BROADWAY: EUCLID TO COUNTRY CLUB - Public Input Report
1/14/2014-02/04/2014
(All items online at http://cms3.tucsonaz.gov/broadway/public-input-report)

#	Date Rec'd	Method	From	Representing	Recipient	Issue Keywords	Issue	Action(s) Assigned	Date, Actions Taken, and Status of Resolution
137	2/3/2014	Email	Joseph Maher, AIA	Self	Mayor Rothschild; CM Uhlich; CM Kozachik	Demolition; 2419 E Broadway "Panda Buffet "Property	" 2/3/14 Subject/Project Panda Buffet demolition, Guest Opinion attached Mayor Rothschild Ms Uhlich, Council Member Mr. Kozachik, Council Member Dear Mayor Rothschild, Ms. Uhilch, and Mr. Kozachik, Please review the attached Guest Opinion, my personal opinion, for your information and understanding for the preferred demolition of this building. I can not attend the Study Session scheduled for tomorrow. I have submitted this opinion to the Daily Star for their consideration. If you have any questions, please contact me. Thank you for your efforts for a better Tucson. Sincerely Yours, Joseph Maher, Jr. AIA	- Forward to CTF	***No additional action required.***
136	2/1/2014	Email	Robert Hadel	Self; Property Owner; Resident, Miles Neighborhood	Broadway@	Congestion; Alternate Design;	>>> On 2/1/2014 at 2:12 AM, Robert Hadel Dear Ms Burdick and the Citizen's Task Force, I am writing this to include my input and hopefully add insight to the Broadway project. I live at 1803 E 13th St in Tucson which is very close to Broadway Blvd. My family and I use Broadway daily. Primarily as cyclists and pedestrians and sometimes on bus transit. As someone that lives close to Broadway it would be incredibly destructive to add any right of way to the current alignment of Broadway. It seems important that Broadway becomes an urban corridor, and to achieve this we must concentrate on intensifying walkability, pedestrian access, batter mass transit options, and smarter use of the existing footprint. There have been numerous recent studies from very reputable institutions outlining that adding more roads and more lanes to roads only worsens congestion and that congestion is actually lessened as population densities rise in an area. I can not support any option that increases the right of way of Broadway boulevard as we need to work at connecting the urban neighborhoods in Tucson not creating more barriers preventing both densification and economic development. I have also included a pdf attachment and a link to a study	-Forward to CTF - Forward to Project Team for review	**2/3/14 - Email response provided by Jenn Toothaker Burdick.** **PROJECT TEAM members will be asked to review the study for application to the project.**

#	Date Rec'd	Method	From	Representing	Recipient	Issue Keywords	Issue	Action(s) Assigned	Date, Actions Taken, and Status of Resolution
135	1/31/2014	Email	Ron Spark, MD	Self; Broadway Coalition	Broadway@	Performance Measures; Congestion	>>> On 1/31/2014 at 10:41 AM How Should We Measure Traffic Congestion Planetizen, Todd Litman Transportation planning is undergoing a paradigm shift which is changing the way we define transport problems and evaluate solutions. http://www.planetizen.com/node/67172	-Forward to CTF and Project Team	***No additional action required.***
134	1/31/2014	Email	Jenn Toothaker Burdick	Project Team	Citizens Task Force; Project Team members	Demolition; 2419 E Broadway "Panda Buffet "Property	"Dear CTF Members, You may have seen the article in today's Arizona Daily Star about the Panda Buffet Property. http://azstarnet.com/business/local/city-seeks-to-demolish-former-panda-buffet/article_fa733379-1533-5ae8-b14f-5a3de68223f3.html The Mayor and Council will be presented information about staff's request for approval to demolish this property this Tuesday, February 4. 2014. http://www.tucsonaz.gov/sirepub/mtgviewer.aspx?meetid=1237&doctype=AGENDA If you are interested in coming to the meeting, the details are as follows: Mayor and Council Study Session Meeting Tuesday, February 4, 2014 12:30pm (Item 4. is estimated to start at ~1:30pm) 255 W. Alameda Mayor and Council Chambers, 1st Floor You may also watch the meeting live (or recorded) online at: http://www.tucson12.tv/programs/MayorandCouncil/index.php	-Forward to CTF and Project Team	***No additional action required.***
133	1/31/2014	Email	Joseph Maher, AIA	Self; Planning Commission liaison	Jenn Toothaker Burdick	Project Design; Alternate Design; Economic Development	>>> On 1/31/2014 at 12:17 PM, So how do we find the balance? Hard work Joseph Maher http://www.theatlanticcities.com/commute/2014/01/dangerous-street-design-spreading-throughsuburbs/8033/#.Uuv2zan9ZH4.email	- Forward to CTF	***No additional action required.***

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#	Date Rec'd	Method	From	Representing	Recipient	Issue Keywords	Issue	Action(s) Assigned	Date, Actions Taken, and Status of Resolution
132	1/30/2014	Email	Greg Foster	Self	Broadway@	Project Design; Downtown Links	>>> Dear Jennifer, I would like to lend my opinion to the present rumblings about scaling back or eliminating the following: Downtown Links_Barraza-Aviation Parkway and I-10, Broadway Boulevard, the 4th Ave and Downtown. (4 lane w/safer railroad crossings and sidewalks) Broadway Boulevard, Euclid Avenue to County Club road (6 travel lanes, plus 2 dedicated bus lanes, bike lanes, and sidewalks. These projects were approved by ALL the voters as part of the plan to improve our roadway system in a way that expands capacity before it lags the actual required needs. The idea was to catch up with over crowded roads and provide excess capacity for future growth. To deliver anything less than the voter approved projects would be a great insult to the voters and another failed promise by local government. The RTA plans were assembled with tremendous stake holder input. Everyone understands that property owners directly effected by the projects may object, but the projects were approved by a vote to serve the ENTIRE community	- Forward to CTF - Forward to Tom Fisher, Downtown Links project manager - Prepare response	**1-30-14 - Jenn Toothaker Burdick and Tom Fisher both provided responses to the email, providing additional information about the projects mentioned.**
131	1/29/2014	Email	Bruce Sayles	Chase Bank	Jenn Toothaker Burdick	Project Schedule	>>> On 1/29/2014 at 11:21 AM, "Sayles, Bruce L" <bruce.l.sayles@jpmchase.com> wrote: Hi Jenn, Can you provide any updates on timing and scope of the project? Chase owns the branch property at Broadway and Country Club and the previous project scope took our parking spaces along Broadway. Thank you. Bruce L. Sayles Vice President Real Estate Transactions Corporate Real Estate and General Services JPMorgan Chase	- Forward to CTF - Prepare response	**1/29/14 - Email response by Jenn Toothaker Burdick provided, along with information about the design decision process underway, and construction schedule.** ***No additional response required.***
130	1/28/2014	Email	Margot Garcia, PhD	Self; Broadway Coalition	Broadway@	Citizens Task Force	>>> On 1/28/2014 at 4:15 PM From: Margot W Garcia <mgarcia@vcu.edu> To: +broadway@tucsonaz.gov Cc: Date: Tue, 28 Jan 2014 16:13:40 -0700 Subject: Agenda I just got your email about the Feb 6 meeting of the CTF. It said an agenda and materials were ready. I checked the CTF site and City Clerk site and neither had an agenda or materials for the meeting. When will they be ready? Margot Garcia	- Forward to CTF - Prepare response	**2/3/14 - Email response by Jenn Toothaker Burdick. Email not seen initially and response late. Original eBlast sent out contained inaccurate info that the agenda and materials were ready (they were made avaiable on 1/31). Request made for eBlast to be sent out with correction; however, decision made not to send out.**

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#	Date Rec'd	Method	From	Representing	Recipient	Issue Keywords	Issue	Action(s) Assigned	Date, Actions Taken, and Status of Resolution
129	1/21/2014	Email	Ron Spark, MD	Self; Broadway Coalition	Broadway@	Alternate Design; Road Diet	>>> Ronald spark <rpsparkmd@yahoo.com> 01/24/14 1:04 PM >>> This article will be of interest to the BCTF and Staff. Ron Jan 21 at 10:07 AM Making Colorado Boulevard a Haven for Pedestrians Los Angeles Times Pasadena is considering plans to narrow portions of famed Colorado Boulevard and use that space to widen sidewalks and create tiny parks. http://www.latimes.com/local/la-me-colorado-blvd-diet-20140121,0,6698432.story#axzz2r02A9JPa	- Forward to CTF - Forward to Ann Chanecka, TDOT Bike and Ped Coordinator - Prepare response	**1/26/14 - Email response from Jenn Toothaker Burdick.** **1/27/14 - Email from Ann Chanecka confirming parklet that is in design.**
128	1/17/2014	Email	Margot Garcia, PhD	Self; Broadway Coalition	Broadway@	Citizens Task Force	>>> On 1/17/2014 at 10:12 AM, Margot W Garcia <mgarcia@vcu.edu> wrote: Jenn, When do you expect to post the agenda for the January 23rd CTF meeting? Margot	- Forward to CTF - Prepare response	**1/17/2014 - Email from Jenn Toothaker Burdick indicating that the agenda is expected to be distributed that same day.**
126	12/4/2013	Email	Aisling McCallum	Self; Homeowner	Broadway@	Alternate Design; Downtown connection	">>> Aisling McCallum <aisycoqui@cox.net> 12/04/13 11:59 AM >>> My husband and I reside in Barrio San Antonio. We wanted to give some input into the potential widening of Broadway. I have heard most of the reasoning behind it which leads us to pose this one question. If you are seeking a greater, brisker traffic flow into downtown, how does it make sense to spend that kind of money when the actual entrance into downtown is a huge bottleneck? Fixing the existing roads makes much more sense to us at this time. Making roads bigger and faster instead of better and more community friendly only encourages a greater use of cars in an environment screaming for us to lessen car use. Thank you, Peter and Aisling McCallum"	- Forward to CTF - Prepare response	**02/04/14 - Email from Jenn Toothaker Burdick, thanking them for emailing, and providing information about Downtown Links and improvements to Broadway/Congress/Toole/4th Ave intersection safety improvements. both to be constructed soon and will help with the bottleneck.** ***No additional response needed.***

Jennifer Burdick - re: widening of broadway

From: Broadway
To: aisycoqui@cox.net
Date: 2/4/2014 6:05 PM
Subject: re: widening of broadway
CC: Broadway

Ms. and Mr. McCallum,

Thank you for emailing in your thoughts about the Broadway improvement project. I understand the concerns you raise, and they are ones that have been brought up by others. I am sharing your comments with the Task Force, who meet this Thursday at 5:30pm, and will include the Public Input Report.

It may be helpful to know that there are some projects underway that will complement the downtown entry along Broadway.

* An extension of the Barraza-Aviation Parkway is almost completely designed/ready for construction that will extend the parkway north and west of Broadway, terminating at St. Mary's/I-10. This would create a bypass around downtown.

* An intersection study, which is now leading to construction of some remedies, was done on the Broadway/4th Ave/Toole intersection. Design is underway on that and construction slated for the near-term.

These projects may assist with the bottleneck envisioned, and it is certainly part of our design process to track and coordinate with these projects.

Your point about trying to keep the neighborhoods connected is understood. How to not create a "chasm" between the neighborhoods by construction of roadways that don't foster connection is something we will need to discuss as we move forward on the design.

Thank you, again, for emailing in your thoughts. I hope you will remain engaged in the project and process as we move forward. I also apologize to you for the delay in my response. I am normally much better at responding in a timely manner, and I lost track of your email. No excuses, but my apologies to you.

Respectfully,
~Jenn

****
Jennifer Toothaker Burdick, Project Manager
Broadway: Euclid to Country Club Roadway Improvement Project
City of Tucson Department of Transportation

Direct: (520) 837-6648 Cell: (520) 390-7094
Web: <www.tucsonaz.gov/broadway>
****

>>> On 12/4/2013 at 7:02 PM, Jennifer Burdick wrote:

>>> Aisling McCallum <aisycoqui@cox.net> 12/04/13 11:59 AM >>>

My husband and I reside in Barrio San Antonio. We wanted to give some input into the potential widening of Broadway. I have heard most of the reasoning behind it which leads us to pose this one question. If you are seeking a greater, brisker traffic flow into downtown, how does it make sense to spend that kind of money when the actual entrance into downtown is a huge bottleneck? Fixing the existing roads makes much more sense to us at this time. Making roads bigger and faster instead of better and more community friendly only encourages a greater use of cars in an environment screaming for us to lessen car use.

Thank you,

Peter and Aisling McCallum

Jennifer Burdick - Re: Agenda

From: Jennifer Burdick
To: Margot W Garcia
Date: 1/17/2014 10:19 AM
Subject: Re: Agenda

Hi, Margot -

We are still trying to get it all finalized for the mailing/emailing to the CTF today.

I am working to have that done before the end of the day, but it depends on how it can all come together. I can alert you when it is ready?

~Jenn

>>> On 1/17/2014 at 10:12 AM, Margot W Garcia <mgarcia@vcu.edu> wrote:

> Jenn,
> When do you expect to post the agenda for the January 23rd CTF meeting?
> Margot

Broadway - Re: Road diet models

From: Jennifer Burdick
To: Broadway
Date: 2/3/2014 6:57 PM
Subject: Re: Road diet models

>>> On 1/27/2014 at 8:38 AM, Ann Chanecka wrote:

> Hi Jenn and Ron,
>
> Yes - the businesses on 6th Avenue near 7th Street are raising funds to install the first parklet. They are hoping to have it operational this summer.
>
> Ann
>
> >>> Jennifer Burdick 1/26/2014 12:06 PM >>>
> Ron -
>
> Thank you for forwarding this. I will forward this link/article to the Task Force as part of the public input report.
>
> It is very interesting - and I believe that Tucson will have it's own first parklet soon? Ann, am is this correct?
>
> I know one challenge we have in comparison to a lot of other cities that are looking to make these changes is the ability of nearby freeway systems to take some of the autos off of the streets. We will continue to talk about these aspects of the Broadway project, particularly as we move into the upcoming design discussions.
>
> ~Jenn
>
> >>> Ronald spark <rpsparkmd@yahoo.com> 01/24/14 1:04 PM >>>
> This article will be of interest to the BCTF and Staff.
> Ron

Jan 21 at 10:07 AM
Making Colorado Boulevard a Haven for Pedestrians
Los Angeles Times

Pasadena is considering plans to narrow portions of famed Colorado Boulevard and use that space to widen sidewalks and create tiny parks.
http://www.latimes.com/local/la-me-colorado-blvd-diet-20140121,0,6698432.story#axzz2r02A9JPa

Broadway - Re: FW: Next Broadway Boulevard CTF Meeting

From: Jennifer Burdick
To: Bruce L Sayles
Date: 1/29/2014 3:59 PM
Subject: Re: FW: Next Broadway Boulevard CTF Meeting
CC: Broadway; JudithA Van Houten; Patrick F Morgan

Bruce, all -
We are still working towards construction starting by end of 2016. The scope is still undecided. We do not expect a recommendation by the Task Force until late this year, and approval by City Mayor and Council and Regional Transportation Authority until Spring/Summer 2015.

The project progress is that the design team is developing very initial maps of different roadways: 4-lanes, 4-lanes plus 2 dedicated bus lanes, 6-lanes, and 6-lanes plus 2 dedicated bus lanes.

These very initial maps will be shared with the Task Force at the end of this month in some concentrated Task Force meetings to discuss the merits/minuses of each, and how to winnow down these alternatives so that we will look more in-depthly at 1 or 2 of them.

The next public meeting will share with the community at-large what the Task Force has looked at for these alternatives, what the impacts/benefits for each are, and which ones the Task Force would like to take forward into further review. We expect that may be held in May 2014.

We do not expect a recommendation on the roadway width or placement from the Task Force until late this year. The recommendation will be shared with the City's Mayor and Council and the project funders for their review and direction to proceed with developing the initial concepts and alignments. When those are ready, and final Task Force and public meetings held, the Mayor and Council will be asked to approve the initial design and roadway alignment.

Upon approval, acquisition for needed right-of-way can begin. Final design of the roadway will begin, as well, and will likely take 1 year to complete all the final engineering and construction drawings. At certain points, utility relocations will start, and then the construction will go to bid.
This may be more information than you were seeking, but hope it is helpful. I know you are wanting to remain informed on our progress. Please let me know if you have any questions about this.

~Jenn

****
Jennifer Toothaker Burdick, Project Manager
Broadway: Euclid to Country Club Roadway Improvement Project
City of Tucson Department of Transportation

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Web: <www.tucsonaz.gov/broadway>
****

>>> On 1/29/2014 at 11:21 AM, "Sayles, Bruce L" <bruce.l.sayles@jpmchase.com> wrote:

> Hi Jenn,
>
> Can you provide any updates on timing and scope of the project? Chase owns the branch property at Broadway

and Country Club and the previous project scope took our parking spaces along Broadway. Thank you.

Bruce L. Sayles
Vice President
Real Estate Transactions
Corporate Real Estate and General Services
JPMorgan Chase
9200 Oakdale Avenue, CA2-4348
Chatsworth, CA 91311
818.775.7255 (office) 818.775.6779 (fax)
bruce.sayles@chase.com

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From: broadway@tucsonaz.gov [mailto:broadway@tucsonaz.gov]
Sent: Tuesday, January 21, 2014 2:34 PM
To: Sayles, Bruce L
Subject: Next Broadway Boulevard CTF Meeting

BROADWAY BOULEVARD
EUCLID to COUNTRY CLUB

Broadway Boulevard

Euclid Avenue to Country Club Road

Greetings!

