IPART New South Wales

Independent Pricing and Regulatory Tribunal

IPART’s review of public transport fares – role of externalities

Presentation to ITLS

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IPART’s approach to fare setting

- Past approach – annual process
  - incremental changes to costs and cost shares
  - declining rate of fare cost recovery – external benefits increasing?
- CityRail review completed in late 2008
  - medium term price path
  - efficient cost build up
  - appropriate funding shares - externalities

CityRail review – treatment of externalities

- IPART considered clear link between appropriate funding shares and external benefits
  - Govt funding match the external benefits
- Engaged Mike Smart from LECG to provide advice
- LECG's report provides detail on total and marginal external benefit
- Total benefit (2006/07) - $1.5 bn
- Marginal benefit - $5.20 per pj

CityRail review – treatment of externalities

- Two possible approaches:
  - Total external benefits
  - Marginal external benefits
- IPART adopted total approach
  - consistent with cost information – building blocks
  - average value of external benefits per pj
  - used this to assess appropriate funding shares - 70% taxpayers/30% users
  - used to set maximum fares
  - also provide basis for future decision making

LECG’s findings

- Adopted LECG’s estimate of external benefits
- Had regard but did not apply LECG’s optimisation/marginal approach
- Uncertainties on marginal cost estimate

Context for public transport fare reviews

- Source of Govt subsidies – taxes and other exp
- Fare structure rail – flagfall and per km charge consistent
- Fare harmonisation – buses
- Bus contract system – fare revenue goes to Govt
- Govt fares policy – eticketing

Bus review process

- IPART commenced fare review – new fares 1 Jan 2010
- IPART has made no decisions on external benefits and LECG’s work
- Released issues paper and LECG’s report
    - Submission due 24 June

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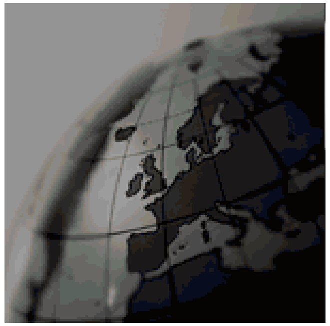

Value of public transport externalities and optimal Government subsidy

May 2009

Mike Smart (LECG),

Eric Groom and Aaron Murray (IPART)

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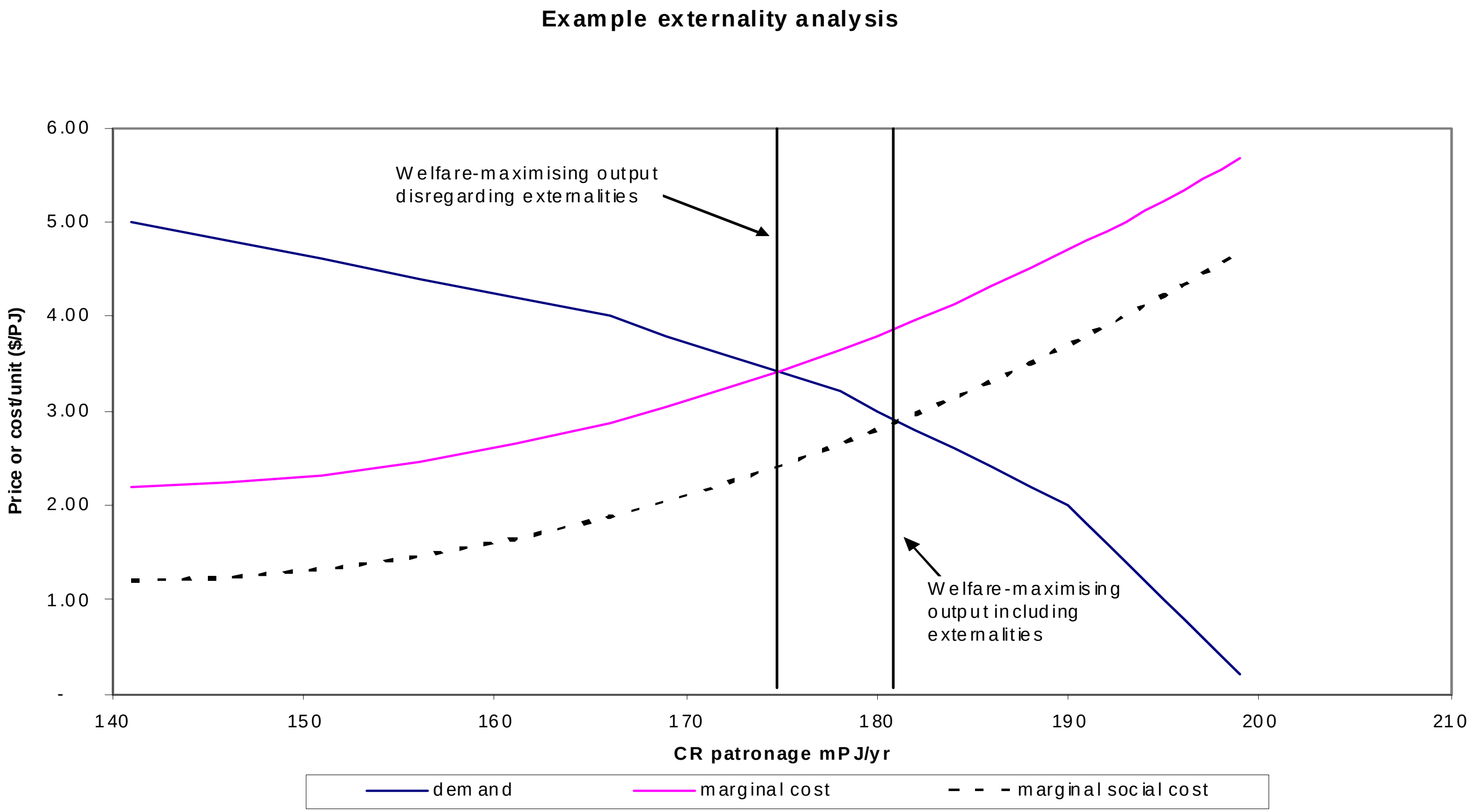
Outline

