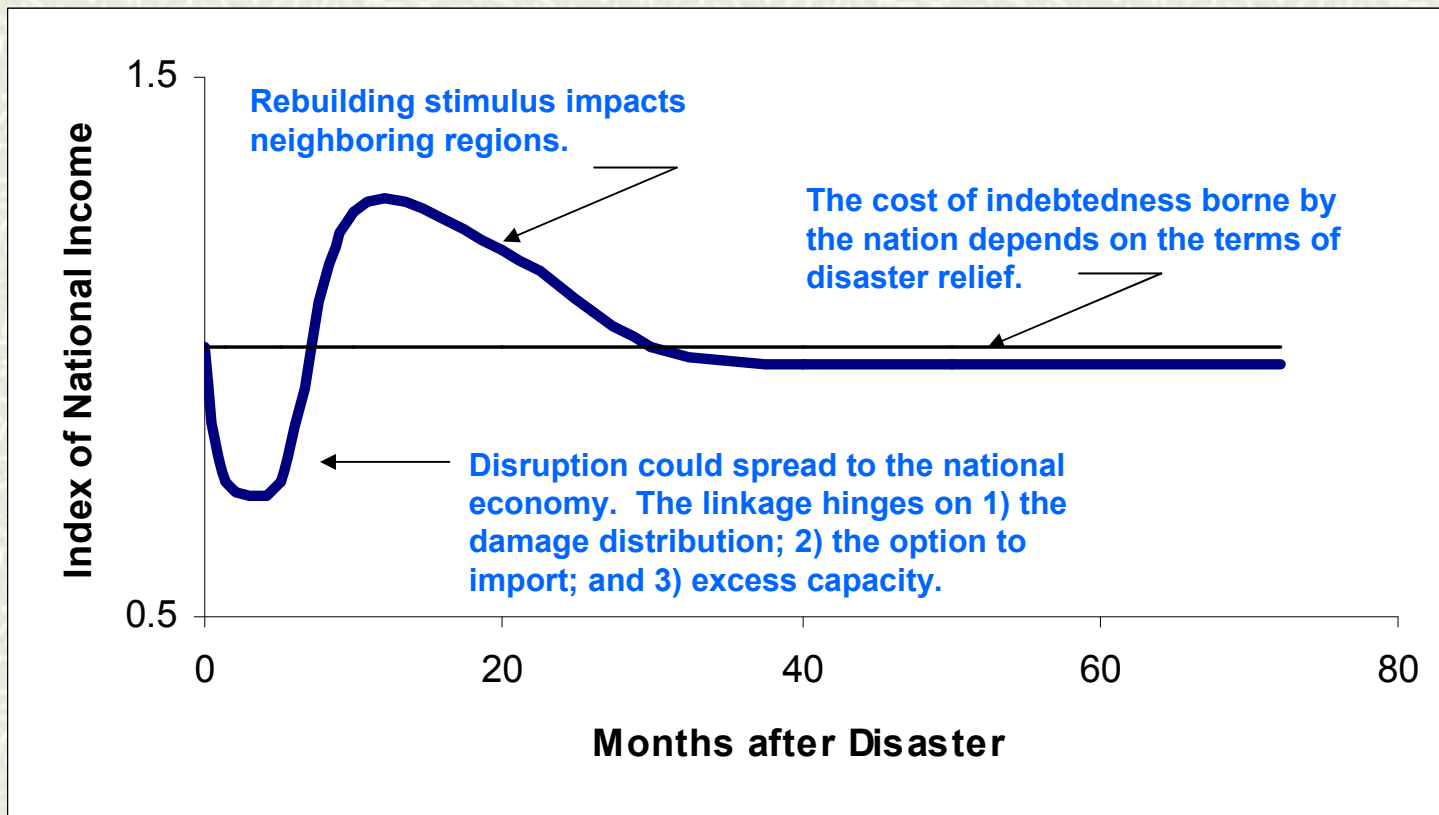
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# Prototypical Regional Loss Pattern



# Prototypical National Loss Pattern





# Simulating Katrina's Impact on New Orleans' Economy





# Initial News Reports

## **Katrina could cost 400,000 jobs -- CBO**

**Congressional Budget Office says storm could also knock up to 1 percent off economic growth.**

September 7, 2005; 12:38 PM EDT

**NEW YORK (CNN/Money) - Hurricane Katrina could cost the U.S. over 400,000 jobs and shave up to 1 percent off the nation's economic growth in the second half of the year, the Congressional Budget Office said.**

The CBO said much of the loss will come from disruption of oil production. It added that the economy, growing at a projected rate of 3.7 percent in 2005, had been growing steadily at the time of the storm.