The next meeting of the Broadway Citizens Task Force is this **Thursday evening, January, 23, 2014 starting at 5:30 p.m.,** at the Child & Family Resources building (2800 E. Broadway).

An agenda and materials are available online: www.tucsonaz.gov/broadway.

The project team would also like to extend an invitation from the Sunshine Mile Business Association to join them for a membership mixer to be held on **Thursday, January, 30, 2014** from 6:00 - 7:00 p.m. at Mid Valley Athletic Club (140 S. Tucson Blvd.). Any business owners within the area interested

January 21, 2014

This e-newsletter is sent to groups and individuals who have expressed interest in the Broadway Boulevard, Euclid to Country Club project.

USEFUL LINKS

> Broadway Project Website

> RTA website

> MainStreet Business Assistance

in joining the Association, or learning more about it, are encouraged to attend. Please click here for more information about the event.

As always, if you have any questions or need more information, please feel welcome to contact one of our team by emailing broadway@tucsonaz.gov or calling 520.622.0815.

Thank you for your continued interest and involvement!
Jenn and the Project Team

For more information about the Broadway Boulevard, Euclid to Country Club project, please visit the project on the web at www.tucsonaz.gov/broadway or call the info line at 622-0815.

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Telephone (520) 791-4371, FAX (520) 791-5641

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Broadway - Fwd: Re: Broadway Boulevard and Downtown Links

From: Jennifer Burdick
To: Broadway
Date: 1/30/2014 2:29 PM
Subject: Fwd: Re: Broadway Boulevard and Downtown Links
Attachments: Downtown Links Project Update- Nov 2013-final.pdf; Tom Fisher1.vcf

>>> On 1/30/2014 at 2:27 PM, Tom Fisher wrote:

> Hello Mr. Foster,
>
> Thanks for your comments and concerns regarding Downtown Links. Much appreciated. Attached you will find a full update on the project as presented to the public, the City Manager, RTA, and others.
>
> Recent good news is that we are gradually resolving some citizen concerns regarding bike connectivity and safety, property acquisitions and demos, and funding. We are at 75% design completion now and will reach 100% by end of year, then construction in late 2015.The RTA Board recently voted to allot $200 million in bonds for upcoming projects, including remaining funding for this one. We are on the cusp of reaching full public consensus on design of the corridor as originally scoped: 4 lanes, landscaping, bike lanes, sidewalks, drainage improvements.
>
> Jenn has a major task on her hands and we hope to offer support as the design team and CAC works through the issues. Would be great if you could participate. She can provide info on upcoming meetings. I believe you work downtown, so feel free to stop by if you can.
>
> Thomas Fisher
> Project Manager
> City of Tucson Dept. of Transportation
> 201 N. Stone, 6th Floor
> Tucson, AZ 85726-7210
> phone (520) 837-6752
> tom.fisher@tucsonaz.gov
>
> >>> Jennifer Burdick 1/30/2014 1:50 PM >>>
> Mr. Foster,
>
> Thank you very much for taking time to express your opinion and logic regarding both the Broadway and Downtown Links projects.
>
> We are continuing to engage in analysis of the scope of Broadway to determine what the need is to address capacity in the immediate term, as well as decades into the future. The Task Force will be receiving initial

analysis of the various alternatives being reviewed right now within the next month, and we expect a larger community meeting to be held later this Spring. I will add you to the project listserv, so you will be kept aware of our progress and when future opportunities to weigh in will be offered.

I will include this email in the Public Input Report for the Broadway Project, which is distributed to the Citizens Task Force for their consideration as we continue in our planning and design phase work.

I will also share this with Tom Fisher, project manager for the Downtown Links project, so he is aware of your thoughts and concerns.

Again, many thanks to you for taking time to share your viewpoints with the Task Force and the project team.

Respectfully,
Jenn

****
Jennifer Toothaker Burdick, Project Manager
Broadway: Euclid to Country Club Roadway Improvement Project
City of Tucson Department of Transportation

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****

>>> On 1/30/2014 at 9:01 AM, Foster & Yates <gregffoster@cox.net> wrote:
Dear Jennifer,

I would like to lend my opinion to the present rumblings about scaling back or eliminating the following:

Downtown Links_Barraza-Aviation Parkway and I-10, Broadway Boulevard, the 4th Ave and Downtown. (4 lane w/safer railroad crossings and sidewalks)

Broadway Boulevard, Euclid Avenue to County Club road (6 travel lanes, plus 2 dedicated bus lanes, bike lanes, and sidewalks.

These projects were approved by ALL the voters as part of the plan to improve our roadway system in a way that expands capacity before it lags the actual required needs. The idea was to catch up with over crowded roads and provide excess capacity for future growth. To deliver anything less than the voter approved projects would be a great insult to the voters and another failed promise by local government. The RTA plans were assembled with tremendous stake holder input. Everyone understands that property owners directly effected by the projects may object, but the projects were approved by a vote to serve the ENTIRE community.

It is unfortunate that there is now talk of either scaling back or eliminating these two projects. Although the recent traffic loads are lower than projected it is my contention that the data has been greatly skewed by the installation of the street car tracks and very, very poor traffic management downtown. If any conclusions should drawn from traffic avoiding the mess created downtown in the need for both of the above projects. They will complement the streetcar's negative impacts on traffic through downtown to I-10 and provide a proper conclusion for the west ends of Broadway and the Barraza-Aviation Parkway which without the links pretty much end in a parking lot downtown, in other words these are roads to nowhere.

The present configuration of Congress Street and Broadway Boulevard downtown are not designed to either move traffic I-10 or aid in getting any more destination traffic into the downtown area. When the streetcar is fully operational the interference with other traffic on these streets will be even greater and provide a huge motivation to avoid the downtown area all together, (i.e.. 22nd St., Grant, and River as alternatives from central and east Tucson to I-10)

Thank you for your work on this project,
Sincerely,

Greg Foster
7358 E. Kenyon Dr.
Tucson, AZ 85710

From my I-Pad

Broadway - Re: Defining the Worst Type of Street Design

From: Jennifer Burdick
To: jmaherjraia@aol.com
Date: 1/31/2014 5:34 PM
Subject: Re: Defining the Worst Type of Street Design
CC: Broadway

Thank you for forwarding this, Joseph!

I'll include it in the Public Input Report and share it with the other CTF members.

Important considerations that relate to our conversations.

~Jenn

>>> On 1/31/2014 at 12:17 PM, <jmaherjraia@aol.com> wrote:

> So how do we find the balance? Hard work Joseph Maher
>
> http://www.theatlanticcities.com/commute/2014/01/dangerous-street-design-spreading-through-suburbs/8033/#.Uuv2zan9ZH4.email
>
> --- This message was sent by jmaherjraia@aol.com via http://addthis.com. Please note that AddThis does not verify email addresses.
>
> Make sharing easier with the AddThis Toolbar: http://www.addthis.com/go/toolbar-em
>
> To stop receiving any emails from AddThis, please visit: http://www.addthis.com/privacy/email-opt-out?e=lj3rLc8myC7EOo8K1DrFIcIj4TzUK9InzynbZsYn1w

Defining the Worst Type of Street Design

SARAH GOODYEAR JAN 07, 2014 94 COMMENTS

Sometimes, you see something in the world that you want to talk about and you realize there isn't really a name for it. So you have to make one up.

That's the situation Chuck Marohn found himself in when looking at the four- and-six-lane-wide thoroughfares, built for speed but also lined with retail and residential developments and all the intersections those entail.

Marohn, a self-described "recovering traffic engineer" and founder of the nonprofit Strong Towns, observed this thing spreading unchecked through suburban and rural America. It was neither fish nor fowl, neither street nor road. It was a strange mutant creature he decided to call a "stroad":

> The STROAD design -- a street/road hybrid -- is the futon of transportation alternatives. Where a futon is a piece of furniture that serves both as an uncomfortable couch and an uncomfortable bed, a STROAD moves cars at speeds too slow to get around efficiently but too fast to support productive private sector investment. The result is an expensive highway and a declining tax base.

Marohn says he coined the term in 2011 to wake up the people who design America's roads. "I really was writing it as a way to push back at the engineering profession and get my fellow engineers to think about the bizarre things they're building," says Marohn. That was why he initially wrote the word in that annoying all-cap style, which he eventually dropped. "I figured engineers would read it and wonder, what was it an acronym for?" he says, laughing.

While Marohn came up with the neologism partly in a spirit of fun, he considers stroads a deadly serious problem. Not only are they dangerous and aesthetically repugnant, he argues that they are economically destructive as well. They don't provide the swift, efficient mobility that is the greatest economic benefit of a good road, and they simultaneously fail to deliver the enduring value of a good street -- which fosters community, good architecture, and financial resilience at the lowest possible cost.

Instead, stroads create hideous, inefficient, and disposable environments that quickly lose value. Marohn puts it this way:

> If you want to … truly understand why our development approach is bankrupting us, just watch your speedometer. Anytime you are traveling between 30 and 50 miles per hour, you are basically in an area that is too slow to be efficient yet too fast to provide a framework for capturing a productive rate of return.

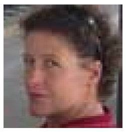
Since Marohn was targeting the engineering community with his coinage, he was a bit surprised when some advocates for more human-friendly urban street design picked up on the word and started using it. *Stroad* has even made it into the Urban Dictionary. He isn't unhappy about that, but he still thinks that the real change needs to happen among the people who are responsible for building the streets and roads of the nation's communities. "I'd like to see 'stroad' in engineering textbooks," he says. That would signal a shift in awareness.

So far, the movement in that direction has been "baby steps," Marohn says. "I don't see an acknowledgment from the engineering profession that high-speed automobiles and human beings shouldn't be in the same place," he says. At the same time, economically stressed rural communities continue to build stroads, especially in proximity to big highways, in the hopes of short-term economic gain. "There's no real constituency for stopping that kind of really bad development," he says.

Stroad is not a pretty word. It isn't supposed to be. Marohn says its unwieldiness is part of the point. It's an ugly word that describes an ugly thing, one that is unfitted for human use in so many different ways.

"It's not a word you would ever use in a loving relationship. 'Oh, let's meet out on the stroad,'" he says, laughing. "You wouldn't ever say that."

Keywords: Language, Sprawl, Rural America, Design, Suburbs, road construction, Traffic Engineering



Sarah Goodyear has written about cities for a variety of publications, including *Grist* and *Streetsblog*. She lives in Brooklyn. All posts »

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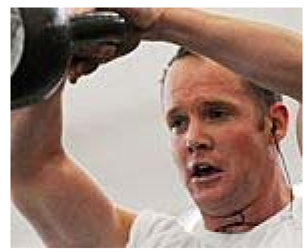

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Broadway - 2/4/14 Mayor & Council Meeting Item: Request for Approval to Demolish Panda Buffet Property

From:	Jennifer Burdick
To:	Broadway
Date:	1/31/2014 6:57 PM
Subject:	2/4/14 Mayor & Council Meeting Item: Request for Approval to Demolish Panda Buffet Property
CC:	Joan Beckim; Josh Weaver; Michael (Tucson) Johnson; Nanci Beizer; phil@community-design.com
Attachments:	Jennifer Burdick.vcf

Dear CTF Members,
You may have seen the article in today's Arizona Daily Star about the Panda Buffet Property.
http://azstarnet.com/business/local/city-seeks-to-demolish-former-panda-buffet/article_fa733379-1533-5ae8-b14f-5a3de68223f3.html

The Mayor and Council will be presented information about staff's request for approval to demolish this property this Tuesday, February 4. 2014.
http://www.tucsonaz.gov/sirepub/mtgviewer.aspx?meetid=1237&doctype=AGENDA

If you are interested in coming to the meeting, the details are as follows:

Mayor and Council Study Session Meeting
Tuesday, February 4, 2014
12:30pm (Item 4. is estimated to start at ~1:30pm)
255 W. Alameda
Mayor and Council Chambers, 1st Floor

You may also watch the meeting live (or recorded) online at:
http://www.tucson12.tv/programs/MayorandCouncil/index.php

Tomorrow, I will send out emails out to the project listserv and to the businesses listserv that clarifies:
- This effort is a special one. A decision to approve the demolition will NOT trigger more demolitions. At this time, without a decision on the alignment, any demolition pursued for the project area will be presented to the Mayor and Council for approval.

- This effort does not indicate that the Broadway project design decision has been made. The planning and design process is still underway with the Citizens Task Force.

- The community will be invited to a special meeting regarding this issue in coming weeks (more details to follow as soon as they are available).

Please let me know if you have questions. I wanted to give you this information today. If you can help with getting word out to your stakeholder groups.

Many thanks,
~Jenn

****
Jennifer Toothaker Burdick, Project Manager
Broadway: Euclid to Country Club Roadway Improvement Project
City of Tucson Department of Transportation

Direct: (520) 837-6648 Cell: (520) 390-7094
Web: <www.tucsonaz.gov/broadway>
****

Broadway - Fwd: Re: Alternative to LOS

From: Jennifer Burdick
To: Broadway
Date: 2/3/2014 6:58 PM
Subject: Fwd: Re: Alternative to LOS

>>> On 1/31/2014 at 6:15 PM, Jennifer Burdick wrote:

> Dr. Spark,
>
> Thank you for sharing this. I will provide this to the CTF and include in the Public Input Report.
>
> Respectfully,
> ~Jenn
>
> >>> On 1/31/2014 at 10:41 AM, Ronald spark <rpsparkmd@yahoo.com> wrote:
>
>> **How Should We Measure Traffic Congestion**
>> **Planetizen, Todd Litman**
>>
>> Transportation planning is undergoing a paradigm shift which is changing the way we define transport problems and evaluate solutions.
>> http://www.planetizen.com/node/67172

Jennifer Burdick - Re: Broadway Widening Project

From: Jennifer Burdick
To: Robert Hadel
Date: 2/3/2014 6:52 PM
Subject: Re: Broadway Widening Project
CC: Broadway; Richard G. Fimbres

Mr. Hadel,

Thank you for submitting your email for consideration to the Citizens Task Force, and to myself, and by extension, the project team.

I am adding your comments to the Public Input Report, which will be distributed to the Task Force and project team prior to this week's meeting.

I admit that the technical details of the report are beyond my training; however, I will ask our project engineers and designers to review.

Your comments do add to the conversation, and it continues to evolve. There are a diverse spectrum of issues to consider that inter-relate - and conflict - with one another. The points you raise are very important, particularly as we look to what Broadway needs to do to support all users better.

We are in the process of analyzing different alternative road widths for their ability to meet today's needs, as well as tomorrow's (at least 20 years into the future). The issue of congestion is one that larger cities are helping evolving mid-size cities understand a bit better. The streetcar is an example of our community's transition to transit. One of the challenges we will continue to face is how to address our unique issues in our region, while still learning from and incorporating the best practices and trends of other cities and regions. These studies help.

Thank you for forwarding, and I hope you will stay involved in the process.

Thank you,
~Jenn

>>> On 2/1/2014 at 2:12 AM, Robert Hadel <rhadel@gmail.com> wrote:

> Dear Ms Burdick and the Citizen's Task Force,
>
> I am writing this to include my input and hopefully add insight to the Broadway project. I live at 1803 E 13th St in Tucson which is very close to Broadway Blvd. My family and I use Broadway daily. Primarily as cyclists and pedestrians and sometimes on bus transit. As someone that lives close to Broadway it would be incredibly destructive to add any right of way to the current alignment of Broadway. It seems important that Broadway becomes an urban corridor, and to achieve this we must concentrate on intensifying walkability, pedestrian access, batter mass transit options, and smarter use of the existing footprint. There have been numerous recent studies from very reputable institutions outlining that adding more roads and more lanes to roads only worsens congestion and that congestion is actually lessened as population densities rise in an

area. I can not support any option that increases the right of way of Broadway boulevard as we need to work at connecting the urban neighborhoods in Tucson not creating more barriers preventing both densification and economic development.

I have also included a pdf attachment and a link to a study entitled "The Fundamental Law of Road Congestion:Evidence from US cities" From the University of Toronto Published in 2010. This study shows exactly what my main point in this letter was: That adding lanes or roads does not work to reduce congestion. Only through intensifying the density of development and better accessibility through pedestrian infrastructure and transit will congestion begin to decrease.

http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.170.7832&rep=rep1&type=pdf

I hope that my comments can be considered and add to the discussion of what Broadway will become.
Thank You,

Robert Hadel
rhadel@gmail.com
(520)481-0749
1803 E 13th St
Tucson, AZ 85719

The Fundamental Law of Road Congestion: Evidence from US cities[§]

Gilles Duranton*
University of Toronto
Matthew A. Turner[‡]
University of Toronto

This draft: 4 July 2010

ABSTRACT: We investigate the effect of lane kilometers of roads on vehicle-kilometers traveled (VKT) in US cities. VKT increases proportionately to roadway lane kilometers for interstate highways and probably slightly less rapidly for other types of roads. The sources for this extra VKT are increases in driving by current residents, increases in commercial traffic, and migration. Increasing lane kilometers one type of road diverts little traffic from other types of road. We find no evidence that the provision of public transportation affects VKT. We conclude that increased provision of roads or public transit is unlikely to relieve congestion.

Key words: roads, vehicle-kilometers traveled, public transport, congestion.

JEL classification: L91, R41

[§]We thank Richard Arnott, Severin Borenstein, Klaus Desmet, Jan Brueckner, Victor Couture, Edward Glaeser, Penny Goldberg, Steve Kohlhagen, Andreas Kopp, David Levinson, Guy Michaels, Se-Il Mun, Ken Small, two anonymous referees who clearly went beyond the call of duty, and seminar and conference participants for comments and suggestions. Thanks also to Byron Moldofsky for assistance with GIS and data processing and Magda Biesiada for excellent research assistance. Financial support from the Canadian Social Science and Humanities Research Council and the Paris School of Economics is gratefully acknowledged by both authors.