- Optimisation
- Nature of externalities
- Displacement of road traffic
- Congestion
- Emissions
- Accidents
- Marginal external benefit
- Outcomes

Optimisation – conceptual approach



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Optimisation scheme

$$\partial W/\partial q = (1+d)[p - MC(q)] + meb(q) + d\, q\partial p/\partial q = 0$$

To solve for optimal p, q, need to know:

- Public transport demand schedule: $q_{PT}(p)$
- Marginal cost, $MC(q_{PT})$
- Modal substitution relations: $q_{car}(q_{PT})$
- Marginal external benefit, $meb(q_{car})$
- Marginal excess burden of taxation, “d”

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Considered in depth today …

- External benefits of public transport:
  - Congestion
  - Pollution
  - Accidents
- Effect of these externality estimates on optimal prices for buses

Nature of externalities

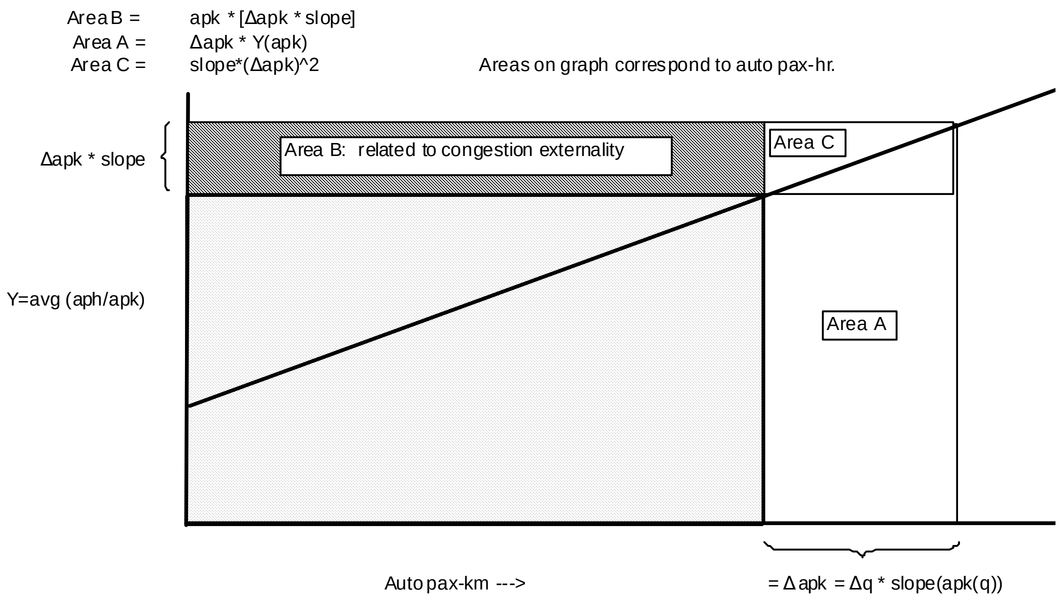
- **Externality is a cost or benefit to a party other than the buyer or seller of a service that is not priced in;**
- **1st type: disbenefit to inframarginal motorists**
  - **Example: congestion**
  - One more car joining crowded road suffers delay
  - The new car delays all others
  - Only the delay to all others is an externality
- **2nd type: disbenefit to wider community (esp. non-motorists)**
  - **Example: air pollution**
  - Polluter may suffer ill health from atmospheric smoke, lead, etc
  - Non-drivers may also suffer ill health
  - Ill health of all sufferers except the polluter is an externality
- **External benefit is generated by public transport <u>usage</u>, not mere availability**