"The devastation in the Gulf Coast region is unlikely to knock the economy far from that course," the CBO said in a letter to Senate Majority Leader Bill Frist, dated Wednesday. "While making specific estimates is fraught with uncertainty, evidence to

### more on **HURRICANE KATRINA**

[Business after disaster](#)

[Don't be scared of September job loss](#)

[BP says Katrina, Rita will cost \\$700M](#)

[Man indicted in Katrina fraud case](#)

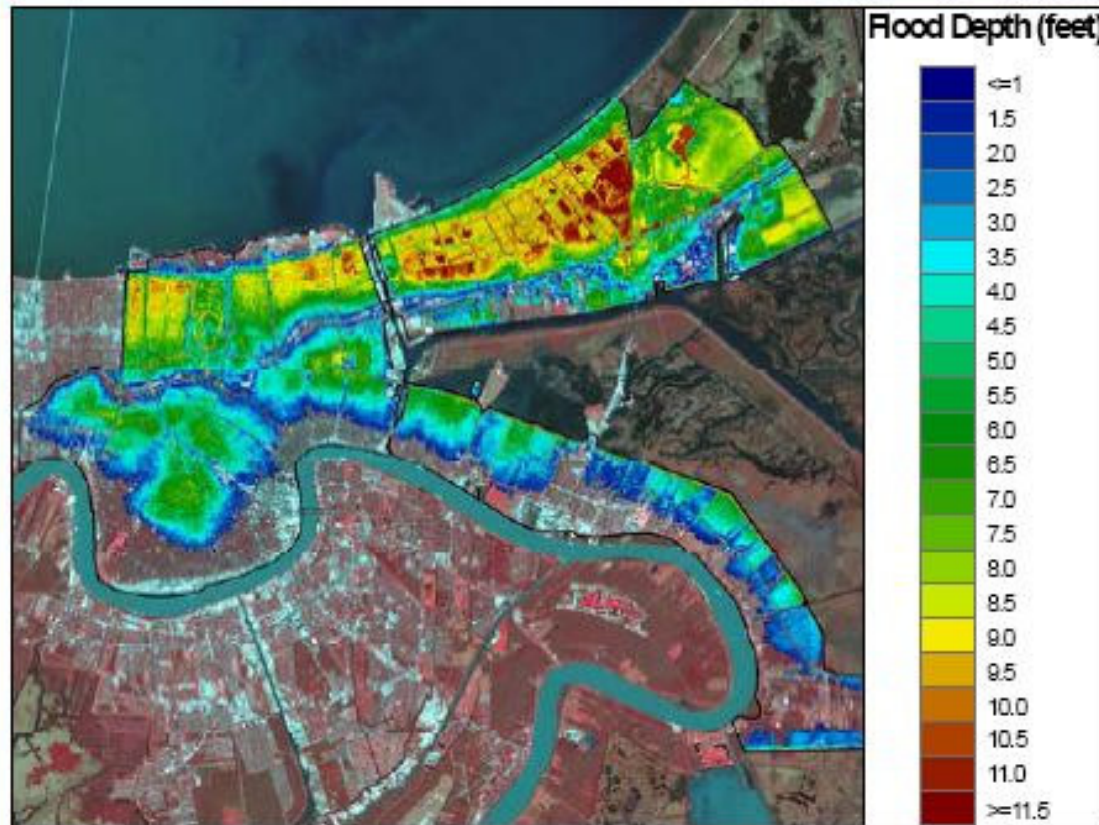
[Six more months of gasoline pain?](#)

[Gulf fisheries see slow recovery](#)

[Report: Computer woes hurt storm relief](#)



# GIS Depth and Damage



**Figure 4.** Estimated water depth in feet for flooded areas of New Orleans on September 2, 2005. Areas in bright red indicate depths over 11.5 feet. Courtesy of the U.S. Geological Survey.



# Inputs

## Disruption (% loss) and Recovery Period (months)

Agriculture	0%	0
Mining	30%	1.5
Electric Utilities	20%	12
Natural Gas Distribution	5%	12
Water and Sanitary Services	100%	0.5
Construction	0%	12
Food Products	0%	12
Chemicals	15%	12
Petroleum Refining	10%	0.5
Other Manufacturing	30%	12
Wholesale Trade	40%	24
Retail Trade	20%	24
Transportation and Warehousing	35%	24
Communication and Information	5%	12
Finance and Insurance	5%	3
Real Estate	5%	4
Health Care and Social Assistance	15%	6
Waste Management & Remediation	10%	12
Other Services	15%	12
Recreation and Tourism	35%	36
Other Public Administration (Gov't)	20%	12