*Department of Economics, University of Toronto, 150 Saint George Street, Toronto, Ontario M5S 3G7, Canada (e-mail: gilles.duranton@utoronto.ca; website: http://individual.utoronto.ca/gilles/default.html). Also affiliated with the Centre for Economic Policy Research, and the Centre for Economic Performance at the London School of Economics.

[‡]Department of Economics, University of Toronto, 150 Saint George Street, Toronto, Ontario M5S 3G7, Canada (e-mail: mturner@chass.utoronto.ca; website: http://www.economics.utoronto.ca/mturner/index.htm).

We investigate the effect of lane kilometers of roads on vehicle-kilometers traveled (VKT) for different types of roads in the US. For interstate highways in metropolitan areas we find that VKT increases one for one with interstate highways, confirming the 'fundamental law of highway congestion' suggested by Downs (1962, 1992). We also uncover suggestive evidence that this law may extend beyond interstate highways to a broad class of major urban roads, a 'fundamental law of road congestion'. These results suggest that increased provision of interstate highways and major urban roads is unlikely to relieve congestion of these roads.

Our investigation is of interest for three reasons. First, an average American household spent 161 person-minutes per day in a passenger vehicle in 2001. These minutes allowed 134 person-km of auto travel at an average speed of 44 km/h. Multiplying by the number of households in the US and any reasonable dollar value of time, we see that the US allocated considerable resources to passenger vehicle travel. That Americans rank commuting among their least enjoyable activities (Krueger, Kahneman, Schkade, Schwarz, and Stone, 2009) buttresses our suspicion that the costs of congestion are large. To the extent that travel resources could have been better allocated, understanding congestion and the effect of potential policy interventions is an important economic problem.

Second, since the costs of congestion and of transportation infrastructure are both large, transportation policy should be based on the careful analysis of high quality data, not on the claims of advocacy groups. Unfortunately, there is currently little empirical basis for accepting or rejecting the claims by the *American Road and Transportation Builders Association* that "adding highway capacity is key to helping to reduce traffic congestion", or of the *American Public Transit Association* that without new investment in public transit, highways will become so congested that they "will no longer work".[1] Our results do not support either of these claims.

Third, with the increasing certainty of global warming comes the need to manage carbon emissions. According to the US Bureau of Transportation Statistics (2007, chapter 4) the road transportation sector accounts for about a third of US carbon emissions from energy use. Understanding the implications for VKT of changes to transportation infrastructure is immediately relevant to this policy problem.

Ours is not the first attempt to measure the effect of the supply of roads on traffic. Following

[1]The quote from the APTA is at www.apta.com/government_affairs/aptatest/documents/testimony060921.pdf. The quote from the ARTBA is harder to find and occurs in an undated flyer which is no longer available on their website, http://www.artba.org/.

Jorgensen (1947), a large literature estimates new traffic for particular facilities after their opening or after a capacity expansion (see Goodwin, 1996, Cervero, 2002, for reviews).[2] However studies of a particular road provide little basis for assessing the impact that changes in infrastructure have on traffic in the city at large, a question that is probably more relevant to transportation policy. As Cervero's (2002) review shows, few studies take an approach similar to ours and assess the effect of road provision on traffic over entire areas. These studies generally find a positive elasticity of VKT to the supply of roads, although their estimates of this elasticity vary widely. We improve on this literature in three respects.

First, we use more and more comprehensive data. To begin, we take average annual daily traffic (AADT) and a description of the road network from the US Highway Performance and Monitoring System (HPMS) for 1983, 1993, and 2003. We add a description of individual and household travel behavior taken from the 1995 Nationwide Personal Transportation Survey and 2001 National Household Travel Survey (which we jointly refer to as NPTS). These data track several measures of traffic and infrastructure for all metropolitan areas in the continental US. Together with data describing truck traffic, public transit, sectoral employment, population and physical geography, these data are a powerful tool with which to investigate the way that VKT responds to changes in the stock of roads and transit in US metropolitan areas. Extant research, on the other hand, examines one specific state (usually California) or a small sub-group of adjacent states (usually on the East coast) taking counties or smaller administrative units as the unit of observation.[3] The resulting estimates of the relationship between infrastructure and traffic in small administrative districts from highly urbanized parts of the US are not obviously relevant to national transportation policy.

Second, we are more careful to establish a causal relationship between roads and traffic. Existing literature either does not recognize that roads and traffic may be simultaneously determined or fails to solve this identification problem. To identify the causal effect of roads on traffic, we examine both time series and cross-sectional variation in our data and exploit three instrumental variables to predict the incidence of roads in MSAs. These instruments are based on the routes of major expeditions of exploration between 1835 and 1850, major rail routes in 1898, and the proposed

[2]While Jorgensen (1947) is our first modern source, the analysis of the effects of new facilities such as bridges and their tariffs on flows of vehicles follows a much older tradition, dating back to Dupuit (1844).

[3]Noland (2001) looks at data for the entire US but uses states as units of observation. Since roads in San Francisco or Buffalo are unlikely to affect behavior in Los Angeles or New York City, states appear to be 'too large' a unit of observation for two reasons: states aggregate city level variation that is useful for inference and, as we argue in Duranton and Turner (2008), the relevant economic unit appears to be the city.

routes of interstate highways in a preliminary plan of the network. Our results strongly support the hypothesis that roads cause traffic.

Third, beyond data and methodological improvements, we extend the conclusions of the existing literature in three ways. Within US MSAs, we distinguish between interstate highways in their 'urbanized' parts and outside. We also use data for a broad class of major urban roads. While we cannot implement our preferred identification strategy for this last class of roads, our OLS results suggest that increases in an MSA's stock of major urban roads also lead to large increases in VKT. We deduce two further implications of the law of road congestion and confirm that these implications are consistent with observation. First, we find no evidence that the provision of public transportation affects VKT. Second, metropolitan areas with less traffic experience a larger increase in travel. Finally, we describe the foundations underlying the fundamental law of highway congestion: people drive more when the stock of roads in their city increases; commercial driving and trucking increase with a city's stock of roads; people migrate to cities which are relatively well provided with roads. Surprisingly, our data also suggest that a new lane kilometer of roadway diverts little traffic from other roads.

1. Roads and traffic: a simple framework

To motivate our econometric strategy consider a simple model of equilibrium VKT. To begin, let R denote lane kilometers of roads in a city, let Q denote VKT, and let $P(Q)$ be the inverse demand for VKT. The downward sloping line in figure 1 represents an inverse VKT demand curve for a particular city.

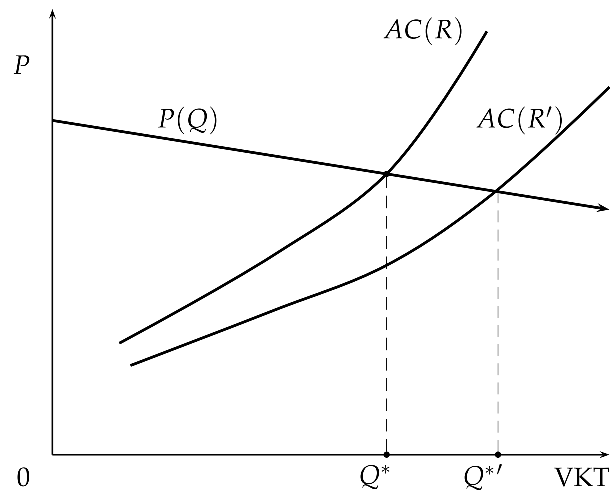
Let $C(R,Q)$ be the total variable cost of VKT, Q, given roads, R. In equilibrium all drivers face the same average cost of travel. Holding lane kilometers constant at R, the average cost of driving increases with VKT. Hence, the average cost curve for VKT is upward sloping. This feature is well documented in the transportation literature (Small and Verhoef, 2007). The leftmost upward sloping curve in figure 1 represents the supply curve $AC(R)$ associated with roads R.

Equilibrium VKT, $Q^*(R)$ is characterized by

$$P(Q^*) = \frac{C(R,Q^*)}{Q^*}. \tag{1}$$

That is, willingness to pay equals average cost.

Figure 1: Supply and demand for interstate traffic.



Increasing the supply of road lane kilometers from R to R' reduces the average cost of driving for any level of VKT.[4] It thus shifts the average cost curve to the right. With R lane kilometers of roads in the city, the demand curve intersects with the supply curve at Q^*, the equilibrium VKT. With $R^{'}$ lane kilometers of road, the corresponding equilibrium implies a VKT of $Q^{'*}$.

We would like to learn the effect of an increase in the stock of roads on driving in cities. That is, we would like to learn about the function $Q^*(R)$ defined implicitly by equation (1). Indexing cities by i and years by t, our problem may be stated as one of estimating,

$$\ln(Q_{it}) = A_0 + \rho_R^Q \ln(R_{it}) + A_1 X_{it} + \epsilon_{it}, \tag{2}$$

where X denotes a vector of observed city characteristics and ϵ describes unobserved contributors to driving. We are interested in the coefficient of R, the road elasticity of VKT, $\rho_R^Q \equiv \partial \ln Q / \partial \ln R$.

With data describing driving and the stock of roads in a set of cities, we can estimate equation (2) with OLS to obtain consistent estimates of ρ_R^Q, provided that $cov(R,\epsilon|X) = 0$. In practice, we hope that roads will be assigned to growing cities and fear that they are assigned to prop-up declining cities. In either case, the required orthogonality condition fails. Thus, we are concerned that estimating equation (2) will not lead to the true value of ρ_R^Q.

As a next step, we partition ϵ into permanent and time varying components, and write

$$\ln(Q_{it}) = A_0 + \rho_R^Q \ln(R_{it}) + A_1 X_{it} + \delta_i + \eta_{it}. \tag{3}$$

[4]There are pathological examples where increases in the extent of a road network can reduce its capacity, in particular the 'Braess paradox' described in Small and Verhoef (2007). We ignore such pathological examples here.

With data describing a panel of cities, we can estimate this equation using city fixed effects to remove all time invariant city effects. This leads to consistent estimates of ρ_R^Q, provided that $cov(R,\eta|X,\delta) = 0$. We also estimate the first difference equation,

$$\Delta \ln(Q_{it}) = \rho_R^Q \Delta \ln(R_{it}) + A_1 \Delta X_{it} + \Delta \eta_{it}, \tag{4}$$

where Δ is the first difference operator. Since all time invariant factors drop out of the first difference equation, we are left with essentially the same orthogonality requirement as for equation (3).[5] If, in equation (4), we include city characteristics in level and initial VKT as control variables, then we account for the possibility that these initial conditions may determine traffic growth and be correlated with changes in roadway.

To our knowledge, there is no study of a comprehensive set of metropolitan areas in the literature. The extant literature, however, has estimated variants of equations (2), (3), and (4) on a small samples of counties or metropolitan areas. While the early literature on induced demand at the area level (e.g. Koppelman, 1972) only ran simple OLS regressions in the spirit of equation (2), second generation work on the issue typically explored a variety of specifications with fixed effects and, sometimes, a complex lag structure. For instance, Hansen, Gillen, Dobbins, Huang, and Puvathingal (1993) and Hansen and Huang (1997) use panels of urban counties and MSAs in California while Noland (2001) uses a panel of US states. All find a positive association between VKT and lane kilometers of roadway, with estimated elasticities generally ranging between 0.3 and 0.7.

While equations (3) and (4) improve upon equation (2), we are concerned that roads will be assigned to cities in response to a contemporaneous shock to the city's traffic. To deal with this identification issue, we model the assignment of roads to cities explicitly. This leads to a two equation model, one to predict the assignment of roads to cities, the other to predict the effect of roads on traffic,

$$\begin{aligned} \ln(R_{it}) &= B_0 + B_1 X_{it} + B_2 Z_{it} + \mu_{it} \\ \ln(Q_{it}) &= A_0 + \rho_R^Q \widehat{\ln(R_{it})} + A_1 X_{it} + \epsilon_{it}, \end{aligned} \tag{5}$$

where $\widehat{\ln(R_{it})}$ is predicted lane kilometers of roadway as estimated in the first stage. We can obtain consistent estimates of ρ_R^Q provided that we are able to find instruments to satisfy $cov(Z,R|X) \neq 0$ and $cov(Z,\epsilon|X) = 0$.

[5]In fact, the two estimates have subtly different properties, see Wooldridge (2001, chapter 4).

The possible simultaneous determination of VKT and lane kilometers is recognized by several authors. To instrument for lane kilometers of highways Cervero and Hansen (2002) use about 20 instruments describing politics and physical geography. This approach is subject to the problems associated with the use of a large number of instruments. Moreover, we expect the physical geography of cities, climate in particular, to affect the demand for travel directly in addition to affecting the supply of roads. This violates the condition $cov(Z,\epsilon|X) = 0$ and invalidates the instruments. Noland and Cowart (2000) use land area and population density as instruments for lane kilometers of roads. Again, we expect population density to be a determinant of the demand for travel as much as a determinant of the supply of roads. Fulton, Noland, Meszler, and Thomas (2000) instrument growth in lane kilometers of highways by short lags of the same variables in a first difference specification. The exclusion restriction then requires that past changes in road supply be uncorrelated with contemporaneous changes in demand. Since changes in road supply are serially correlated (and they need to be so for the instrument to have any predictive power), the exclusion restriction is unlikely to hold when new roads are supplied as a result of VKT demand shocks. We postpone a discussion of our own choice of instruments.

Each of the approaches described above relies on different variation in the data to estimate ρ_R^Q. Equation (2) relies on cross-section variation, while equations (3) and (4) use only time series variation. Equation (5) exploits the instrumental variables we describe later. Should all three methods arrive at the same estimate of ρ_R^Q, then all are correct, or all are incorrect and an improbable relationship exists between the various errors and instrumental variables.

We now turn to a description of our data and estimates of ρ_R^Q based on the estimating equations presented in this section.

2. Data and estimation

We take the (Consolidated) Metropolitan Statistical Area (MSA) drawn to 1999 boundaries as our unit of observation. Since each MSA aggregates one or more counties, MSA boundaries often encompass much land that is not 'urban' in the common sense of the word. However, MSAs are generally organized around one or more 'urbanized areas' which make up the core(s) of the MSA and typically occupy only a fraction of an MSA's land area. By using data collected at the level of 'urbanized areas' we can distinguish more from less densely developed parts of each metropolitan area.

To measure each MSA's stock of interstate highways and traffic we use the US Highway Performance and Monitoring System (HPMS) 'Universe' and 'Sample' data for 1983, 1993, and 2003.[6] The data appendix provides a more detailed description of the HPMS. The US Federal Highway Administration collects these data, which are used by the federal government for planning purposes and to apportion federal highway money. For each year, for the entire universe of the interstate highway system within their boundaries states must report the length, number of lanes, and the number of vehicles per lane per day passing any point. This last quantity is referred to as the average annual daily traffic (AADT). We use a county identifier to match every segment of interstate highway to an MSA. We then calculate lane kilometers, VKT, and AADT per lane km for interstate highways within each MSA.

In the Sample data states report the same information (and more) for every segment of interstate highway within urbanized areas. By merging the Sample with the Universe data we distinguish urban from non-urban interstates within MSAs.

The Sample data also report information about a sample of other roads within urbanized areas. This sample is intended to represent all major roads in urbanized areas within the state. From the sample data we calculate road length, location, AADT and share of truck traffic for all major roads in the urbanized area. The HPMS sample data also assigns each segment to one of six functional classes, described in US Federal Highway Administration (1989). One of these classes is 'interstate highway'. We group four of the remaining five classes; 'collector', 'minor arterial', 'principal arterial', and 'other highway' into a measure of major urban roads, omitting the last class, 'local roads'.[7] Our definition of 'major urban road' thus includes all non-local roads that are not interstate highways. Within urbanized areas, interstates represent about 1.5% of all road kilometers and 24% of VKT while major urban roads represent 27% of road kilometers and another 62% of VKT (United States Federal Highway Administration, 2005*a*). The data appendix provides more detail.

Table 1 presents MSA averages of AADT for the 228 MSAs with non-zero interstate milage in 1983, 1993, and 2003. These data show that AADT, the number of vehicles passing any point on an average lane of interstate highway, increased from 4,832 in 1983 to 9,361 in 2003. Thus, at the

[6]The HPMS is available annually. We focus on 1983, 1993 and 2003 because these dates are close to census years and to the years for which we have data on public transportation. In addition, we sometimes make use of the 1995 and 2001 HPMS.

[7]Loosely, a 'local road' is one that primarily provides access to land adjacent to the road and every other class of road serves to connect local roads. The HPMS does not require states to report data on local roads, although some local roads appear in the data.

Table 1: Summary statistics for our main HPMS and public transportation variables (averaged over MSAs, means and standard deviations between brackets).