Disbenefit to inframarginal motorists

Only shaded area is an externality.

Other areas are private costs to the switching motorists.

If slope of line=0 then marginal externality = 0.

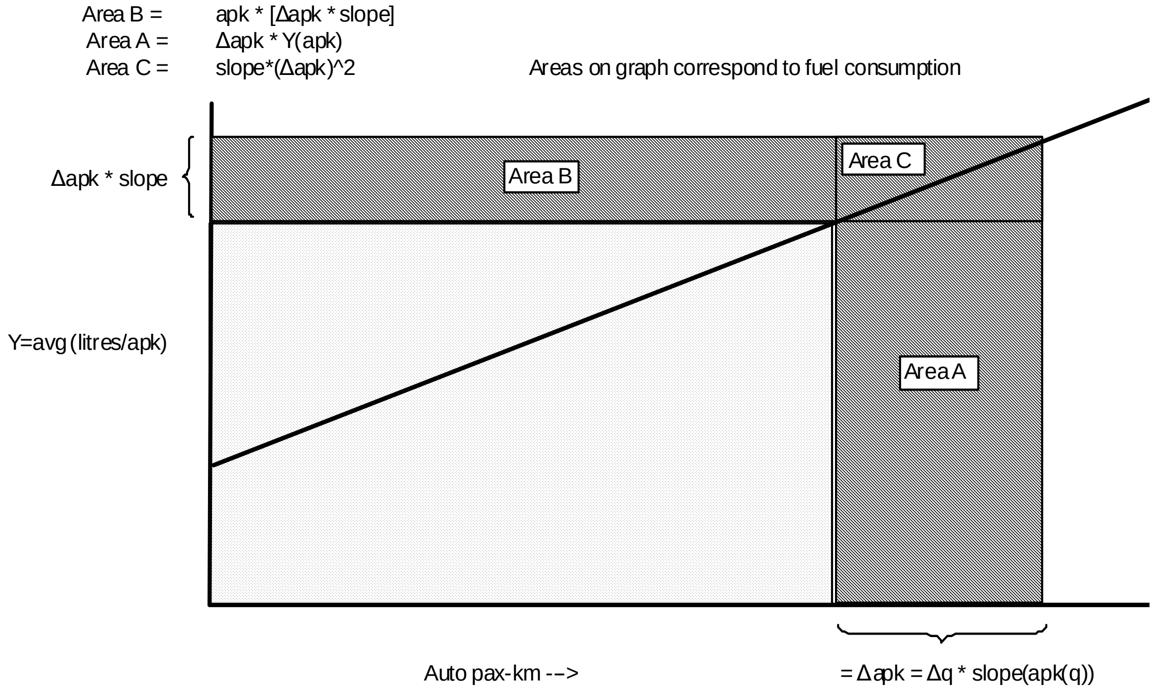


Disbenefit to wider community

Whole shaded area is an externality.

Even if slope = 0, marginal externality > 0 as long as y-int>0.