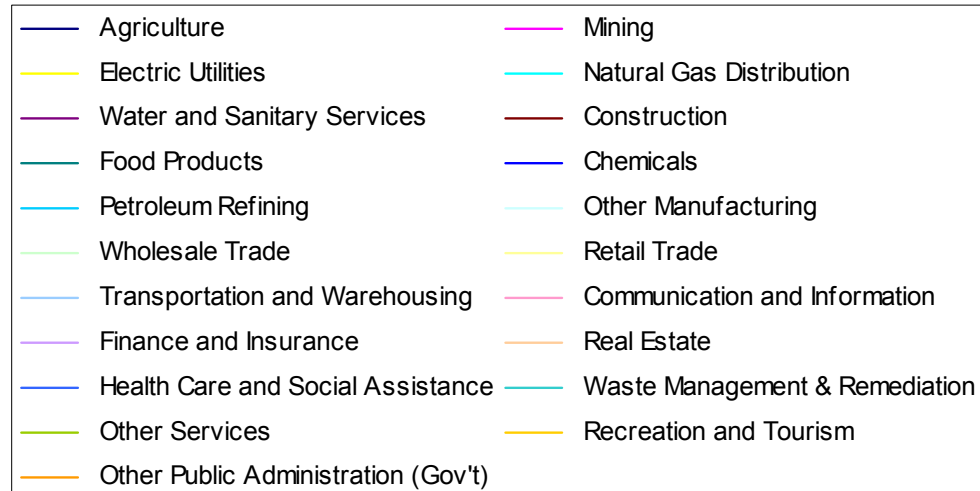
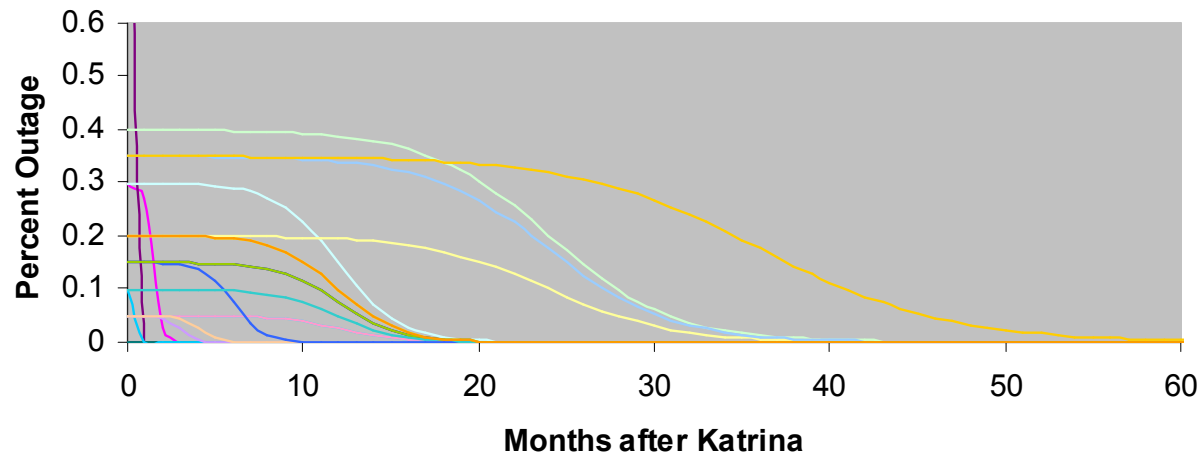
Damage \$100 billion