Year:	1983	1993	2003
Mean daily VKT (IH,'000 km)	7,777	11,905	15,961
	(16,624)	(24,251)	(31,579)
Mean AADT (IH)	4,832	7,174	9,361
	(2,726)	(3,413)	(4,092)
Mean lane km (IH)	1,140	1,208	1,280
	(1,650)	(1,729)	(1,858)
Mean lane km (IH, per 10,000 pop.)	26.7	24.3	22.1
	(26.9)	(20.9)	(16.4)
Mean daily VKT (MRU,'000 km)	14,553	22,450	31,242
	(36,303)	(49,132)	(70,692)
Mean AADT (MRU)	3,146	3,646	3,934
	(847)	(947)	(1,059)
Mean lane km (MRU)	3,885	5,071	6471
	(7,926)	(9,119)	(12,426)
Mean VKT share urbanized (IHU/IH)	0.38	0.44	0.48
Mean lane km share urbanized (IHU/IH)	0.29	0.36	0.40
Mean share truck AADT (IH)	0.11	0.12	0.13
Peak service large buses per 10,000 pop.	1.20	1.09	1.34
	(1.02)	(0.98)	(0.98)
Peak service large buses	169	165	217
	(563)	(562)	(742)
Number MSAs	228	228	228
Mean MSA population	753,726	834,290	950,054

IH denotes interstate highways for the entire MSA. IHU denotes interstate highways for the urbanized areas within an MSA. MRU denotes major roads for the urbanized areas within an MSA.

end of our study period, an average lane of interstate highway carries almost twice as much traffic as at the beginning. We also find that lane kilometers of interstate highways increase by about 6% between 1983 and 1993 and between 1993 and 2003. Together, the increase in lane kilometers and the increase in AADT imply that interstate VKT in an average MSA more than doubled over our twenty year study period.

Table 1 also presents descriptive statistics for major urban roads. Major roads represent between three and five times as many lane kilometers as interstate highways but only twice as much VKT. Note that urbanized area boundaries, unlike MSA boundaries, are not constant over our three cross-sections, so the dramatic increase in urbanized area VKT and lane kilometers over our study period may partly reflect increases in the extent of urbanized areas.

Cross-sectional estimates of the roadway elasticity of VKT

We now turn to estimating the elasticity of MSA VKT to lane kilometers for each of the following categories of roads and travel: All MSA interstates (IH), urbanized MSA interstates (IHU), non-urban MSA interstates (IHNU), and major urban roads (MRU). Table 2 presents estimates of this elasticity

Table 2: VKT as a function of lane kilometers, OLS by decade.

	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]	[11]	[12]
Year:	1983	1983	1983	1983	1993	1993	1993	1993	2003	2003	2003	2003
Panel A. Dependent variable: ln VKT for Interstate Highways, entire MSAs												
ln(IH lane km)	1.24^a	0.92^a	0.94^a	0.92^a	1.25^a	0.73^a	0.76^a	0.77^a	1.23^a	0.71^a	0.75^a	0.76^a
	(0.04)	(0.06)	(0.06)	(0.05)	(0.02)	(0.05)	(0.04)	(0.04)	(0.02)	(0.05)	(0.04)	(0.04)
ln(pop.)		0.43^a	0.42^a	1.01^a		0.54^a	0.51^a	0.46^c		0.53^a	0.49^a	0.39
		(0.04)	(0.05)	(0.37)		(0.04)	(0.04)	(0.25)		(0.04)	(0.04)	(0.35)
Elev. range			-0.057	-0.076			-0.027	-0.038			-0.026	-0.030
			(0.060)	(0.054)			(0.056)	(0.054)			(0.053)	(0.048)
Ruggedness			6.81^c	5.29			5.86^c	3.90			5.72^c	3.46
			(3.46)	(3.24)			(3.00)	(3.00)			(3.06)	(3.11)
Heating d.d.			-0.014^a	-0.015^a			-0.012^a	-0.013^a			-0.011^a	-0.013^a
			(0.004)	(0.01)			(0.003)	(0.004)			(0.003)	(0.004)
Cooling d.d.			-0.019^c	-0.027^b			-0.019^a	-0.022^b			-0.019^b	-0.020^b
			(0.010)	(0.012)			(0.007)	(0.009)			(0.007)	(0.009)
Sprawl			0.0059^c	0.0061^c			0.0033	0.0019			0.0021	0.0016
			(0.0031)	(0.0036)			(0.0028)	(0.0029)			(0.0027)	(0.0027)
Census div.			Y	Y			Y	Y			Y	Y
Hist. pop.				Y				Y				Y
Socio-econ. char.				Y				Y				Y
R^2	0.86	0.93	0.94	0.95	0.87	0.94	0.95	0.96	0.88	0.94	0.96	0.96
Panel B. Dependent variable: ln VKT for Interstate Highways, urbanized areas within MSAs												
ln(IHU lane km)	1.26^a	1.04^a	1.05^a	1.06^a	1.23^a	0.95^a	0.97^a	1.00^a	1.20^a	0.92^a	0.94^a	0.97^a
	(0.02)	(0.03)	(0.03)	(0.03)	(0.02)	(0.03)	(0.03)	(0.04)	(0.02)	(0.03)	(0.03)	(0.04)
Panel C. Dependent variable: ln VKT for Major Roads, urbanized areas within MSAs												
ln(MRU lane km)	1.08^a	0.90^a	0.89^a	0.88^a	1.13^a	0.72^a	0.78^a	0.80^a	1.14^a	0.66^a	0.67^a	0.70^a
	(0.02)	(0.03)	(0.03)	(0.03)	(0.01)	(0.04)	(0.04)	(0.04)	(0.01)	(0.04)	(0.04)	(0.04)
Panel D. Dependent variable: ln VKT for Interstate Highways, outside urbanized areas within MSAs												
ln(IHNU lane km)	1.06^a	0.83^a	0.85^a	0.84^a	1.03^a	0.81^a	0.83^a	0.82^a	1.00^a	0.82^a	0.84^a	0.83^a
	(0.03)	(0.05)	(0.04)	(0.03)	(0.03)	(0.04)	(0.03)	(0.03)	(0.04)	(0.03)	(0.03)	(0.03)

The same regressions for different types of roads are performed in all four panels.
All regressions include a constant. Robust standard errors in parentheses.
228 observations for each regression in panel A and 192 in panels B-D. *a*, *b*, *c*: significant at 1%, 5%, 10%.

for four specifications of the cross-sectional equation (2) for each type of road in 1983, 1993, and 2003.

In panel A of this table, the dependent variable is MSA interstate VKT. Columns 1 to 4 consider the 1983 cross-section. In the first column we include only our variable of interest, the log of lane kilometers of road, and a constant. In the second we add MSA population. In the third, we add nine census division dummy variables along with five measures of physical geography: elevation range within the MSA, the ruggedness of terrain in the MSA, two measures of climate, and a measure of how dispersed is development in the MSA. Details about these variables are available in the data appendix. In column 4 we also add socio-economic controls; share of population with at least some college education, log mean income, share poor, share of manufacturing employment, and an index of segregation. We also add decennial population variables from 1920-1980 to control for the long-run growth of MSAs. Because past population and socio-economic variables are likely to correlate with unobserved attributes of MSAs that determine the demand for driving, regressions including these variables are useful robustness checks. Columns 5 to 8 replicate these regressions for 1993, while columns 9-12 are for 2003.

Depending on the decade, the elasticity of MSA interstate highway VKT with respect to lane kilometers is between 1.23 and 1.25 when estimated without controls, ranges between 0.71 and 0.94 in specifications with controls, and is estimated precisely in each specification. While some estimates are statistically different from one, all are positive and greater than 0.71.

Turning to the other explanatory variables, we also note that the elasticity of MSA interstate highway VKT with respect to population is much less than one in all specifications. This will persist in nearly all of our estimations and suggests that people in larger cities drive much less, per capita, than they do in smaller cities. We consider the possible endogeneity of this variable below. We also note that VKT is higher in MSAs with mild weather, neither cold nor hot. For the other measures of geography, including the extent to which development is scattered or compact, as measured by the variable 'sprawl', we do not find a robust association with MSA interstate highway VKT.

Panel B of table 2 is similar to panel A, but the dependent variable and the measure of roads are based on *urban* interstates. The estimations in panel B suggest that the urban interstate VKT elasticity of urban interstate lane kilometers is closer to one and larger than for all interstates when controls are included. Panels C and D of table 2 are also similar to panel A, but investigate major urban roads and non-urban interstates. These results are close to those presented in panel A.

Columns 1-4 of table 3 replicate the four specifications of table 2 for all interstate highways but pool the three cross-sections. Unsurprisingly the estimates for the roadway elasticity of VKT are in-between the estimates of table 2 for the different decades. Column 3, which controls for population and geography but not for (possibly endogenous) socio-economic characteristics of MSAs, is our preferred specification. Hence, we take the value of 0.86 as our preferred OLS estimate of the elasticity of MSA interstate highway VKT with respect to lane kilometers (but note that OLS is not our preferred estimation method).

Appendix table 1 (in a separate appendix) reports further regressions pooling all three cross-sections for different types of roads in urbanized areas and outside. The results of this table generally confirm those of table 2, with the caveat that some changes in roads and traffic may reflect changes in urbanized area boundaries.

Table 3: VKT as a function of lane kilometers, pooled OLS.

	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]
MSA sample	All	All	All	All	All	All	All	w. IHU	Big	Small
Dependent variable: ln VKT for interstate highways, entire MSAs										
ln(IH lane km)	1.24[a]	0.82[a]	0.86[a]	0.85[a]	1.05[a]	1.06[a]	1.05[a]	0.95[a]	1.05[a]	1.12[a]
	(0.02)	(0.05)	(0.05)	(0.04)	(0.04)	(0.04)	(0.04)	(0.03)	(0.04)	(0.08)
ln(pop.)		0.48[a]	0.44[a]	0.32[a]		0.34[a]	0.39[a]	0.32[a]	0.44[a]	0.31[b]
		(0.04)	(0.04)	(0.12)		(0.09)	(0.09)	(0.09)	(0.11)	(0.12)
Geography			Y	Y						
Census div.			Y	Y						
Socio-econ. char.				Y			Y			
Hist. pop.				Y						
MSA fixed effects					Y	Y	Y	Y	Y	Y
R^2	0.88	0.94	0.95	0.96	0.94	0.94	0.95	0.94	0.96	0.93

All regressions include year effects. Robust standard errors in parentheses (clustered by MSA in col. 1-4).
Complete sample of 228 MSAs (684 observations) with interstate highways in columns 1-7;
192 MSAs (576 observations) with urban interstate highways in column 8;
114 MSAs (342 observations) above the median population size in 1990 in column 9;
114 MSAs (342 observations) below the median population size in 1990 in column 10.
a, *b*, *c*: significant at 1%, 5%, 10%.

Fixed effects and time series estimates of the roadway elasticity of VKT

Thus far we have reported estimates of ρ_R^Q which exploit cross-sectional variation. We now turn to estimates of ρ_R^Q based on time series variation. Because the data is fully comparable over time only for all interstate highways within MSAs, we focus on this type of road.

Columns 5-10 of table 3 estimate equation (3) by including MSA fixed effects in our cross-sectional regression. Because they condition out permanent determinants of VKT for each city which are potentially correlated with roadway, we prefer the specifications with MSA fixed effects to those without. In column 5 we replicate column 1 of the same table but include MSA fixed effects. In column 6, we augment the specification of column 2 with MSA fixed effects. In column 7, we repeat this for column 4. In column 8 we replicate column 6 using only the 192 MSAs which have *urban* interstate highways in all years instead of the 228 MSAs which report interstate highways in all three of our sample years. Columns 9 and 10 run the same regression again on MSAs with below and above median 1990 population size respectively. All the fixed-effect estimates of the interstate VKT elasticity of interstate lane kilometers are slightly above one except for column 8 where the estimate is slightly below one. This is obtained for the more restricted sample of MSAs with interstate highways in their urbanized area. However, given the similarity between the results, we do not concern ourselves further with sample selection. While it is estimated precisely in all specifications, ρ_R^Q is not statistically different from one at standard levels of confidence in columns 5 through 10. Overall, we note that including MSA fixed effects leads to slightly higher estimates of

Table 4: Change in VKT as a function of change in lane kilometers.

MSA sample	[1] All	[2] All	[3] All	[4] All	[5] All	[6] Lane ↑	[7] Lane ↑	[8] Lane ↓	[9] All	[10] All
Panel A. Dependent variable: $\Delta \ln$ VKT for interstate highways, entire MSAs, OLS										
$\Delta \ln$(IH lane km)	1.04^a	1.05^a	1.02^a	1.00^a	0.93^a	1.09^a	0.90^a	0.82^a	1.03^a	1.03^a
	(0.05)	(0.05)	(0.04)	(0.04)	(0.04)	(0.06)	(0.06)	(0.09)	(0.05)	(0.05)
$\Delta \ln$(pop.)		0.34^a	0.40^a	0.44^a	0.39^a	0.31^c	0.45^b	0.16		0.51^b
		(0.10)	(0.10)	(0.11)	(0.13)	(0.17)	(0.21)	(0.22)		(0.20)
ln(initial VKT)			-0.047^a	-0.057^a	-0.12^a		-0.15^a	-0.13^a		
			(0.006)	(0.007)	(0.02)		(0.03)	(0.04)		
Geography				Y	Y		Y	Y		
Census div.				Y	Y		Y	Y		
Socio-econ. char.					Y		Y	Y		
Hist. Pop.					Y		Y	Y		
MSA fixed effects									Y	Y
R^2	0.87	0.87	0.89	0.90	0.91	0.91	0.94	0.69	0.91	0.94
Panel B. Dependent variable: $\Delta \ln$ VKT for interstate highways, entire MSAs, TSLS										
$\Delta \ln$(IH lane km)		1.05^a	1.02^a	1.00^a	0.92^a	1.07^a	0.90^a	0.82^a		1.03^a
		(0.05)	(0.04)	(0.04)	(0.04)	(0.06)	(0.05)	(0.09)		(0.03)
$\Delta \ln$(pop.)		0.093	0.34^b	0.45	1.02^b	-0.16	1.14	1.50		0.62^c
		(0.18)	(0.16)	(0.32)	(0.45)	(0.29)	(0.72)	(1.45)		(0.37)
First stage Stat.		63.3	54.3	29.2	23.9	45.7	12.3	4.05		20.1

All regressions include a constant and decade effects. Robust standard errors clustered by MSA in parentheses. 456 observations for each regression in columns 1-5 and 9-10, 205 in columns 6-7 which consider only increases in lane kilometers of more than 5%, and 115 in column 8 which considers declines in lane kilometers greater than 5%. Instrument for $\Delta \ln$(pop.) is expected population growth based on initial composition of economic activity. *a*, *b*, *c*: significant at 1%, 5%, 10%.

ρ^Q_R.

We now estimate the interstate VKT elasticity of interstate lane kilometers using our first difference estimating equation (4). Unlike the fixed effects estimations of table 3, in the first difference regressions of table 4, we allow the levels of MSA initial characteristics to affect the growth of traffic. Using our three cross-sections we compute two cross-sections of first differences. In panel A of table 4 we pool these two cross-sections of first differences to estimate equation (4). Our dependent variable is the 10 year change in interstate VKT. In column 1, we include only a constant and year dummies as controls. In column 2, we add changes in MSA population. In column 3, we also control for initial VKT. In column 4, we add physical geography and census division dummies. Column 5 adds decennial MSA population levels from 1920-1980 and initial socioeconomic characteristics of cities. In each case, our point estimate of ρ^Q_R is very close to one and is precisely estimated.

Columns 6-8 consider more restricted samples of observations. Column 6 replicates column 2 using only observations with increases in lane kilometers greater than 5%. Column 7 uses the same selection rule to replicate column 5. Column 8 replicates column 5 again but this time using only observations with declines in lane kilometers greater than 5%. The results for large increases in lane kilometers are the same as for the whole sample of MSAs. The elasticity we estimate in column 8 is 0.8. These estimations do not allow us to determine whether the response of traffic to roads is non-linear in the amount of change to the road network, or if metropolitan areas experiencing large changes are different from those experiencing small changes.[8]

Finally, column 9 of table 4 estimates equation (4) including MSA fixed effects and year fixed effects as controls, while column 10 adds MSA population. These estimates are second difference estimates which exploit changes in the rate of change of roads and traffic. Strikingly, these regressions also estimate the interstate VKT elasticity of interstate highways to be very close to one.

In panel B of table 4, we repeat the first difference regressions of panel A except that we instrument for the change in population. Following Bartik (1991) and others after him, we construct our instrument for MSA level population growth from the initial shares of sectoral employment in the MSA and the national growth rate of each sector during the study period. Interacting these quantities yields the MSA population growth that would occur if all MSA sectors grew at the national average rate with sectoral shares constant. To construct our population growth instrument we use employment data for each MSA and the entire US for two-digit sectors from the County Business Patterns.

Despite the strength of the instrument, when running these regressions on a complete sample of MSAs, the standard errors for the coefficient on population change are much larger than in OLS. The OLS range for this coefficient is between 0.3 and 0.5. When instrumenting the range is broader, from close to zero to above unity. We draw two conclusions from this second panel. First, there is a suggestion that the TSLS coefficient on population changes is above its OLS value when more controls are introduced. This is consistent with population migrating to MSAs where VKT increases more slowly, all else equal. Second, the coefficient on changes in lane kilometers of roads is unaffected by this change in estimation strategy. This strongly suggests that even if population is endogenous, our estimate for the elasticity of interstate highway VKT is unaffected. Our preferred estimate for the roadway elasticity of VKT in table 4 is 1.00 from column 3 in panel B. This is the first-difference estimate for our preferred specification which takes into account the endogeneity of population.

In the separate appendix, we perform a number of further checks on our first difference results.

[8] Apart from measurement error, decreases in lane kilometers are likely to reflect temporary closures while increases reflect new and permanent construction.