Examples:
•GHG
•Air pollution
•Accidental injury to non-car-occupants
•Lost labour



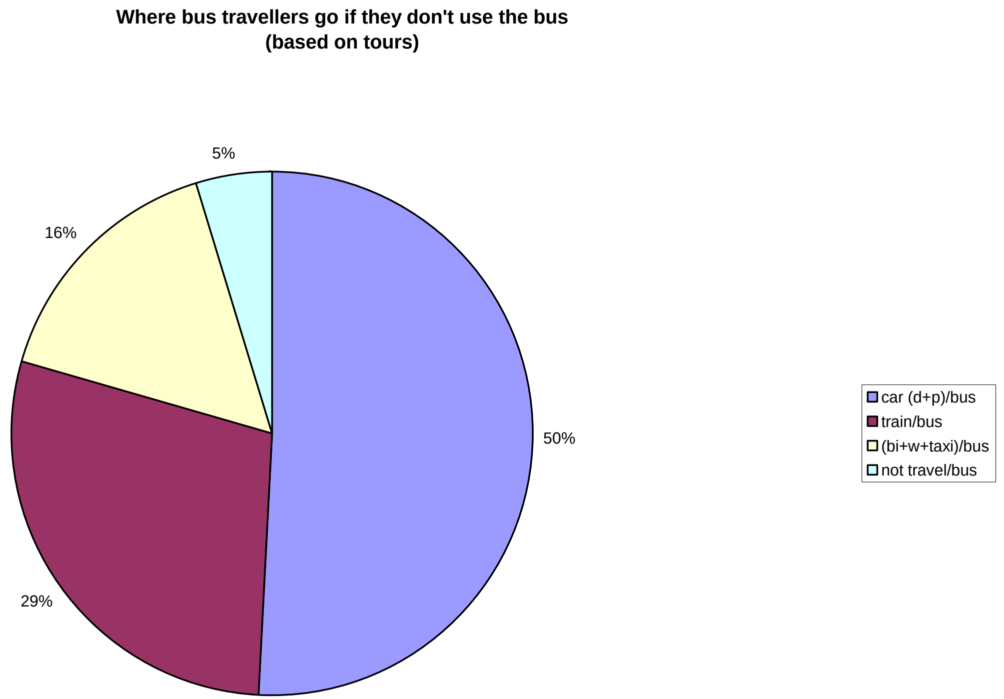
Displacement of road traffic—method

- Transport Data Centre was commissioned to do several runs of Sydney Strategic Travel Model to assess impact on road traffic (cars and buses) and rail patronage of changes to bus patronage;

- SSTM takes into account time of day and specific Sydney road layout;

- Measured price sensitivity of travellers, waiting and walking time for public transport are taken into account.

Where displaced bus journeys go



TDC model runs permit quantitative estimate of substitution effect between buses and cars or trains.

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Congestion – Value of Time

- **Congestion costs depend on the value of travel time**
- **VOT is related to average hourly wage = $28.80 (Feb 08 est)**
- **Literature reveals dispersed values for VOT/wage**
- **BTE OP51 provides range of study values:**
  - Median of commuter time VOT/wage = 35%
  - Median of business travel time VOT/wage = 76%
- **Range adopted for sensitivity testing: $9.23/hr - $22.60/hr**
- **Central case value adopted = $15.80/hr**

Congestion – cars

Congestion reduces average speeds, increasing the average hrs/km travelled. Longer time per journey is a cost to motorists. Assume quadratic relationship:

aph(apk) = A (apk)2 + B apk + C

Coefficients A, B, and C are estimated as follows. Since aph(0) = C = 0.
The ratio (aph/apk), given by:

aph/apk = A apk + B

must be equal to 1/60 km/hr, when apk = 0. Therefore, B = 0.01667 hr/km.

Let Y0 = aph at 2006 and X0 = apk at 2006.

Y0/X0 = A X0 + B

=> A = (Y0/X0 – B)/X0

Assumed speed—fuel consumption relationship

Fuel consumption rates are averages across all vehicle types: city and highway values shown in yellow.

Other values derived by interpolation, and extrapolation, based on expected "U-shape".

Linking consumption to car speed permits the congestion effect on fuel consumption (and associated emissions) to be measured.

Speed band km/hr		litres fuel consumed by cars / vkm
min	max	
0	5	0.321
5	10	0.285
10	15	0.250
15	20	0.215
20	25	0.179
25	30	0.144
30	35	0.108
35	40	0.104
40	45	0.101
45	50	0.097
50	55	0.094
55	60	0.090
60	65	0.086
65	70	0.083
70	75	0.079
75	80	0.076
80	85	0.072
85	90	0.072
90	95	0.072
95	100	0.072
100	105	0.072
105	110	0.072

Emissions – GHG

- Assumed CO_2 emission rate = 2.64 kg CO_2/litre
- $25/tonne CO_2 carbon price assumed, but lower values could have been used
- NSW Greenhouse Abatement Certificate price around $12/t$CO_2$e
- Under a national emissions trading scheme price may be around $10/t$CO_2$e

Emissions—air pollution

- **British literature survey** (Maddison, Pearce, Johansson, Calthrop, Litman, Verhoef 1997) presents estimates of marginal external health costs from conventional air pollution expressed per litre of fuel.