Percent outside aid 50%

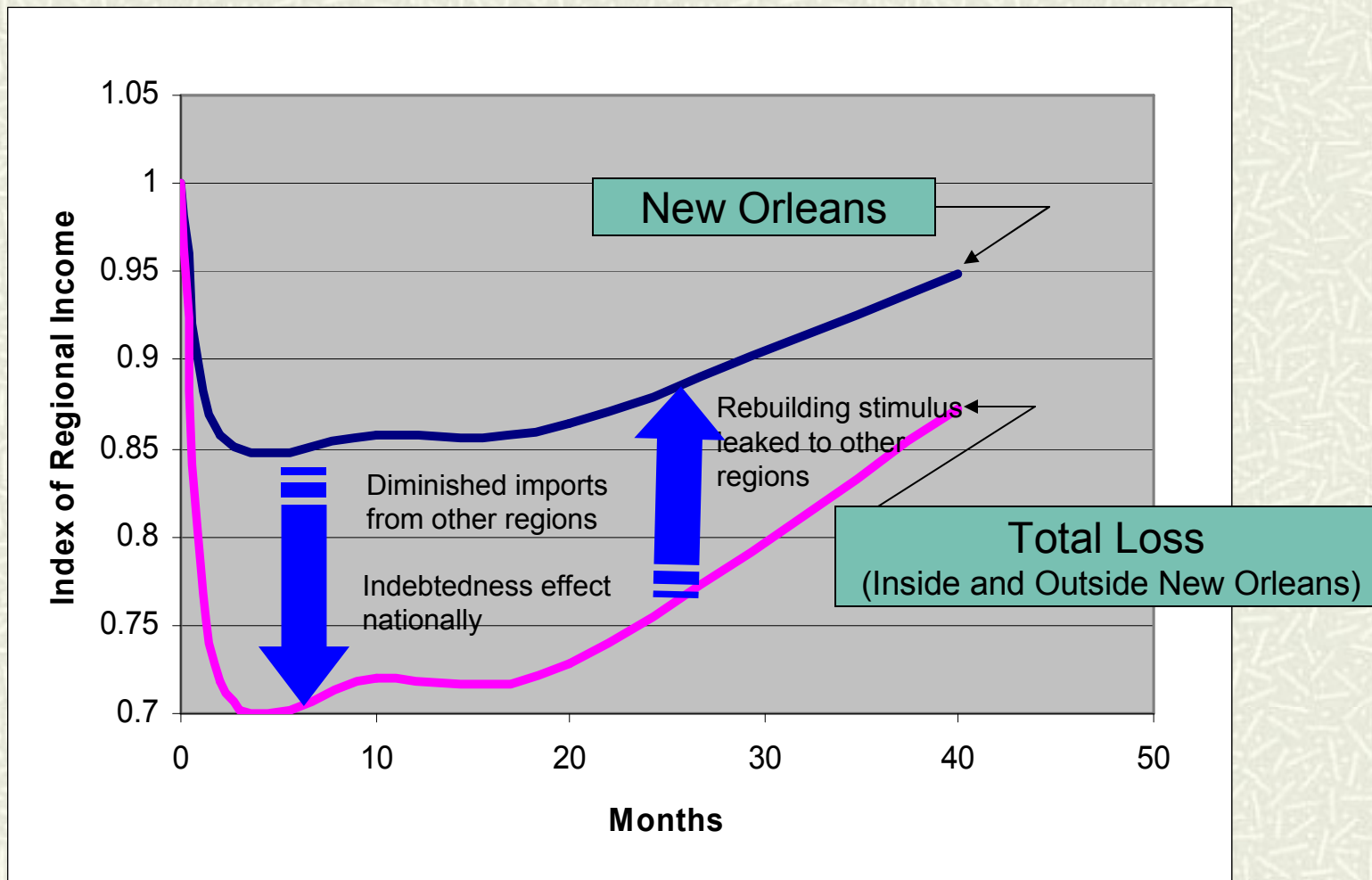
Interest rate 3%

Unemployment rate 5.5%

# Recovery Functions