Appendix table 2 presents regressions conducted on each of our two cross-sections of first differences separately. They confirm results of table 4 but, like table 2, indicate a slight decrease of ρ_R^Q over time. In appendix tables 3 and 4 we perform two simple falsification tests. In appendix table 3 we focus on changes in VKT between 1993 and 2003 as dependent variable. We show that the coefficient on contemporaneous changes in lane kilometers of interstate highways (i.e., between 1993 and 2003) is unaffected by the inclusion in the regression of earlier changes in lane kilometers of interstate highways (i.e., between 1983 and 1993). The coefficient on earlier changes is always insignificant. In appendix table 4, we focus on changes in VKT between 1983 and 1993 as dependent variable. We show that the coefficient on contemporaneous changes in lane kilometers of interstate highways (i.e., between 1983 and 1993) is unaffected by the inclusion in the regression of later changes in lane kilometers of interstate highways (i.e., between 1993 and 2003). The coefficient of the later changes variable is small, positive, and significant when we include contemporaneous changes in the regression.[9]

IV *estimates of the roadway elasticity of* VKT

In order for estimates of equations (2), (3), and (4) to result in consistent estimates, we require that the unobserved error be uncorrelated with the stock of roads (or changes in this stock). If the demand for VKT helps to determine an MSA's road network, then our measure of roads is endogenous, and this assumption does not hold. To address this possibility, we estimate the instrumental variables system described in equation (5).

We rely on three instruments: planned interstate highway kilometers from the 1947 highway plan; 1898 railroad route kilometers, and the incidence of major expeditions of exploration between 1835 and 1850. Baum-Snow (2007), Michaels (2008), and Duranton and Turner (2008) also use planned interstates as an instrument for features of the interstate system. Duranton and Turner (2008) use the 1898 railroad system for the same purpose. The exploration routes variable is new to the literature.[10]

Our measure of MSA kilometers of 1947 planned interstate highways is based on a digital image of the 1947 highway plan created from its paper record (United States House of Representatives,

[9]This may reflect either by serial correlation in roadway changes or a lagged response in the supply of roadway to increases in VKT.

[10]The discussion of the 1947 highway plan and 1898 railroad routes is derived from, and abbreviates more extensive discussions of these variables by these earlier authors, particularly Duranton and Turner (2008).

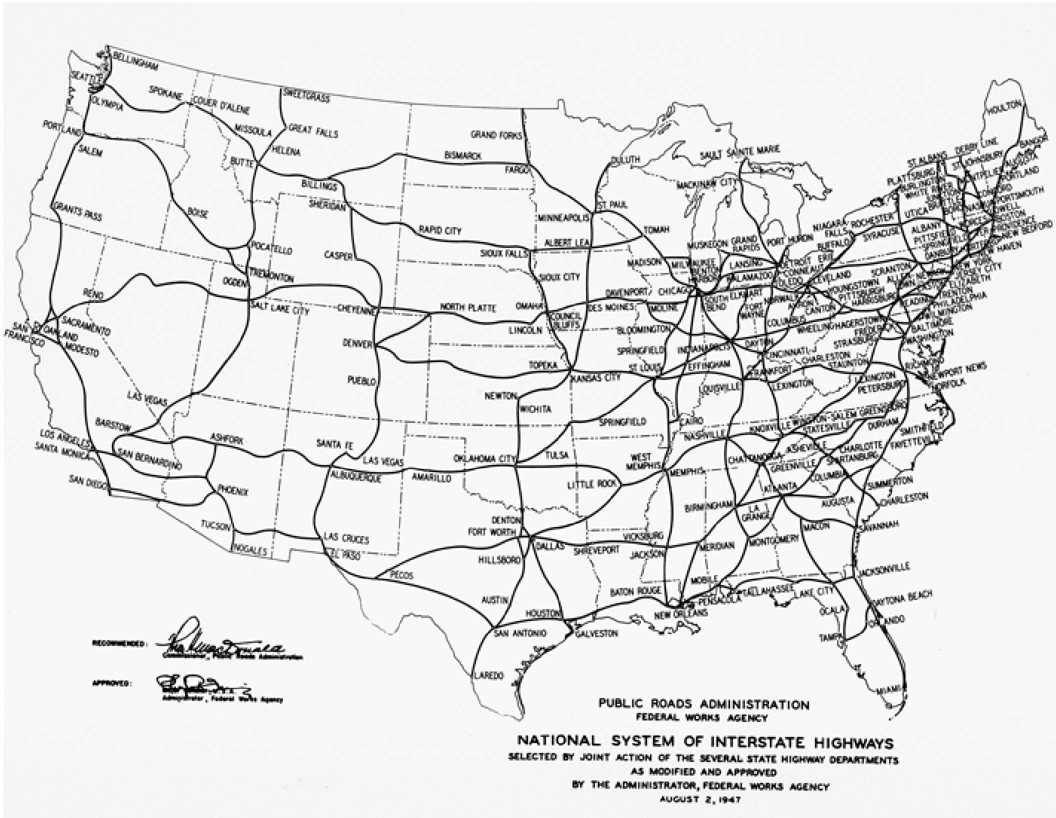


Figure 2: 1947 US interstate highway plan from United States House of Representatives (1947).

1947) and converted to a digital map as in Duranton and Turner (2008). Kilometers of 1947 planned interstate highway in each MSA are calculated directly from this map. Figure 2 shows an image of the original plan. Our measure of MSA kilometers of 1898 railroads is based on a digital image of a map of major railroad lines in 1898 (Gray, c. 1898). This image was converted to a digital map as in Duranton and Turner (2008). Kilometers of 1898 railroad contained in each MSA are calculated directly from this map. Figure 3 shows an image of the original railroad map. Our measure of early exploration routes is based on a map of routes of major expeditions of exploration of the US between 1835 and 1850 (United States Geological Survey, 1970). An image based on this map is reproduced in figure 4. Note that, in addition to exploration routes, this map also shows the routes of major roads established prior to 1835 in the more settled eastern part of the country. The data appendix provides more detail about these variables.

Common sense suggests that all three instruments should be relevant. The 1947 plan describes many interstate highways that were subsequently built. Many 1898 railroads were abandoned

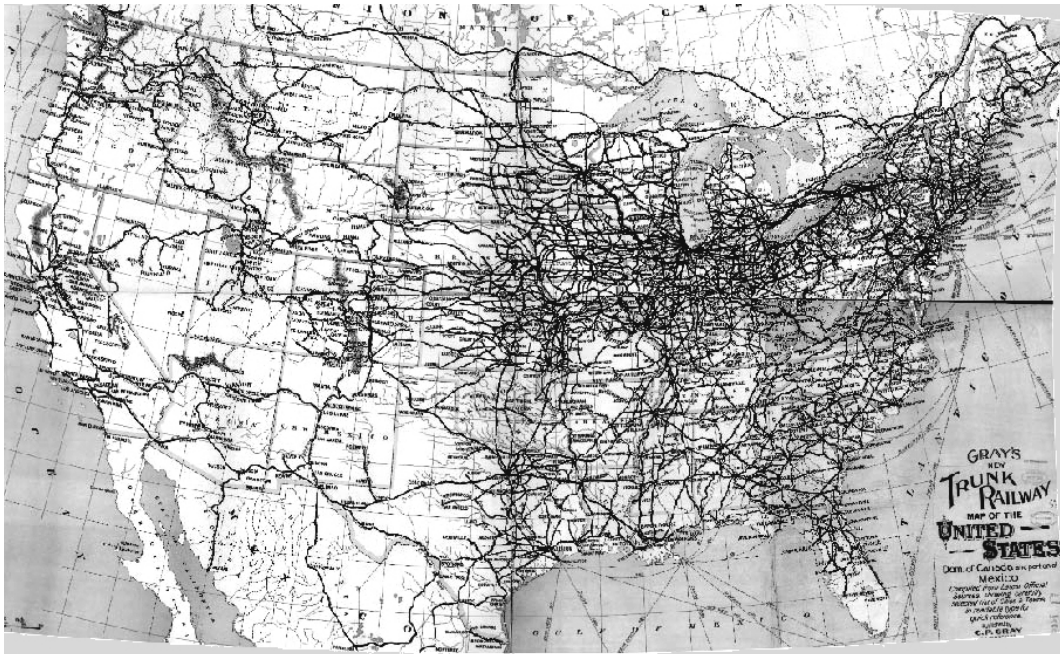


Figure 3: Image based on Gray's map of 1898 railroads (Gray, c. 1898).

Figure 4: Routes of major expeditions of exploration in the US between 1835 and 1850. Image based on United States Geological Survey (1970) [p. 138].

and turned into roads. Many current interstate highways follow the same routes taken by early explorers. Estimates of the reduced form equation predicting roads as a function of our instruments confirm this intuition. In almost all specifications predicting interstate lane kilometers, the first-stage statistic for the instrumental variables is large enough to pass the weak instrument tests proposed in Stock and Yogo (2005). We generally report the results of conventional TSLS estimations, but in the few cases where our instruments are weak, we also report the corresponding LIML estimates.[11]

A qualifier is important here. Our instruments are good predictors of MSA level stocks of interstate highways and urban interstate highways. They are not good predictors of MSA level stocks of major roads or of non-urban interstate highways. For this reason, we conduct IV estimations only for interstate highways and urban interstate highways.

We now turn to the conditional exogeneity of our two instruments. The 1947 highway plan was first drawn to *'connect by routes as direct as practicable the principal metropolitan areas, cities and industrial centers, to serve the national defense and to connect suitable border points with routes of continental importance in the Dominion of Canada and the Republic of Mexico'* (United States Federal Works Agency, Public Roads Administration, 1947, cited in Michaels, 2008). That the 1947 highway plan was, in fact, drawn to this mandate is confirmed by both econometric and historical evidence reviewed in Duranton and Turner (2008). In particular, in a regression of log 1947 kilometers of planned interstate highways on log 1950 population, the coefficient on log 1950 population is almost exactly one, a result that is robust to the addition of various controls. On the other hand population growth around 1947 is uncorrelated with planned highway kilometers. Thus, the 1947 plan was drawn to fulfill its mandate and connect major population centers of the mid-1940s, not to anticipate future population or traffic demand.

Note that the exclusion restriction associated with equation (5) requires the orthogonality of the dependent variable and the instruments conditional on control variables. This observation is important. Cities that receive more roads in the 1947 plan tend to be larger than cities that receive fewer. Since we observe that large cities have higher levels of VKT, 1947 planned interstate highway kilometers predicts VKT by directly predicting population and indirectly by predicting 1980 road kilometers. Thus the exogeneity of this instrument hinges on having an appropriate set of controls,

[11] Limited information maximum likelihood (LIML) is a one-stage IV estimator. Compared to TSLS, it provides more reliable point estimates and test statistics with weak instruments.

population in particular.

Next consider the case for the exogeneity of the 1898 railroad network. This network was built, for the most part, during and immediately after the civil war, and during the industrial revolution. At this time, the US economy was much smaller and more agricultural than during our study period. In addition, the rail network was developed by private companies with the intention to make a profit from railroad operations in the not too distant future. See Fogel (1964) and Fishlow (1965) for two classic accounts of the development of US railroads. As for the highway plan, the same qualifying comment applies: instrument validity requires that, conditional on control variables, rail routes be correlated with the dependent variable only through contemporaneous interstate highways. With this said, after controlling for historical populations and physical geography, it is difficult to imagine how a rail network built for profit could anticipate the demand for vehicle travel in cities 100 years later save through its effect on roads.

Finally, consider the case for the exogeneity of routes of expeditions of exploration between 1835 and 1850. Among these routes are; a Mexican boundary survey, the Whiting-Smith 1849 search for a commercial route between San Antonio and El Paso, the 1849 Warner-Williamson expedition in search of a route from Sacramento to the Great Basin, the 1839 Farnham-Smith expedition from Peoria to Portland, and the Smith scientific expedition to the Badlands of South Dakota. Some of these expeditions were explicitly charged with finding an easy way from one place to another and it is hard to imagine that this objective was not also important to the others. While we expect that these early explorers were drawn to attractive places, after controlling for historical populations and physical geography it is difficult to imagine how these explorers could select routes that anticipate the demand for vehicle travel in cities 150 years later save through their effect on roads.

Table 5 presents instrumental variables estimations where our dependent variable is all MSA interstate VKT. In panel A we use all three of our instruments, and we pool our three decennial cross-sections. Column 1 includes only interstate lane kilometers and decade effects as controls. Column 2 adds population as a control, column 3 adds our physical geography variables and census division indicators, column 4 adds our other city level demographic variables, and column 5 adds decennial population levels from 1920 to 1980. We pass standard over-identification test in all specifications, and the values of our first-stage statistics suggest that they are either strong, or near the critical values suggested by Stock and Yogo (2005). In columns 2 through 5 we see that

Table 5: VKT as a function of lane kilometers, IV.

	[1]	[2]	[3]	[4]	[5]
Panel A (TSLS). Dependent variable: ln VKT for interstate highways, entire MSAs. Instruments: ln 1835 exploration routes, ln 1898 railroads, and ln 1947 planned interstates					
ln(IH lane km)	1.32[a]	0.92[a]	1.03[a]	1.01[a]	1.04[a]
	(0.04)	(0.10)	(0.11)	(0.12)	(0.13)
ln(pop.)		0.40[a]	0.30[a]	0.34[a]	0.23[c]
		(0.07)	(0.09)	(0.10)	(0.12)
Geography			Y	Y	Y
Census div.			Y	Y	Y
Socio-econ. char.				Y	Y
Hist. pop.					Y
Overid.	0.60	0.11	0.26	0.24	0.29
First stage Stat.	42.8	16.5	11.8	11.5	8.84
Panel B (LIML). Dependent variable: ln VKT for interstate highways, entire MSAs. Instruments: ln 1835 exploration routes, ln 1898 railroads, and ln 1947 planned interstates					
ln(IH lane km)	1.32[a]	0.94[a]	1.05[a]	1.02[a]	1.06[a]
	(0.04)	(0.11)	(0.12)	(0.13)	(0.15)
Overid.	0.60	0.11	0.26	0.25	0.30
Panel C. (TSLS). Dependent variable: ln VKT for interstate highways, entire MSAs. Instruments: ln 1947 planned interstates					
ln(IH lane km)	1.33[a]	1.00[a]	1.10[a]	1.08[a]	1.12[a]
	(0.05)	(0.11)	(0.13)	(0.13)	(0.15)
First stage Stat.	99.7	41.5	29.8	29.5	26.7
Panel D. (TSLS). Dependent variable: ln VKT for interstate highways, entire MSAs. Instruments: ln 1898 railroads					
ln(IH lane km)	1.31[a]	0.83[a]	1.03[a]	1.00[a]	1.02[a]
	(0.06)	(0.15)	(0.18)	(0.18)	(0.22)
First stage Stat.	23.7	25.8	19.0	21.1	11.9
Panel E (TSLS). Dependent variable: ln VKT for interstate highways, entire MSAs. Instruments: ln 1835 exploration routes					
ln(IH lane km)	1.25[a]	0.63[a]	0.75[a]	0.68[a]	0.72[a]
	(0.08)	(0.17)	(0.18)	(0.21)	(0.22)
First stage Stat.	53.6	13.8	9.91	7.15	6.32
Panel F (LIML). Dependent variable: ln VKT for interstate highways, entire MSAs, 1983. Instruments: ln 1898 railroads and ln 1947 planned interstates					
ln(IH lane km)	1.39[a]	1.09[a]	1.18[a]	1.15[a]	1.20[a]
	(0.04)	(0.10)	(0.11)	(0.13)	(0.16)
Overid.	0.69	0.10	0.31	0.25	0.29
First stage Stat.	37.9	17.7	12.1	14.4	9.51
Panel G (LIML). Dependent variable: ln VKT for interstate highways, entire MSAs, 1993. Instruments: ln 1898 railroads and ln 1947 planned interstates					
ln(IH lane km)	1.33[a]	0.98[a]	1.13[a]	1.08[a]	1.13[a]
	(0.05)	(0.13)	(0.16)	(0.15)	(0.17)
Overid.	0.91	0.53	0.97	0.88	0.81
First stage Stat.	53.1	22.7	14.4	15.8	11.7
Panel H (LIML). Dependent variable: ln VKT for interstate highways, entire MSAs, 2003. Instruments: ln 1898 railroads and ln 1947 planned interstates					
ln(IH lane km)	1.26[a]	0.82[a]	0.93[a]	0.92[a]	0.97[a]
	(0.05)	(0.11)	(0.13)	(0.13)	(0.16)
Overid.	0.77	0.55	0.96	0.98	0.93
First stage Stat.	52.2	21.0	14.2	14.4	9.76

All regressions include a constant (and year effects for panels A-E). Robust standard errors in parentheses (clustered by MSA in panels A-E). 684 observations corresponding to 228 MSAs for each regression for panels A-E and 228 observations for panels F-H. *a*, *b*, *c*: significant at 1%, 5%, 10%.

our estimates of ρ_R^Q are within one standard error of 1. In column 1, the coefficient of interstate highways is larger because of the correlation between interstate highway lane kilometers and population levels.

We note that the IV estimates of the roadway elasticity of VKT are slightly higher than their OLS counterparts (in tables 2 and 3) by 0.1 to 0.2. While the differences between IV and OLS are not all significant, they are suggestive of a negative feedback between VKT and the allocation of roadway. More precisely, lane kilometers of interstate highways appear to be allocated to MSAs with a lower demand for travel. This would be consistent with the finding of Duranton and Turner (2008) that there is more road construction in cities that experience negative shocks to employment.

In columns 3, 4, and 5 of panel A our instruments are near the critical values suggested in Stock and Yogo (2005), so in panel B we present the corresponding LIML estimates. These estimates are essentially identical to the TSLS estimates of panel A.