- **Their approach was applied to Australian data for 2002 (Beer, 2002).**
  - $1.24/litre unleaded petrol
  - $1.36/litre diesel

Accidents – approach

- **Idea is that by reducing car usage, buses reduce the likelihood of traffic accidents.**
- **Two complications in measuring this effect:**
  1. Accident costs borne by (motorist) accident victims are not external, and insurance further internalises most costs
  2. Under congested conditions, there are likely to be fewer accidents per vehicle km and less severe accidents.
- **Therefore, marginal external accident costs are probably small, hard to measure, and possibly unfavourable to bus.**
- **Internal accident costs should in theory be taken into account when motorist compares bus fare with cost of driving.**

Internal and external accident costs

Total accident costs are estimated in BTE report 102.

A suggested split between internal and external is given here.

It is the marginal external benefit from accident reduction that is relevant to the PT fare/subsidy split.

Many costs are borne internally by motorist either directly or through insurance.

Source of total costs: BTE report 102 "Road Crash Costs in Australia" p. xi

Note All figures in $m 1996 dollars	Total	guessed	internal	external	who bears cost?
Human costs $million	cost	% internal	cost	cost	
Medical/ambulance/rehabilitation	361.00	100%	361.00	-	
Long-term care	1,990.00	100%	1,990.00	-	motorist or passenger
Labour in the workplace	1,625.00	0%	-	1,625.00	employer *
Labour in the household	1,494.00	0%	-	1,494.00	family members *
Quality of life	1,769.00	100%	1,769.00	-	
Legal	813.00	100%	813.00	-	motorist or passenger
Correctional services	17.00	0%	-	17.00	taxpayer
Workplace disruption	313.00	0%	-	313.00	employer
Funeral	3.00	100%	3.00	-	motorist or passenger
Coroner	1.00	0%	-	1.00	taxpayer
Vehicle costs					
Repairs	3,885.00	100%	3,885.00	-	
Unavailability of vehicles	182.00	100%	182.00	-	
Towing	43.00	100%	43.00	-	motorist or passenger
General costs					
Travel delays	1,445.00	0%	-	1,445.00	inframarginal motorist
Insurance administration	926.00	100%	926.00	-	motorist or passenger
Police	74.00	0%	-	74.00	taxpayer
Non-vehicle property damage	30.00	100%	30.00	-	motorist or passenger
Fire and emergency services	10.00	0%	-	10.00	taxpayer
Overall total	14,980.00		10,002.00	4,979.00	
	TOTAL		Internal	External	
1996 b vehicle km	166.45		166.45	166.45	
avg cost $/vehicle km	0.09		0.06	0.03	
avg cost $/auto pax km	occupancy	1.10	0.0546	0.0272	
avg cost savings $/bus pax journey	apk/bpj	5.42	0.296	0.147	

Accidents – conclusions

- **The marginal external accident benefit is small and hard to measure.**
- **More public transport patronage means less congested roads, which means higher average car speeds.**
- **Higher car speeds mean greater likelihood of accident per vehicle km and more severe accidents on average.**
- **While the total number of accidents may be higher with reduced public transport, accident rate per passenger km will be lower.**
- **Upper limit to value of accident externality is approx 15 cents/BPJ—10% of total external benefit.**
- **Avg calculation probably overstates lost labour externalities—BTE assumed whole life loss of labour (full employment assumption is implicit).**
- **Traffic delay externality may also be overstated—only effect on inframarginal motorists is an externality.**

Other externalities

- Analysis has focused on congestion, emissions, and accident externalities.
- Other externalities are often discussed but hard to quantify (agglomeration economies).
- Land value effects are arguably part of consumer surplus, rather than a true externality.
- Some types of externalities (equity of transport access) involve distributional issues, and others (amenity) involve subjective judgements.