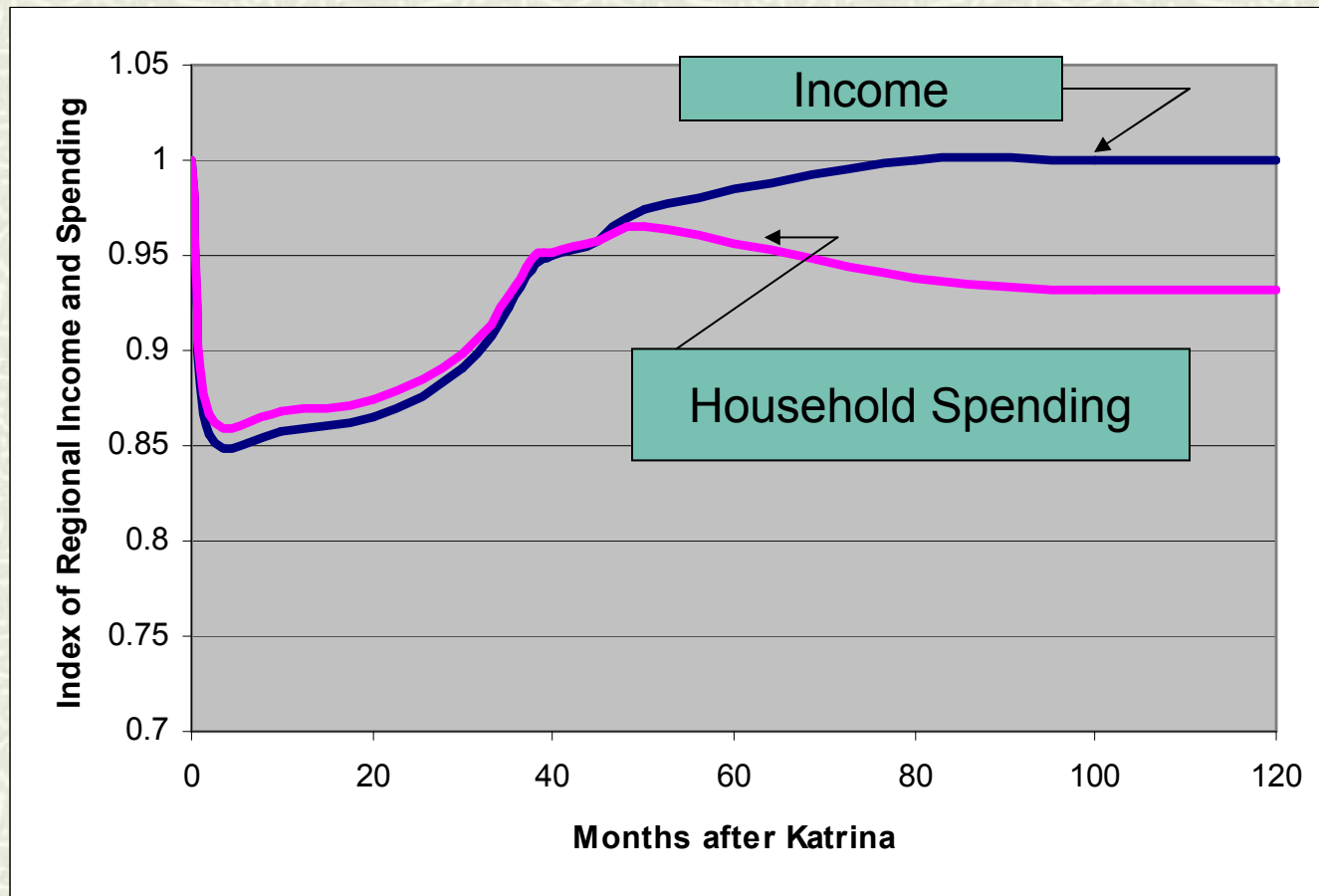


# Economic Loss Inside and Outside New Orleans (Delayed Reconstruction)