In panels C, D, and E, we repeat the TSLS estimates of panel A using each of our instruments alone. We find that using the 1947 highway instrument alone results in slightly higher estimates, that using 1898 railroads alone results in essentially identical estimates, and that using 1835 exploration routes alone results in slightly lower estimates. In all, the IV estimates presented in panels A-E of table 5 strongly suggest that the interstate VKT elasticity of interstate highways is close to one.

In panels A-E of table 5 we pool our three cross-sections. This may conceal cross-decade variation in our parameters. To address this issue, in panels F-H we report IV estimates of ρ_R^Q using each of our cross-sections separately. We see that the roadway elasticity of VKT decreases from slightly above one in 1983 to slightly below one in 2003. However this decline is not statistically significant when including geographic and other controls. This (admittedly weak) trend downward suggests the conjecture that more roadway can lead to a more than proportional increase in traffic when roads are not congested. Alternatively, it may be that the most useful highway segments are developed earlier and receive more traffic. This second conjecture is consistent with Fernald's (1999) conclusion that the productivity effects of the US interstate system shows a marked decline over time. We hope future research will more completely investigate these issues.

In table 5, our preferred estimate for the elasticity of interstate highway VKT with respect to lane kilometers is from panel A and column 3 at 1.03. This estimate also constitutes our preferred estimate overall since it is obtained using our preferred estimation method, which controls for the endogeneity of roads, and our preferred specification, which includes geographical controls but not the socio-economic characteristics of MSAs.

3. Implications of the fundamental law of road congestion

We now note two logical implications of the fundamental law of road congestion. By confirming that these implications are consistent with observation, we provide further indirect evidence of the law.[12]

Traffic and transit

The fundamental law of road congestion requires that new road capacity be met with a proportional increase in driving. A corollary is that if we were to somehow remove a subset of a city's drivers from a city's roads, then others would take their place. We can think of public transit in this way. Public transit serves to free up road capacity by taking drivers off the roads and putting them in buses or trains. Thus, the fundamental law implies that the provision of public transit should not affect the overall level of VKT in a city. We now investigate this proposition.

To measure an MSA's stock of public transit, we use MSA level data on public transit. These data are based on the Section 15 annual reports, and measure public transportation as the daily average peak service of large buses in 1984, 1994, and 2004. We note that these data do not allow us to investigate other forms of public transportation, such as light rail, independently of buses.[13]

Since we expect that the stock of public transit in an MSA may depend in part on how congested is the road network, we are concerned that our measure of public transit will be endogenous in a regression to explain MSA interstate VKT. To deal with this issue, we again resort to instrumental variables estimation. In addition to the 1947 highway plan and 1898 railroad kilometers, we use the MSA share of democratic vote in the 1972 presidential election as an instrument in this estimation.

The 1972 US presidential election between Richard Nixon and George McGovern was fought on the Vietnam War and McGovern's very progressive social agenda. It ended with Nixon's landslide victory. Places where McGovern did well are also arguably places which elected local officials with

[12]In the working paper version of this article (Duranton and Turner, 2009), we also show that if the long run variable costs of producing VKT is approximately constant returns to scale, the fundamental law of road congestion then implies that the demand for travel should be flat. We provide evidence to this effect and use this result in a welfare calculation.

[13]There are too few MSAs with light rail to permit informative cross-sectional analysis. Our data indicate that there are only 11 MSAs with any light rail at all in 1984, and of these only 6 had more than 100 rail cars. The situation is only marginally better in 1994 when 21 MSAs had light rail or commuter rail service and 7 had more than 100 cars. We have experimented with an index that sums large buses and rail cars.

a strong social agenda. Importantly, this election also took place shortly after the 1970 Urban Mass Transportation Act and it only briefly predates the first oil shock and the 1974 National Mass Transportation Act that followed. While total federal support for public transportation was less than 5 billion dollars (in 2003 dollars) for the entire decade starting in 1960, the 1970 act appropriated nearly 15 billion dollars and the 1974 act appropriated 44 billion dollars. Similar levels of funding persist to the time of this writing (see Weiner, 1997, Hess and Lombardi, 2005, for a history of US public transportation). More generally, during the 1970s public transit expanded and evolved from a private fare-based industry to a quasi-public sector activity sustained by significant subsidies.

In order for a 1972 election to predict 1984 levels of public transit infrastructure, public transit funding must be persistent. In fact, the 'stickiness' of public transit provision is widely observed (Gomez-Ibanez, 1996) and is confirmed in our data. The Spearman rank correlation of bus counts between 1984 and 2004 is 0.90. Our data also suggest that MSAs which voted heavily for McGovern in 1972 made a greater effort to develop public transit in the 1970s, and these high levels of public transit persisted through our study period. Furthermore, the raw data confirms the relevance of our instrument. The pairwise correlation between log 1984 buses and 1972 democratic vote is 0.34. This partial correlation is robust to adding controls for geography and past population. In a nutshell, the 1972 share of democratic vote is a good predictor of the 1984 MSA provision of buses which then grew proportionately to population.

The argument for the exogeneity of the 1972 democratic vote is less strong than that for the road instruments.[14] Nonetheless, a good argument can be made that funding for public transportation in American cities in the early 1970s was a response to contemporaneous social needs. More specifically, the provision of buses at this time did not seek to accommodate traffic congestion during the 1983-2003 period.

Two facts strengthen the case for our empirical strategy. First, as we show below, the results for public transportation are robust and stable as we change specifications. Second, when it is possible to conduct over identification tests, our results always pass these tests.

[14]In particular, it is possible that a high share democratic vote in 1972 was associated with a variety of other policies and local characteristics that affected subsequent VKT. Since we control for 1980 population (and thus implicitly for growth between 1970 and 1980), we would need these policies to have long-lasting effects and not be reflected in population growth. In this respect, Glaeser, Scheinkman, and Schleifer (1995) find very weak or no association between a number of urban policies (though not public transport) and urban growth between 1960 and 1990. In addition, recent work by Ferreira and Gyourko (2009) could find no evidence of any partisan effect with respect to the allocation of municipal expenditure.

Table 6: VKT as a function of lane kilometers and buses, pooled regressions.

	[1] OLS	[2] OLS	[3] OLS	[4] OLS	[5] OLS	[6] OLS	[7] LIML	[8] LIML	[9] LIML	[10] LIML
Dependent variable: ln VKT for interstate highways, entire MSAs										
ln(IH lane km)	1.07[a]	0.82[a]	0.86[a]	0.86[a]	1.06[a]	1.06[a]	1.38[a]	0.96[a]	1.09[a]	1.18[a]
	(0.04)	(0.05)	(0.05)	(0.04)	(0.05)	(0.05)	(0.08)	(0.10)	(0.13)	(0.17)
ln(bus)	0.14[a]	-0.023	0.026	0.039[b]	0.021[b]	0.012[c]	-0.035	-0.081[c]	0.12	0.21
	(0.02)	(0.017)	(0.019)	(0.018)	(0.009)	(0.008)	(0.049)	(0.046)	(0.10)	(0.14)
ln(pop.)		0.51[a]	0.40[a]	0.26[b]		0.32[a]		0.50[a]	0.079	-0.15
		(0.05)	(0.05)	(0.12)		(0.10)		(0.12)	(0.207)	(0.27)
Geography			Y	Y					Y	Y
Census div.			Y	Y					Y	Y
Socio-econ. char.				Y						Y
Hist. pop.				Y						Y
MSA fixed effects					Y	Y				
R^2	0.90	0.94	0.95	0.96	0.94	0.94	-	-	-	-
Overid.							0.90	0.46	0.47	0.38
First stage Stat.							23.3	21.1	9.53	5.68

All regressions include a constant and year effects. Robust standard errors clustered by MSA in parentheses. 684 observations corresponding to 228 MSAs for each regression. Instruments for buses and lane kilometers are ln 1898 railroads, ln 1947 planned interstates, and 1972 presidential election share of democratic vote. *a*, *b*, *c*: significant at 1%, 5%, 10%.

Regressions in table 6 are similar to regressions in tables 3 and 5 except that we also include the log count of large buses in an MSA as an explanatory variable. In columns 1 through 6 we present OLS regressions while in columns 7 through 10 we report LIML regressions (rather than TSLS since our set of instruments is sometimes marginally weak). Our dependent variable is log VKT for all interstates. As in results reported earlier, the lane kilometer elasticity of VKT is close to one in all specifications. The second row gives our estimates of the bus elasticity of VKT. These estimates are consistently small, are in general precisely estimated, do not have a consistent sign, and are often statistically indistinguishable from zero.

To check the robustness of our results, appendix table 5 (in a separate appendix) repeats some of the regressions of table 6 for each of our three cross-sections. The resulting estimates of the bus elasticity of VKT are qualitatively unchanged. As a further check, appendix table 6 repeats the regressions of table 6 using a broader measure of transit adding all train cars to our count of buses. The resulting elasticity estimates of this table are virtually identical to those of table 6.

Consistent with the fundamental law, these results fail support the hypothesis that increased provision of public transit affects VKT. This finding also should be of independent interest to policy makers.

Convergence of AADT *levels*

The fundamental law of road congestion requires that each MSA have an intrinsic natural level of traffic conditional on lane kilometers of roadway. An implication of this is that a deviation from this natural level ought to be followed by a return to it. Traffic flows should exhibit convergence to this natural level. In this subsection we thus examine the evolution of average annual daily traffic (AADT) rather than vehicle kilometers traveled (VKT).

The raw data suggest that such convergence may occur. From 1980 to 2000 the cross-MSA standard deviation of all interstate AADT decreases from 1.40 to 1.28. To investigate the possibility of convergence more carefully, table 7 presents the results of 'AADT growth regressions' in which we pool first differences in interstate AADT for 1990 and 2000 and regress them on initial interstate AADT levels.

In the first four columns of table 7 we see that for interstate AADT the relationship between initial levels and changes is negative in the cross-section, even as we add an exhaustive set of controls. In column 5 we see that mean reversion persists if we include MSA fixed effects and consider only time series variation.[15] In column 6 we account for the possibility of an endogenous relationship between changes in AADT and changes in population by instrumenting for the latter using our population change instrument described above. This IV estimate shows mean reversion similar to what we see in the OLS regressions.

In appendix table 7 (in a separate appendix), we replicate these regressions for corresponding measures of AADT for interstate highways in urbanized areas, non-urban interstates, and major urban roads and find evidence of convergence for these roads as well.

4. Where does all the VKT come from?

Our data show that building roads elicits a large increase in VKT on those roads. We now turn our attention to understanding where all the extra VKT comes from. In particular, we consider four possible sources of demand for VKT: changes in individual behavior; the migration of people and

[15]The much higher coefficient obtained in this regression is reminiscent of results in GDP growth regressions and might be explained by the greater importance of measurement error for differences than for levels. However our results in the other columns do not appear to be driven by measurement error. Traffic convergence during the 1990s is the same in OLS or TSLS when instrumenting initial AADT with its 10-year lagged value.

Table 7: Convergence in daily traffic.

	[1] OLS	[2] OLS	[3] OLS	[4] OLS	[5] OLS, FE	[6] TSLS
Dependent variable: Change in ln daily traffic (AADT) for interstate highways, entire MSAs.						
Initial ln IH AADT level	-0.11[a]	-0.12[a]	-0.17[a]	-0.22[a]	-0.98[a]	-0.17[a]
	(0.02)	(0.02)	(0.02)	(0.03)	(0.05)	(0.02)
Δ ln(pop.)		0.38[a]	0.48[a]	0.29[b]		0.69[b]
		(0.10)	(0.11)	(0.14)		(0.31)
Geography			Y	Y		Y
Census div.			Y	Y		Y
Initial Share Manuf.				Y		Y
Hist. pop.				Y		
Socio-econ. char.				Y		
R^2	0.26	0.32	0.39	0.44	0.82	-
First stage Stat.						47.6

All regressions include decade effects. Robust standard errors in parentheses (clustered by MSA).
456 observations corresponding to 228 MSAs for each regression. *a*, *b*, *c*: significant at 1%, 5%, 10%.
Instrument for Δ ln(pop.) is expected population growth based on initial composition of economic activity. interacted with the national growth of sectors.

Table 8: Truck VKT as a function of lane kilometers, pooled regressions.

	[1] OLS	[2] OLS	[3] OLS	[4] OLS	[5] OLS	[6] OLS	[7] OLS	[8] OLS	[9] TSLS	[10] TSLS
Dependent variable: ln Truck VKT for interstate highways, entire MSAs										
ln(IH lane km)	1.30[a]	1.16[a]	1.20[a]	1.25[a]	1.19[a]	1.46[a]	1.48[a]	1.52[a]	2.09[a]	2.32[a]
	(0.07)	(0.13)	(0.13)	(0.13)	(0.14)	(0.26)	(0.27)	(0.27)	(0.44)	(0.43)
ln(pop.)		0.16[c]	0.13	0.23[b]	1.79[b]		2.14[b]	2.02[b]	-0.48	-0.77[b]
		(0.08)	(0.11)	(0.10)	(0.79)		(0.94)	(0.91)	(0.31)	(0.34)
Geography			Y	Y	Y					Y
Census div.			Y	Y	Y					Y
Socio-econ. char.				Y	Y			Y		
Hist. pop.					Y					
MSA fixed effects						Y	Y	Y		
R^2	0.53	0.54	0.58	0.59	0.61	0.31	0.34	0.34	-	-
Overid.									0.27	0.18
First stage Stat.									16.5	11.8

All regressions include a constant and year effects. Robust standard errors clustered by MSA in parentheses.
Instruments are ln 1835 exploration routes, ln 1898 railroads, and ln 1947 planned interstates.
684 observations corresponding to 228 MSAs for each regression. *a*, *b*, *c*: significant at 1%, 5%, 10%.

economic activity, increases in the commercial transportation sector, and diversion of traffic from other roads.

Commercial VKT

To investigate the relationship between changes in the road network and changes in truck VKT we first use the HPMS Sample data's reports of the daily share of single unit and combination trucks using each road segment on an average day. With our other data, this allows us to calculate truck VKT for all roads in our sample. With these measures of truck VKT in hand, we replicate our earlier analysis of all VKT for truck VKT.

Table 8 reports these results. Our dependent variable is all interstate highway truck VKT and the explanatory variable of interest is lane kilometers of interstate highways. In columns 1 through 5, we report OLS estimates. In columns 6, 7 and 8 we include MSA fixed effects and identify the effect of interstate highways on truck VKT using only time series variation. In columns 9 and 10 we report TSLS where we use our three historical variables to instrument for contemporaneous lane kilometers. In every case, our estimate of the highway elasticity of truck VKT is above one and is estimated precisely. While the OLS and fixed-effect estimates are generally within two standard deviations of one, the IV estimates in columns 9 and 10 are above 2 and are more than two standard deviations above one.

In all, we find that a 10% increase in interstate highways causes about a 10-20% increase in truck VKT, so that commercial traffic is at least as responsive to road supply as other traffic.

We confirm these results for all interstate highways in Appendix table 8 which runs separate regressions for each decade. We also replicate these regressions for urbanized roads. Interestingly truck VKT in cities responds less to changes in major roads than does interstate truck traffic to changes in interstates.

In a separate appendix, we also examine the relationship between roads and employment in traffic intensive activities. We use County Business Patterns data for 1983, 1993, and 2003. These data provide county level information on employment in "Motor freight transportation and warehousing" (SIC 42). Appendix tables 9 and 10 present results of regressions predicting log MSA employment in trucking and warehousing. These regressions show that employment in this sector increases with interstate lane kilometers, that it is more responsive to the supply of non-urbanized area interstate than to the supply of urbanized area interstate, and that it has become more sensitive to changes in the supply of interstate highways over the course of our study period.

An interesting explanation for our findings is that improvements to highways cause large increases in the use of these routes by long-haul truckers, while improvements to the local road network cause smaller increases in local commercial traffic.

Individual driving behavior and highways

We now investigate the extent to which individual or household driving behavior changes in response to changes in the extent of an MSA's interstate network. To accomplish this, we look at the relationship between lane kilometers of interstate highway and three different measures of individual and household driving taken from the 1995 and 2001 NPTS.

The NPTS actually consists of four parts. The 'household survey' provides categorical variables describing the age, race, education, and income of the household head or the principal respondent.[16] Confidential geocode information allows us to assign all households to MSAs.[17] The 'vehicle survey' provides a detailed description of each household motor vehicle including the survey respondents' report of how many kilometers it was driven in the past twelve months. We use the vehicle survey to construct an estimate of total VKT for the household during the survey year. The 'person survey' describes travel behavior for household members over the past week, commuting behavior in particular. We use the person survey to measure commuting behavior for the average commuter in a respondent household. Finally, the 'trip survey' describes all household travel on a given randomly selected day. We use this survey to measure all household daily VKT.

While we provide more detailed discussion of the NPTS and some descriptive statistics in the data appendix, it is useful to discuss the relationship between the NPTS and HPMS based measures of VKT. The NPTS reports a per household measure of VKT on all roads while the HPMS reports aggregate VKT on interstates and major urban roads within MSAs. Thus, the HPMS looks at all traffic on a subset of roads while the NPTS looks at all household driving on any roads, but ignores commercial or through traffic and changes in population.

To investigate the extent to which individual or household driving behavior changes in response to changes in the extent of an MSA's interstate network we look at the relationship between lane kilometers of interstate highway and our three NPTS derived measures of individual and household driving.