Marginal external benefits—buses

Marginal external costs ($/BPJ)

	work trips									
BPJ/workday	auto VOT	CRF train VOT CRF	bus VOT	auto GHG	auto airpol	auto fuel	bus GHG	bus airpol	bus fuel	mec
-	- 1.07	-	-	- 0.03	- 0.52	- 0.03	0.00	0.19	-	- 1.46
50,000	- 1.06	-	-	- 0.03	- 0.52	- 0.03	0.00	0.19	-	- 1.45
100,000	- 1.05	-	-	- 0.03	- 0.52	- 0.03	0.00	0.19	-	- 1.44
150,000	- 1.05	-	-	- 0.03	- 0.52	- 0.03	0.00	0.19	-	- 1.43
200,000	- 1.04	-	-	- 0.03	- 0.52	- 0.03	0.00	0.19	-	- 1.42
250,000	- 1.03	-	-	- 0.03	- 0.52	- 0.03	0.00	0.19	-	- 1.42
300,000	- 1.02	-	-	- 0.03	- 0.52	- 0.03	0.00	0.19	-	- 1.41
400,000	- 1.01	-	-	- 0.03	- 0.52	- 0.03	0.00	0.19	-	- 1.39
500,000	- 0.99	-	-	- 0.03	- 0.52	- 0.03	0.00	0.19	-	- 1.38
600,000	- 0.98	-	-	- 0.03	- 0.51	- 0.03	0.00	0.19	-	- 1.36
700,000	- 0.96	-	-	- 0.03	- 0.51	- 0.03	0.00	0.19	-	- 1.34
800,000	- 0.95	-	-	- 0.03	- 0.51	- 0.03	0.00	0.19	-	- 1.33

Comparison to prior studies

	Total external benefit $m/yr		Total external benefit $/pax journey		
Source of benefit	**STA buses**	**Metro buses**	**STA buses**	**Metro buses**	**CityRail**
Avoided road congestion	176.0	236.8	1.07	1.03	4.94
Net Avoided air pollution	37.3	75.8	0.23	0.33	1.61
Net Avoided greenhouse gas	3.2	6.1	0.02	0.03	0.09
Avoided noise pollution	-	-	-	-	-
Avoided road accidents	-	-	-	-	-
Avoided road damage	-	-	-	-	-
Total net external benefits	216.5	318.7	1.32	1.39	6.64

Optimisation results—bus

Sensitivity result table									
			$/BPJ	$/BPJ	pax/workday	$/workday	$m/yr	% fare	$m/yr
case name	reg name	d	p0	p*	q*	W* - W0	W* - W0	increase	GC*
sf low MC	MBSC	0	1.51	0.64	1,329,061	156,583	39.15	-58%	697.06
sf low MC	MBSC	0.1	1.51	0.88	1,154,602	63,679	15.92	-41%	581.46
sf mid MC	MBSC	0	1.51	1.15	1,033,840	20,626	5.16	-24%	510.78
sf mid MC	MBSC	0.1	1.51	1.51	919,398	0	0.00	0%	405.61
sf high MC	MBSC	0	1.51	1.68	878,708	3,615	0.90	11%	360.48
sf high MC	MBSC	0.1	1.51	2.15	791,549	42,302	10.58	42%	259.12
sf low MC	MBSC-hiVOT	0.1	1.51	0.54	1,429,829	202,303	50.58	-65%	760.00
sf mid MC	MBSC-hiVOT	0.1	1.51	1.11	1,047,222	23,738	5.93	-26%	522.59
sf high MC	MBSC-hiVOT	0.1	1.51	1.73	867,430	5,760	1.44	15%	347.73
sf low MC	MBSC-loVOT	0.1	1.51	1.27	990,468	7,936	1.98	-16%	461.88
sf mid MC	MBSC-loVOT	0.1	1.51	1.91	831,342	17,705	4.43	27%	318.49
sf high MC	MBSC-loVOT	0.1	1.51	2.56	734,680	103,336	25.83	69%	188.96
sf low MC	4 largest regions	0	1.47	0.90	807,334	44,293	11.07	-39%	353.39
sf low MC	4 largest regions	0.1	1.47	1.18	718,943	8,452	2.11	-19%	283.09
sf mid MC	4 largest regions	0	1.47	1.28	697,243	4,236	1.06	-13%	268.96
sf mid MC	4 largest regions	0.1	1.47	1.67	623,009	3,444	0.86	14%	192.30
sf high MC	4 largest regions	0	1.47	1.67	622,808	3,903	0.98	14%	188.31
sf high MC	4 largest regions	0.1	1.47	2.18	558,355	36,433	9.11	48%	106.33

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