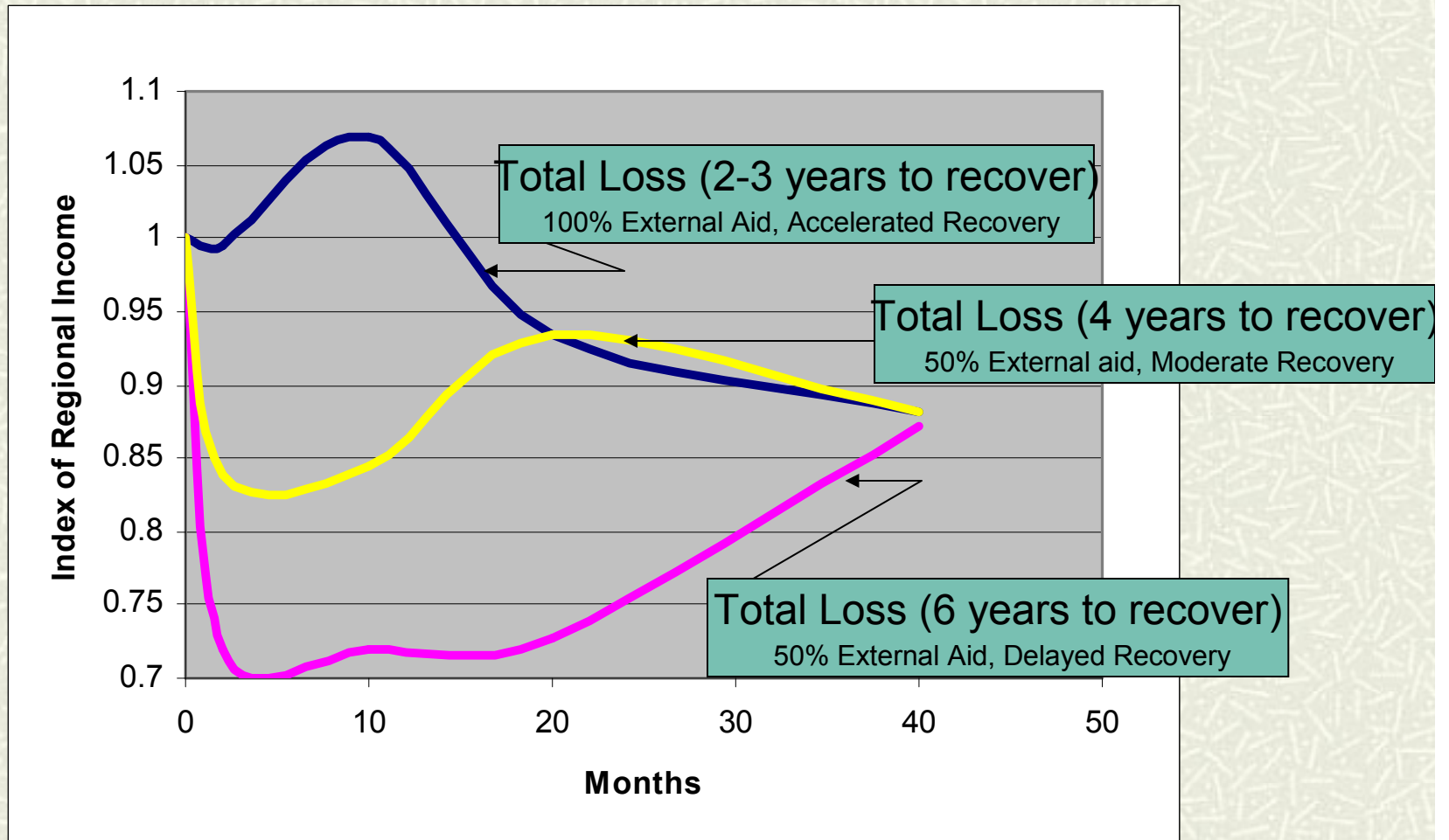




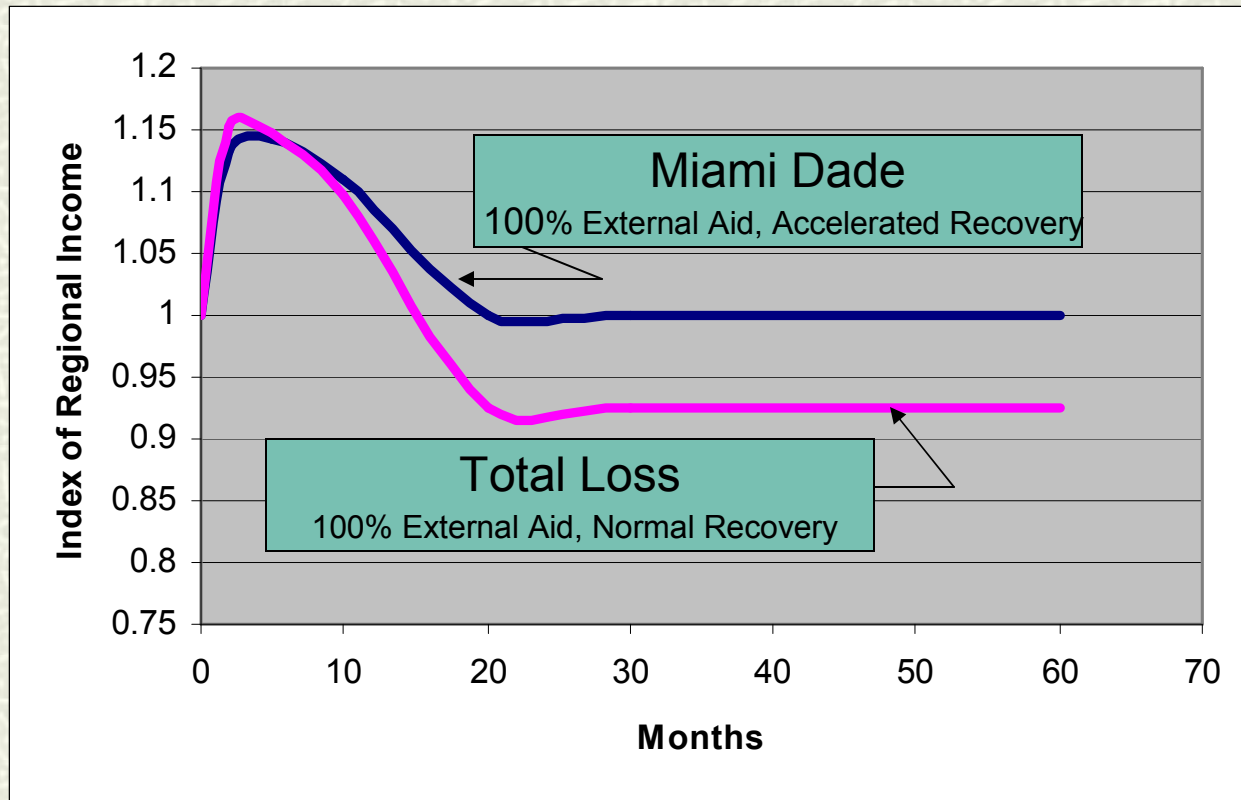
# Regional Income and Household Spending During Recovery