We perform two series of estimations using our two pooled cross-sections of the NPTS. The first uses our city level cross-section estimating equation (2), adjusted to reflect the fact that our unit of

[16]It is worth noting that the NPTS survey protocol requires a phone call, a house visit, and that respondents keep a travel diary. Thus it should be regarded as accurate relative to other sources self-reported travel data. The 2000 US census provides an alternative source of information regarding commute times. This information is reported for a sample of the population using 12 time-bands. A comparison between 2000 census and 2001 NPTS data of mean commute times across 227 MSAs yields a raw correlation of 0.63. This correlation is 0.85 when considering only MSAs with population above 1 million. Means computed from the NPTS appear more noisy. Regressing log census mean commute times for all commuters (including those using public transportation) against mean NPTS car commute times yields a coefficient of 1.05 in a regression without constant.

[17]The public use data only reveals respondents's MSAs for respondents residing in large MSAs. We do not use earlier waves of the NPTS because they cannot be geocoded.

Table 9: Individual travel as a function of interstate lane kilometers.

	ln commute distance			ln HH daily VKT			ln HH annual VKT		
	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]
Panel A (OLS) on interstate highways, entire MSAs.									
ln(IH lane km)	0.094[a]	0.074[a]	0.074[a]	-0.028	0.087[a]	0.082[a]	-0.047[a]	0.055[a]	0.054[a]
	(0.013)	(0.022)	(0.021)	(0.020)	(0.022)	(0.020)	(0.016)	(0.016)	(0.015)
ln(pop.)		0.022	0.25		-0.091[a]	0.12		-0.075[a]	-0.046
		(0.021)	(0.17)		(0.019)	(0.20)		(0.014)	(0.116)
Geography		Y	Y		Y	Y		Y	Y
Census div.		Y	Y		Y	Y		Y	Y
Hist. pop.			Y			Y			Y
Observations	51447	51447	51447	65318	65318	65318	60320	60320	60320
R^2	0.06	0.06	0.06	0.10	0.10	0.10	0.18	0.19	0.19
Panel B (TSLS) on interstate highways, entire MSAs. Instruments: ln 1898 railroads and ln 1947 planned interstates									
ln(IH lane km)	0.097[a]	0.10[b]	0.10[a]	-0.017	0.11[b]	0.089[c]	-0.040[b]	0.056[b]	0.049[c]
	(0.014)	(0.04)	(0.04)	(0.021)	(0.05)	(0.053)	(0.016)	(0.027)	(0.028)
ln(pop.)		-0.00072	0.22		-0.11[b]	0.11		-0.076[a]	-0.040
		(0.0331)	(0.17)		(0.04)	(0.21)		(0.022)	(0.119)
Observations	51447	51447	51447	65318	65318	65318	60320	60320	60320
Overid	0.063	0.36	0.52	0.28	0.14	0.45	0.12	0.63	0.94
First stage F	51.7	18.6	16.8	50.1	17.5	15.5	49.1	16.9	14.6

All regressions include a constant and control for individual characteristics (income, education, gender, age, and race). Robust standard errors in parentheses (clustered by MSA).
228 MSAs represented in all regressions. *a*, *b*, *c*: significant at 1%, 5%, 10%.

observation is now a person or household in a particular city and year. In particular, we estimate,

$$\ln(Q_j^{\text{AR}}) = A_0 + \rho_{R^{\text{IH}}}^{Q^{\text{AR}}} \ln(R_{ij}^{\text{IH}}) + A_1 X_{ij} + \epsilon_j, \tag{6}$$

where Q_j^{AR} denotes VKT on all roads for household (or individual) j and i indexes MSAs. Because of the log specification, the coefficient on lane kilometers is the elasticity of household VKT on all roads with respect to interstate highway lane kilometers. We include as control variables both MSA level characteristics and individual demographic characteristics, and allow for clustering of errors at the MSA level.

Our second set of estimations is the individual or household level analog of our instrumental variables estimating equation (5). Here, except for the presence of controls for individual characteristics, our first stage equation predicts interstate kilometers and is identical to the first stage in equation (5), the second stage corresponds to equation (6).

Table 9 reports the results of regressions to explain three measures of individual driving using pooled cross-sections from the 1995 and 2001 NPTS. Panel A of the table presents OLS estimates and panel B presents TSLS estimates. In the first three columns our dependent variable is commute kilometers on a typical day for all NPTS individuals who commute. In columns 4 through 6 our dependent variable is total household vehicle kilometers on a particular travel day. In columns 7 through 9, our dependent variable is total VKT by all household vehicles in the survey year.

With the exception of the regression in column 7, for which there is no measurable relationship between interstate kilometers and household vehicle kilometers, all estimates suggest a positive and statistically significant relationship between the extent of the highway network and individual travel. Our preferred estimates are the TSLS estimates in panel B. These estimates suggest that a 10% increase in the extent of the interstate network causes about a 1% increase in individual driving on all roads. While the NPTS data does not reveal which classes of roads accommodate this increase in driving, below we use the HPMS to explore the diversion of traffic between classes of roads.

Population growth

By reducing the cost of transportation within a city, all else equal, improvements to a city's road network make a city more attractive relative to other cities. Given the high mobility of the US population, this suggests that changes to a city's road network should be met with changes to a city's population. In fact, this conjecture appears to be true, and the extant literature estimates the size of this effect.

Michaels (2008) and Chandra and Thompson (2000) provide suggestive evidence. Both papers consider the effect of improvements in access to the interstate system on rural counties in the US. Michaels (2008) finds that an interstate highway in a rural county leads to large increases in retail earnings. Chandra and Thompson (2000) find that improved access to the interstate system causes an overall increase in firm earnings. Together, these results show that interstate highways cause increases in the level of local economic activity. To the extent that population levels and overall economic activity are linked, this suggests that improvements to the interstate network lead to population increases.

Duranton and Turner (2008) provide more direct evidence. Duranton and Turner (2008) consider US MSAs between 1980 and 2000, and investigate the way that population growth responds to changes in the road network. Like the current paper, they rely on an early plan of the interstate highway network and 1898 railroad routes as instruments for the modern road network. They find that a 10% increase the extent of the road network causes a 1.3% increase in MSA population over 10 years, and a 2% increase over 20 years.

Diversion from other roads

We measure traffic and lane kilometers for three exclusive classes of roads in each MSA; urbanized area interstates, non-urbanized area interstates, and major urbanized area roads. These data allow direct tests of whether changes to one class of roads affects VKT on the others. In particular, we estimate each of the three following variants of equation (2),

$$\ln(Q_{it}^{\text{IHU}}) = A_0 + \rho_{R^{\text{IHU}}}^{Q^{\text{IHU}}} \ln(R_{it}^{\text{IHU}}) + \rho_{R^{\text{IHNU}}}^{Q^{\text{IHU}}} \ln(R_{it}^{\text{IHNU}}) + \rho_{R^{\text{MRU}}}^{Q^{\text{IHU}}} \ln(R_{it}^{\text{MRU}}) + A_1 X_{it} + \epsilon_{it} \quad (7)$$

$$\ln(Q_{it}^{\text{IHNU}}) = B_0 + \rho_{R^{\text{IHU}}}^{Q^{\text{IHNU}}} \ln(R_{it}^{\text{IHU}}) + \rho_{R^{\text{IHNU}}}^{Q^{\text{IHNU}}} \ln(R_{it}^{\text{IHNU}}) + \rho_{R^{\text{MRU}}}^{Q^{\text{IHNU}}} \ln(R_{it}^{\text{MRU}}) + B_1 X_{it} + \gamma_{it} \quad (8)$$

$$\ln(Q_{it}^{\text{MRU}}) = C_0 + \rho_{R^{\text{IHU}}}^{Q^{\text{MRU}}} \ln(R_{it}^{\text{IHU}}) + \rho_{R^{\text{IHNU}}}^{Q^{\text{MRU}}} \ln(R_{it}^{\text{IHNU}}) + \rho_{R^{\text{MRU}}}^{Q^{\text{MRU}}} \ln(R_{it}^{\text{MRU}}) + C_1 X_{it} + \nu_{it}. \quad (9)$$

In equation (7), $\rho_{R^{\text{IHNU}}}^{Q^{\text{IHU}}}$ is the urbanized area interstate VKT elasticity of non urbanized area interstate lane kilometers. If, for example, this parameter is -0.1 then a 10% increase in non-urbanized area interstate lane kilometers results in a 1% decrease in urbanized area interstate VKT. Interpretation of other coefficients is similar.

Table 10 reports estimates of equations (7)-(9). In all regressions we pool our three cross-sections of HPMS data and use OLS. Panel A presents estimates of equation (7). In these regressions our dependent variable is urbanized area interstate VKT and the dependent variables of interest are the three measures of lane kilometers. We exploit cross-sectional variation and from left to right, use progressively more exhaustive lists of controls. Panels B and C are similar to panel A, but use non-urbanized interstate VKT and major urbanized area road VKT as dependent variables.

Consistent with our earlier results we see that VKT elasticity of own lane kilometers is close to one for all specifications in panel A and above 0.8 for all specifications in panels B and C. The largest estimated cross elasticity is 0.22 for the non-urbanized area interstate VKT elasticity of urbanized area major road lane kilometers, in column 1, row 3 of panel B. This estimate is not robust to the addition of controls, and is negative or indistinguishable from zero in other specifications. The estimate of the urbanized area interstate VKT elasticity of urbanized area major road lane kilometers in row 3 column 1 of panel A is similar. Other cross-elasticities are generally quite small. Our preferred regressions are reported in column 5. In this specification, all cross-elasticities are negative with magnitudes no larger than 0.1. In sum, table 10 suggests that, while traffic diversion does occur in response to changes in the road network, the fundamental law of road congestion mainly reflects traffic creation rather than traffic diversion.

Table 10: VKT as a function of lane kilometers for different types of roads, pooled OLS.

	[1]	[2]	[3]	[4]	[5]
Panel A. Dependent variable: ln VKT for interstate highways, urbanized areas within MSAs					
ln(IHU lane km)	1.09^a	1.01^a	1.04^a	1.03^a	1.04^a
	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)
ln(IHNU lane km)	-0.026	-0.083^a	-0.086^a	-0.087^a	-0.099^a
	(0.031)	(0.025)	(0.024)	(0.024)	(0.023)
ln(MRU lane km)	0.22^a	-0.13^b	-0.12^b	-0.12^b	-0.100^b
	(0.04)	(0.06)	(0.06)	(0.05)	(0.05)
ln(pop.)		Y	Y	Y	Y
Geography			Y	Y	Y
Census div.			Y	Y	Y
Socio-econ. char.				Y	Y
Hist. pop.					Y
R^2	0.96	0.97	0.97	0.98	0.98
Panel B. Dependent variable: ln VKT for interstate highways, outside urbanized areas within MSAs					
ln(IHU lane km)	0.032	-0.049	-0.030	-0.030	-0.013
	(0.037)	(0.034)	(0.031)	(0.030)	(0.032)
ln(IHNU lane km)	0.87^a	0.81^a	0.84^a	0.85^a	0.83^a
	(0.04)	(0.03)	(0.03)	(0.02)	(0.02)
ln(MRU lane km)	0.22^a	-0.14^b	-0.053	-0.046	-0.013
	(0.05)	(0.05)	(0.052)	(0.050)	(0.050)
R^2	0.85	0.88	0.92	0.92	0.93
Panel C. Dependent variable: ln VKT for Major Roads, urbanized areas within MSAs					
ln(IHU lane km)	0.015	-0.049^a	-0.049^a	-0.057^a	-0.048^a
	(0.021)	(0.018)	(0.016)	(0.014)	(0.015)
ln(IHNU lane km)	0.042^b	-0.0038	0.00063	-0.0044	-0.0042
	(0.021)	(0.0181)	(0.0150)	(0.0133)	(0.0133)
ln(MRU lane km)	1.09^a	0.81^a	0.82^a	0.81^a	0.82^a
	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)
R^2	0.97	0.98	0.99	0.99	0.99

All regressions include a constant and year effects. Robust standard errors clustered by MSA in parentheses. 572 observations corresponding to 192 MSAs for each regression. *a*, *b*, *c*: significant at 1%, 5%, 10%.

In a separate appendix, we confirm these results in appendix tables 11 and 12. In these tables we replicate the results of table 10 in decade by decade OLS regressions and in first difference regressions.

An accounting exercise

The fundamental law of road congestion requires that changes in the extent of the road network are met with proportional changes in traffic. We have suggested four possible sources for this increase in traffic; changes in trucking and commercial driving, changes in individual or household driving behavior, changes in population, and diversion of traffic. We now consider whether these four sources are sufficient to explain the fundamental law and assess their relative importance.

To begin, consider a 10% increase in the interstate network of an average MSA around 2000. Using our preferred estimate from column 3 of table 5, this increase causes a 10.3% increase in VKT on the interstates of our hypothetical city.

In table 1 we see that in 2003, trucks accounted for 13% of VKT on interstate highways in an average MSA. In table 8, our preferred specification is column 10, where the truck VKT elasticity of interstate highways is about 2.3. This means that a 10% increase in the stock of roads causes about a 23% increase in truck VKT and a 3.0% increase in overall interstate VKT, about 29% of the total increase in VKT caused by our 10% increase in roads. While our preferred elasticity of 2.3 may seem high, the average of all estimates in panel A of table 8 is 1.5. This lower value would imply that trucks represent 18% of the total increase in VKT. Therefore, we estimate that trucks account for between 19 and 29% of the total increase in interstate VKT that results from our hypothetical 10% increase in interstate lane kilometers.

For migration, taking the preferred estimate from Duranton and Turner (2008), our 10% increase in the interstate network causes about a 2.1% increase in population. From column 3 of table 5, the MSA population elasticity of interstate VKT is 0.30. Together, these two elasticities suggest that a 10% increase in population results in about a 0.6% increase interstate VKT, about 6% of the total increase. This elasticity of 0.30 is estimated in a regression that also controls for decennial population levels between 1920 and 1970. Because decennial population levels are highly correlated, this may understate the effect of population on VKT.

Panel B of table 4, which controls for the endogeneity of population in first difference estimates, reports higher estimates. The estimate in column 5 is 1.02. This alternative value implies that population growth represents 21% the total effect of an extension in interstate lane kilometers. Therefore, we estimate that migration accounts for between 5 and 21% of the total increase in interstate VKT that results from our hypothetical 10% increase in interstate lane kilometers.

Turning to substitution across roads, we suppose that the 10% increase in our MSA's interstate lane kilometers network is accomplished by increasing both urbanized and non-urbanized interstates by 10%. Since we are considering increases to both classes of interstate highways, we need only be concerned with diversion of traffic from major urbanized area roads. This is estimated in panel C of table 10. In rows 1 and 2 of column 5, we see that a 10% increase in urbanized and non-urbanized interstate causes a decrease in major urban road VKT of 0.48% and 0.04%, respectively (and basing our calculation on column 3 or 4 would yield similar results). That is, our 10% increase in interstate lane kilometers diverts 0.52% of traffic from major urban roads. Using the levels of VKT for major urban and all interstates given in table 1 allows us to calculate that this diversion amounts to about a 1% increase in interstate VKT, or about 10% of the total effect of our hypothetical 10% extension. Because many estimates in table 10 (or in appendix tables 12 and 13) indicate no substitution from major urban roads towards interstates, we cannot rule out the absence of a substitution effect. Therefore, we estimate that the diversion of traffic from other classes of roads accounts for between 0 and 10% of the total increase in interstate VKT that results from our hypothetical 10% increase in interstate lane kilometers.

Calculating the contribution of changes to household behavior is more difficult. Table 9 estimates the effect of interstate lane kilometers on individual driving behavior. We take the estimate of 0.11 given by column 5 of panel B (which is very close to the corresponding estimate for alternative measures of VKT in columns 2, 3, and 6 of both panels). A 10% increase in interstate lane kilometers causes a 1.1% increase in household annual VKT. Unfortunately, our data do not allow us to apportion household driving to different road networks. A first possibility is to assume that this 1.1% increase in driving is proportional to current driving across all road networks. Since households represent 87% of interstate VKT, this 1.1% increase represents an increase in interstate VKT of 0.9% or 9% of the total increase in interstate VKT caused by a 10% increase in lane kilometers. This is arguably an unrealistic lower bound. Alternately, suppose that the 1.1% increase in household driving takes place only on interstates (recall that we earlier reported that about 24% of VKT takes place on interstates). In this case, the increase in interstate VKT would account for 4.1% of the total change in VKT or 39% of the effect of our expansion in lane miles. This constitutes an upper-bound. Therefore, we estimate that increases in household driving account for between 9 and 39% of the total increase in interstate VKT that results from our hypothetical 10% increase in interstate lane kilometers.

To sum up, of four possible sources for the new traffic following an increase in lane kilometers of interstates, changes to individual behavior and changes in commercial driving are the most important. Migration and traffic diversion are significantly less important. We also note that if we take the upper bounds for the shares of all four sources we account for just about the entire increase in VKT.

5. Conclusion

This paper analyzes new data describing city level traffic in the continental US between 1983 and 2003. Our estimates of the elasticity of MSA interstate highway VKT with respect to lane kilometers are 0.86 in OLS, 1.00 in first difference, and 1.03 with IV. Because our instruments provide a plausible source of exogenous variation, we regard 1.03 as the most defensible estimate. We take this as a confirmation of the 'fundamental law of highway congestion' suggested by Downs (1962) where the extension of interstate highways is met with a proportional increase in traffic for US MSAS.

We also provide suggestive evidence that this law extends beyond urban highways, a 'fundamental law of road congestion'. For a broad class of major roads within the 'urbanized' part of MSAS we estimate a roadway elasticity of VKT between 0.67 and 0.89 depending on the decade in OLS. Changes in the boundaries of urban areas over time and the weakness of our instruments for this class of roads preclude reliable first-difference and IV estimates.