# Losses in New Orleans with Accelerated/Delayed Reconstruction

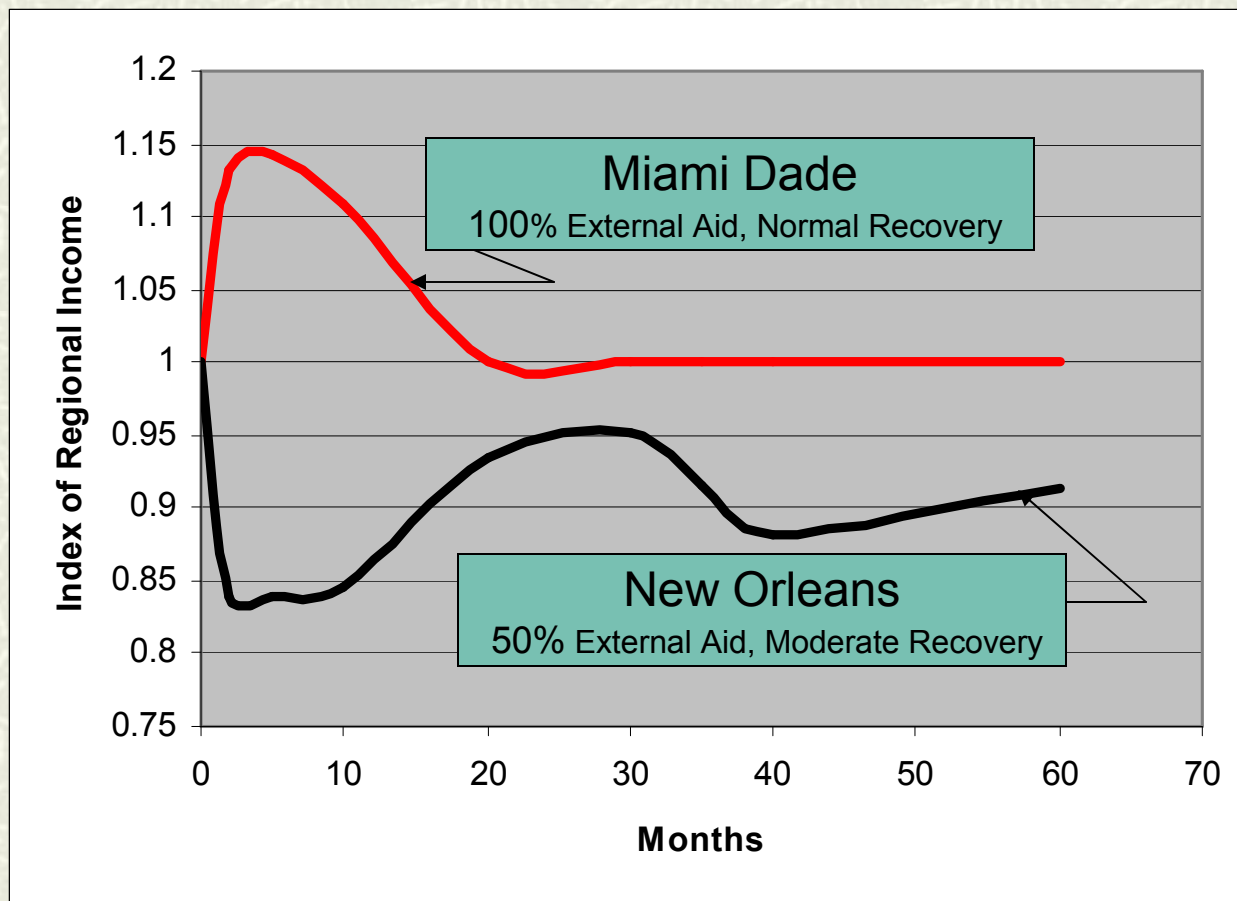


# Economic Impact of Andrew on Miami Dade County





# The Economic Impact of Katrina Contrasted with Andrew

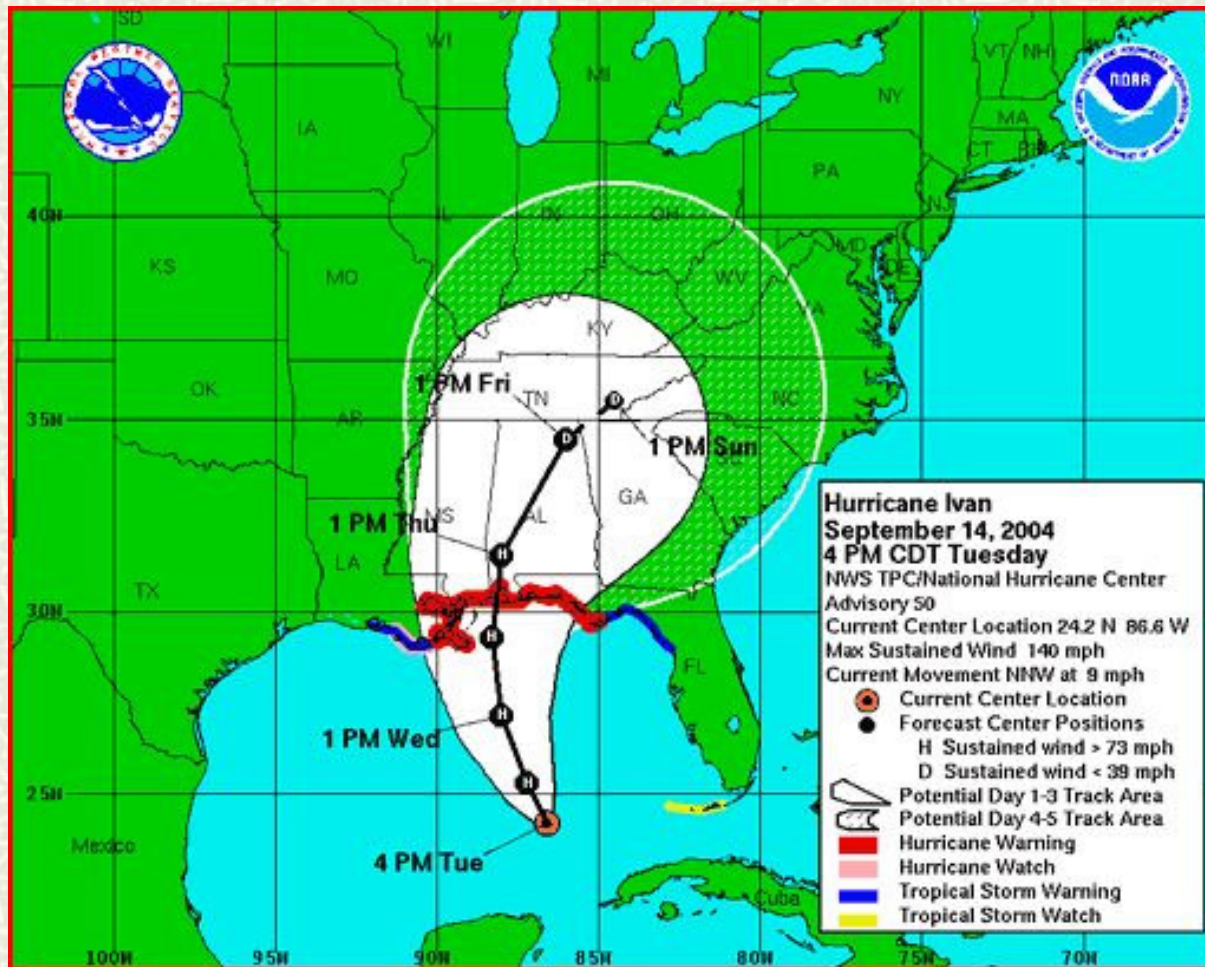




# Example Applications



# Evacuation = Economic Disruption Not Trivial

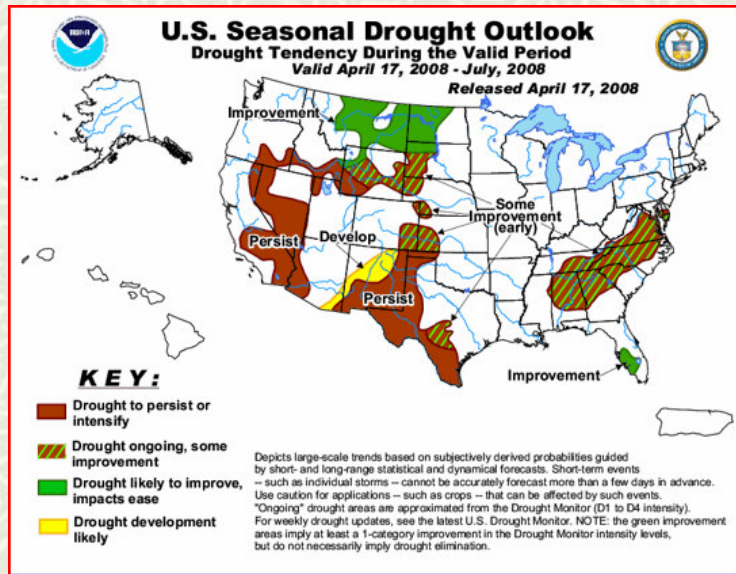




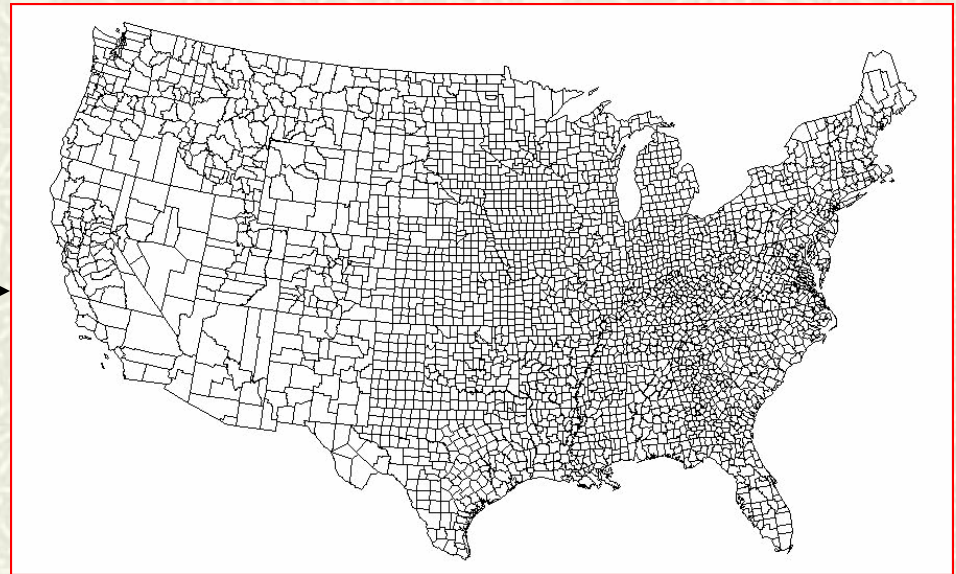
# Climate Change/Prediction

## County Level Economic Impact of Drought

### Drought Outlook



### County Level Economic Impact



# Conclusions

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1. Regional economic loss is sensitive to the state of the pre-disaster economy, the pace of reconstruction/recovery, and the magnitude of direct damage.
  2. Because each disaster is unique, it is unlikely that case studies, or statistical analyses of past events will produce accurate estimates of regional loss.
  3. The approach presented here could be used to address a variety of weather/climate related issues. Examples include: a) an estimate of the savings (reduced economic dislocation) due to improved hurricane track forecasts; b) an estimate of the economic dislocation stemming from climate change; c) provide the news media a rapid assessment of the economic damage likely to result from a particular hurricane's predicted landfall.
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