Beyond direct evidence we confirm two implications of the fundamental law of road congestion; we find no evidence that public transit affects VKT and there is convergence of traffic levels. Our results also suggest that roads are assigned to MSAS with little or no regard for the prevailing level of traffic.

We also consider the sources of new traffic elicited by extensions to the interstate network. We find that changes to individual driving behavior and increases in trucking are most important. Migration is somewhat less important. Surprisingly, diversion of traffic from other road networks does not appear to play a large role.

These findings suggest that both road capacity expansions and extensions to public transit are not appropriate policies with which to combat traffic congestion. This leaves congestion pricing as the main candidate tool to curb traffic congestion.

Appendix A. Description of data

A.. Consistent MSA *definitions*

MSA's are defined as aggregations of counties. We use the 1999 MSA definitions. In order to insure that our definitions are constant over time, we track changes in county boundaries back to 1920 and make adjustments to MSA definitions as required in each decade.

B.. HPMS data

We rely extensively on the Highway Performance Monitoring System (HPMS) data for 1983, 1993, and 2003, and slightly on the HPMS data for 1995 and 2001. These data are collected and maintained by the US Federal Highway Administration in cooperation with many sub-national government agencies. Documentation is available in United States Department of Transportation, Federal Highway Administration (2005*b*), United States Department of Transportation, Federal Highway Administration (2003*a*) and United States Department of Transportation, Federal Highway Administration (2003*b*).

The HPMS consists of two parts. The *Universe data* is supplied for most road segments in the interstate highway system and some other major roads and provides a description of each segment. The *Sample data* provides additional information about all segments in the Universe data, including an urbanized area code for segments falling in urbanized areas. For a sample of smaller urbanized area roads, the Sample data also provides all data fields that occur in the Universe and Sample data.

In general, each segment reported in the HPMS represents a larger set of similar segments (typically of the same road), called a sample. Thus, each reported segment is associated with an expansion factor which relates the length of the segment described in the data to the length of the sample it represents. Since states are required to report information on every interstate highway segment, all interstate highway segments should have an expansion factor of one. In fact, the average expansion factor for these segments is about 1.5, so that states seem not to be in compliance with reporting requirements. For non-interstate segments, principally smaller classes of roads, reporting requirements permit expansion factors of up to 100. In fact, a small number of larger expansion factors occur but we exclude these segments from our sample. For urbanized area roads in the relevant classes, reporting rules require that the union of all samples be the set of all urbanized area roads. Loosely, urbanized area road segments are partitioned into sets of similar segments, and one segment from each set is reported in the HPMS sample data. In this sense, Sample data represents all urbanized road segments subject to reporting requirements.

For the interstate highway system the HPMS records number of lanes, length, AADT, and county. By construction, road segments do not cross county borders. For segments in urbanized areas, the HPMS also provides an urbanized area code. Since MSAs are county based units, these data allow us to calculate VKT for the urbanized and non-urbanized area interstate systems by MSA.

Within urbanized areas, the HPMS, not only describes the interstate highway system, but also all roads in the following functional classes: Principal arterial - Other freeways and expressways, Principal arterial - other, Minor arterial, Collector, Local. There is no mandated reporting of local roads, so they make up only a small share of the HPMS data and are excluded from our analysis. Our 'major roads' are defined as the union of the remaining classes. The definitions of these road classes are given in United States Department of Transportation, Federal Highway Administration (1989) and span about 20 pages. Loosely, a local road is one which is predominantly used to access addresses on that road, e.g., a residential street. Any road used principally to connect local roads (but not an interstate) falls in one of the larger classes that we consolidate into major roads.

C.. NPTS data

In appendix table 11, we report some descriptive statistics about our two waves of the NPTS. Surprisingly, these data show that driving distances per person, household, and vehicle all declined between 1995 and 2001.

The 'vehicle survey' provides a detailed description of each household motor vehicle including the survey respondents' report of how many kilometers it was driven in the past twelve months. We use this information to construct an estimate of total VKT for the household during the survey year. This information is reported in the top section of appendix table 11. The 'person survey' describes travel behavior for each household member on a typical travel day. From this, we construct household mean commute distance, time and speed for household members who drive to work. Table 11 shows that mean commute distance decreased from 20.4 km in 1995 to 19.4 in 2001. This decrease in distance resulted in a small decrease in mean commute times despite a decline in speed. Finally, the 'travel day' survey collects detailed information about each trip taken by each household member on a randomly selected travel day. These data allow the calculation of household person-kilometers of vehicle travel, along with the person-minutes required to accomplish this travel, and the average speed of this travel. Table 11 shows that total daily household person-kilometers of travel was approximately constant over the study period, but that the time required to accomplish this travel increased from 147.7 minutes to 160.9 minutes and speed decreased from 48.4 to 43.9 km/h.

The descriptive statistics in appendix table 11 point at stability or a small decline in VKT per

Table 11: Summary statistics for our main NPTS variables (averaged over individuals or HH, means and standard deviations between brackets) and HMPS VKT for corresponding years.

Year:	1995	2001
NPTS vehicle survey (annual)		
Mean vehicle km (person)	12,436	12,203
	(7,737)	(8,398)
Mean vehicle km (HH)	32,546	30,352
	(19,672)	(20,198)
Mean vehicle km (vehicle)	19,560	17,573
	(9,355)	(9,030)
NPTS person survey (daily)		
Distance to work (km)	20.4	19.4
	(21.6)	(20.2)
Minutes drive to work	22.4	21.3
	(17.3)	(16.3)
Speed to work	50.9	49.6
	(21.1)	(22.1)
NPTS trip survey (daily)		
Total HH person-km	134.8	134.5
	(119.9)	(112.0)
Total HH person-minutes	147.7	160.9
	(88.7)	(90.7)
Mean HH km/h	48.4	43.9
	(12.2)	(15.1)
Total HMPS VKT		
Interstate Highways ('000 km)	2,876,074	3,484,750
Major Urban Roads ('000 km)	5,530,845	6,624,656
Number MSAs	228	228

household between 1995 and 2001. For the same period, the HPMS indicates increases of around 20% for VKT, as reported at the bottom of appendix table 11. It is natural to wonder whether these two findings are contradictory. To see that they are not, note that the NPTS and the HPMS report different measures of VKT.[18] The NPTS reports a per household measure of VKT on all roads. On the other hand, the HPMS reports aggregate VKT on interstates and major urban roads within MSAs. Thus, the HPMS looks at a different set of roads than the NPTS and the 2001-1995 difference reflects changes in commercial traffic and number of households, in addition to changes in VKT per household.

[18]We rule out sampling errors. NPTS data sample a large number of households, are broadly acknowledged to be of high quality, and their correlation with census data is also high as mentioned above. Schipper and Moorhead (2000) also provide evidence that reported VKT in the NPTS is highly consistent with odometer VKT from the 1994 Residential Transportation Energy Consumption Survey. As for the HPMS, it is carefully scrutinized by the Bureau of Transportation Statistics which uses it as the basis of its Transportation Statistics Annual Report.

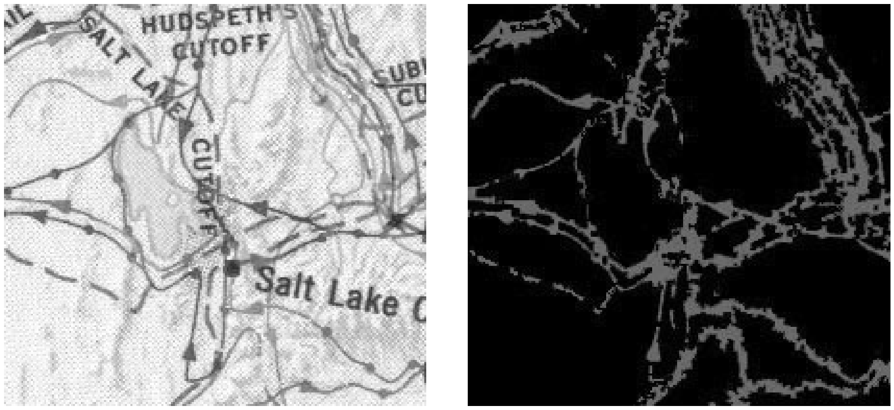


Figure 5: Right panel gives detail of original map of 1835-1850 exploration routes for a segment of the Oregon trail near Salt Lake City. Left panel shows incidence of exploration routes in same region. For this region, our measure of exploration routes is the count of grey pixels in the right panel.

D.. Instruments

Our measures of the 1947 interstate highway plan and the 1898 railroad network are taken from Duranton and Turner (2008) and are documented there. Further discussion of the 1947 highway plan is available in Michaels (2008) and Baum-Snow (2007).

While our exploration routes variable is new, Duranton and Turner (2008) experimented with a different formulation and found that it did not have much predictive ability. In this initial formulation of the exploration route data, we treated the exploration route map in exactly the same way as we did the 1947 highway plan and the 1898 railroad map. That is, all routes are treated in exactly the same way and receive exactly the same weight. In particular, this means that well used and important routes, such as the Oregon or Santa Fe trails, are given the same weight as less successful routes. With this said, since the exploration routes map provides a line for each expedition it describes, even if this line is very close to the line for another expedition on the same route, the map does permit us to distinguish more intensively used routes from less. In particular, if we digitize the map and count all pixels assigned to any route, we have a measure of the intensity with which a region was used by explorers between 1835 and 1850. This is precisely what we did. Figure 5 illustrates.

The share of the democratic vote in the 1972 presidential election is calculated from the General Election Data for the United States, 1950-1990, from the Inter-university Consortium for Political and Social Research (ICPSR).

E.. *Geography*

Our data includes five measures describing the physical geography of an MSA taken from the data used by Burchfield, Overman, Puga, and Turner (2006). The particular measures of physical geography that we use are: elevation range within the MSA, the ruggedness of terrain in the MSA, heating degree days, and cooling degree days and 'sprawl' in 1992. Elevation range is the difference in meters between the elevation of the highest and lowest point in the MSA. Ruggedness is calculated by imposing a regular 90 meter grid on each MSA and calculating the mean difference in elevation between each cell and adjacent cells. Heating and cooling degree days are engineering measures used to assess the demand for heating and cooling. Sprawl is the measure of sprawl calculated in Burchfield *et al.* (2006) and measures the share of undeveloped land in the square kilometer surrounding an average structure. More detail about these variables is available in Burchfield *et al.* (2006) and at `http://diegopuga.org/data/sprawl/`.

F.. *Employment*

To measure employment we use the County Business Patterns data from the US Census Bureau. These data are available annually from 1983 to 2003. We construct disaggregated employment data at the two digit-level (with 81 sectors) to investigate whether the supply of interstate highways and other major roads affects the composition of economic activity and, in particular, employment in transportation-intensive sectors. Between 1983 and 2003, three different industrial classifications have been used in the US: the standard industrial classification (SIC) which remained unchanged at the two-digit level until 1997, the 1997 North American Industry Classification System (NAICS) from 1998 to 2002, and the 2002 NAICS for 2003. Using the same cross-walk as in Duranton and Turner (2008), we perform our employment regressions using SIC categories.

G.. *Public transit infrastructure*

To comply with Section 15 of the Urban Mass Transportation Act, all public transit districts in the US submit annual reports to the federal government detailing their assets and activities over the course of the year. Our data for 1984 bus service comes from table 3.6, p3-308, of United States Department of Transportation, Urban Mass Transit Administration (September 1986). The section 15 reports are available in electronic form starting in 1984. While these reports do not assign transit districts to an MSA, they contain enough geographic information, e.g., zipcode, so that about 700 of the 740 transit districts that operate during 1984, 1994, or 2004 can be assigned to a non-MSA county or to an MSA.

With this correspondence constructed, we count all 'large buses' in each MSA at peak service for 1984. We use this daily average number of large buses operating at peak service in 1984 to measure an MSA's stock of public transit infrastructure. In our definition of large buses we include buses in the following Section 15 reporting classes: articulated bus; bus A (>35 seats); bus B (25-35 seats); bus C (<25 seats); double deck bus; motor bus; motor bus (private); street car; trolley bus.

H.. Socio-economic characteristics:

To measure MSA socio-economic characteristics, we use three data sources. The share of manufacturing employment is computed from the County Business Patterns for 1983, 1993, and 2003 to match the years of data for VKT and roadway. The 1980 segregation index is calculated from 1980 census tract level data and is based on the measure of housing segregation described in equation (3), p. 836 of Cutler and Glaeser (1997). Finally, the share of college educated workers, share of poor, and average earnings are computed using data from the 1980, 1990, and 2000 decennial censuses. From the education questions in these three censuses, we are able to build a consistent variable capturing the share of residents with some college education (or more) by MSA. The three censuses also contain a question about poverty which can be aggregated in the same way. Individual earnings are also aggregated in a similar fashion with the caveat that the bands and the top code differ across censuses.

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Jennifer Burdick - Panda Buffet demolition, Guest Opinion attached

From: <JMAHERJRAIA@aol.com>
To: <mayor1@tucsonaz.gov>, <Karin.Uhlich@tucsonaz.gov>, <Ward6@tucsonaz.gov>
Date: 2/3/2014 7:54 AM
Subject: Panda Buffet demolition, Guest Opinion attached
CC: <JMAHERJRAIA@aol.com>, <Jennifer.Burdick@tucsonaz.gov>
Attachments: 1PANDA~1.PDF

2/3/14

Subject/Project:
Panda Buffet demolition, Guest Opinion attached

Mayor Rothschild
Ms Uhlich, Council Member
Mr. Kozachik, Council Member

Dear Mayor Rothschild, Ms. Uhilch, and Mr. Kozachik,
Please review the attached Guest Opinion, my personal opinion, for your information and understanding for the preferred demolition of this building.

I can not attend the Study Session scheduled for tomorrow.

I have submitted this opinion to the Daily Star for their consideration.

If you have any questions, please contact me.
Thank you for your efforts for a better Tucson.

Sincerely Yours,

Joseph Maher, Jr. AIA
architect
3184757
Cc: Ms Jenn Burdick

Guest Opinion:
"Empathy for A Building"
Broadway's "Sunshine Mile": A "Panda" Design Discussion

As an architect, it's not unusual to have respect, adoration and even empathy for inanimate objects such as an excellently designed & important building.

For the Panda building, it's better that we create "lemonade" from this lemon.

The facts are:

The building is not historic nor important 'rchitectural design.

Restaurants are the most difficult to remodel for many design reasons including costs beyond the vandalism. In several locations, existing restaurants were demoed, replaced with new restaurants.

This building is too near the street right of way (ROW), which in this area is only eighty-feet (80) in width. Most boulevards contain a 100 foot or more ROW.

This building will probably be demolished for minimal improvements: a wider bike lane & sidewalk and street landscaping—all of these are missing and desperately needed to beautify the *Sunshine Mile* streetscape and historic buildings.

Apparently, City funds will be saved by the demolition, with the hope these are utilized more constructively at this site.

So how do we mix the "lemonade"?

In a brief meeting last week headed by Jennifer Burdick, Project Manager for the Broadway Corridor Committee and several interested individuals, many excellent, positive ideas were discussed on how to utilize resources saved to enhance the site temporarily or preferably permanently as part of the *Sunshine Mile.*

I look forward to final suggestions from Jennifer and this group.

However, *my design vision* is to place these enhancements at the west portion and/or southwest corner of the site, positioned to avoid a future ROW widening—preferably permanent---but retain the majority of the site for future improvements, which hopefully respect *Sunshine Mile's 'Rchitectural Design Integrity.*

Some of my favorite design ideas:

Install an historic signage on the site, similar to the famous El Con Mall sign.

Install a kiosk to display future events, activities and other *Sunshine Mile* information.

Provide bicycle parking for possible Neighborhood or Community events held on site or elsewhere.

Install large shade trees at the south edge which can be relocated if needed.

Create a plaza for seating and gathering.

Probably the most difficult is to relocate the bus stop & shelter to this site; these must be located a required distance from a street corner.

"How do we respect Sunshine Mile's 'Rchitectural Design Integrity?
These aspects would assist in a design vision, add to the Design Integrity:

The sign code limits installations of historic signs, and needs to be revised.

The *Sunshine Mile* nor the Broadway Corridor Project provides any "*'Rchitectural Design Guidelines"* to enhance the streetscape & building facades with cohesive, pleasing designs applicable to the *Sunshine Mile* and future construction.

Cash investments, donations or sponsorships by the Community and the *Sunshine Mile* businesses may be needed to supplement the city monies provided.

The existing zoning is inconsistent related to the existing buildings desired for retention.

Hence, the creation of a "district overlay" is critical to provide a path for building retention, shared parking, building & site architectural design guidelines, and incentives for design excellence.

The most enduring asset of the *Sunshine Mile* is the new respect for *"rchitectural Design* missing or misunderstood in our beloved Tucson.

Enduring design elements would increase protection for the adjacent Neighborhoods but also benefiting our entire Community in a vastly improved
"Boulevard of Dreams & Destinations*" in a future multi-modal corridor known as the *Sunshine Mile.

Fin

Please Note: This is my personal opinion.

Joseph Maher, Jr. AIA
Architect

"Great Design and Planning can solve any 'Rchitectural situation."

A local architect, UA Grad, AZ native, self proclaimed 'Richitectural Criti", active in several City of Tucson Citizen Committees; Liaison to the Broadway Corridor project from the City of Tucson Planning Commission; Executive Board Member, the Southern Arizona Chapter of the American Institute of Architects (SAC/AIA)

"Support for Reading, Riting, Rithmatic and Rchitecture can provide a path for Community Design success."

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